Exploring the text free interface for illiterate users

Designing an icon-based prototype for mobile phones

by

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Spring 2010

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Abstract: This study explores the topic of interfaces for illiterate users, and more specifically how an icon-based interface for a mobile phone can be implemented to support such users. The thesis will introduce previous research done at this field, and what is included in the process of making interfaces that have no text. Discussion around theory reveals factors that must be considered when designing icons for such an interface. Drawings were collected from illiterate persons, which are used in the development of a prototype that aims at giving a concrete answer to the research question. Heuristic evaluation of the prototype follows the design, revealing errors with the prototype.

Results from evaluation indicate that these factors can help a user understand new icons: concreteness, low complexity, balanced level of details and use of action elements. Evaluators also identified low complexity and consistency as positive when interpreting the icons. Use of hands manipulating objects in the icons, providing the icons with a context, was introduced based on drawings gathered in this study, and received positive feedback from evaluators.

Conclusions from evaluating the prototype further underlines the superiority of concrete over abstract icons in terms of being intuitive. It was also discovered that evaluators relied a great deal on their expectations of where to find functions when testing the interface. The need for an icon-based help function is present in text-free interfaces, until the icons are truly intuitive. Further testing and gathering of data is required to make sets of icons that represent the intended meaning regardless of the user's cultural background.

Acknowledgements

Writing a master thesis is a comprehensive task. While there have been many good times, there have also been those filled with frustration.

I would like to thank my supervisor through the process of writing this master thesis, Frode Guribye. Special thanks go to Ingerid Rødseth for help with the early work with the thesis and inspiration.

Without the help of people involved with the institutions visited in the search for new data, it would not have been possible to develop the prototype.

Last, thanks go out to my family and friends.

Table of content

List of figures

List of tables

1 Intro

Mobile phones are a part of everyday life. They support verbal and textual communication, allow playing games, making schedules and listening to music. Most of the mobile phone interfaces today are based on textual menus and descriptions that you need to read in order to understand the icons or functions connected to them. For most people, that is not a problem. However there are about 759 million adults in the world today who can't read or write (UNESCO, 2010), and thus are unable to take proper advantage of mobile phones. To allow this portion of the world's population to get the same benefits from mobile phones that textually literate people do, specially adapted mobile phones must be made.

Designing mobile phones for illiterate users is a means of allowing them to get the same benefits from mobile phones as literate users. We talk about the same benefits, not use of mobile phones, because illiterate people use mobile phones, although often limited to functions like answering calls and turning on the phone. The mobile phone is not the same tool for an illiterate person, because it can't be used as a phonebook, a way to store shopping lists, remember appointments, or sending textual messages. By designing for the illiterate users, it may be possible to open up more of these functions to them. Telecommunication and technology expert Tomi Ahonen predicts an increase of mobile phone usage in developing countries, and a doubling of mobile phones in use on a world basis, from 4,3 billion subscriptions today, to over 8 billion in a few years. This growth will mainly come from developing countries, where the amount of mobile phone users is rapidly growing already. Many of the expected new users will be illiterate persons in need of adapted phones to fully benefit from the technology (NRK, 2009).

There are approaches towards making technology for the illiterate, both computers and phones, taking advantage of oral guidance either from an instructor or from prerecorded material. The drawback of this approach is that the technology itself can't be used in noisy environments, it can only be used by those who understand the language of the recorded material, and obviously you can't have an instructor following you every time you want to use the phone. To solve this problem and allow illiterate people to use mobile phones independently, the technology must be made intuitive, so that any one user can pick it up and immediately understand how they can manipulate it to do what they want it do to. One approach towards this solution, which is the one that will be explored in this study, is to make text free interfaces for mobile phones. This requires us to re-think the icons used on mobile

phones today, which are not always easy to understand without reading the text that supplements it. Icons and images were long believed to be universally understood, but research has changed this view through studies indicating that members of different cultures interpret icons differently (Pappachan & Ziefle, 2008; Lalji & Good, 2008; Lansdale, 1988 in Schröder & Ziefle, 2008).

Never the less, Schröder & Ziefle (2008) argue that text free interfaces enable the user to perform operations more quickly than with textual. This means that in addition to enabling the illiterate to use mobile phones, the text free interfaces can be useful to literate users as well.

The goal of this study is to explore the text free interface, and to make a prototype of an icon based menu for mobile phones that can support illiterate users through an interface that does not require reading skills to understand or use. The research question to be answered is:

How can an icon-based interface for mobile phones be designed to support use by illiterate people?

In order to do this, there will first be an introduction of research that is done in the field of text free user interfaces, and topics concerning digital literacy to establish an understanding of why an interface like this is helpful, and to limit the field of knowledge touched by this study. Chapter three will describe the research design; discussion about the approach to answering the problem of the study. Following this, there will be a discussion leading to development of the prototype. Chapter four will introduce the design phase of the prototype, from the first iteration to the last, leading to a heuristic analysis to determine whether the interface prototype is according to the guidelines. Finally, chapter six has conclusions and discussion regarding future research.

2 Research area and literature review

In this chapter there will be an introduction to previous and ongoing research in the fields relevant to this study. Previous studies include attempts to create a sign language that can be learned and used across cultural and lingual borders (Bliss, 1965), efficiency measuring of textual versus iconic menus for mobile phones (Schröder & Ziefle, 2008), non-textual interfaces for mobile phones and computers, and research looking specifically at how icons are interpreted by members of different cultures (Pappachan & Ziefle, 2008). Human-Computer Interaction will be presented, specifying the main topics of the field which will be the basis of this study's research. Digital literacy will be introduced in order to place this study in a setting, and to explain how it fits into the big context of products aiding "outside the norm"-users approach to technology. Research on illiteracy will be introduced to give a pointer of how large the potential user group that could take advantage of the results of this study is.

2.1 Icons and interaction

Icon is defined by the Oxford dictionary (2010) as "a devotional painting of Christ or another holy figure, typically on wood, venerated in the Byzantine and other Eastern Churches." We see that even back then, icons were images with meaning. When used in modern technology, icons are pictures, often small and linked to a button on some device. On mobile phones and personal computers you see them all the time, telling you where to click to open the phonebook or a word processing application of your choice. Over time you recognize an icon just from its features, be it color, shape or the pictured object, without having to read the text underneath it. But what if you received a new mobile phone with icons you had never seen before, and there was no accompanying text to describe them. Would you then be able to use the phone as you wanted to? This is where the challenge lies when it comes to making text free interfaces: designing icons that are descriptive enough to let you understand what they are trying to tell you the first time you pick it up.

An important part of understanding and analyzing visual content is to find the meaning it represents. This task is challenging because people are subjective, and though they might see the same visual features in an image, they will interpret it in different ways. In turn, the validity is reduced when there is not only one specific result of a visual analysis. Reading an image beyond the pictured object itself is especially important when analyzing icons and symbols, as is explained below.

Iconography is divided in three layers: representational meaning, iconographical symbolism and iconological symbolism (van Leeuwen & Jewitt, 2001). Representational meaning is what we recognize from presented graphic based on our practical experience, and includes such as understanding gestures depicted, i.e. a man lifting his hat is a form of greeting, and that medieval paintings showing humans and animals floating in the air isn't trying to tell us that in those days, man could hover. Iconographical symbolism is described by Panofsky (1970:54) as symbols, or combinations of symbols, that act as standardized representations of concepts. A male figure with a knife represents St. Bartholomew, and a dove represents peace. Iconological symbolism, on the other hand, is not based around standardized symbols representing a specific person or phenomena, but rather the meaning that we can draw from an icon by ourselves, and is in many cases not intended by the artist. On the contrary, a specific symbol can also be used as a signature for one artist, where they include a specific object in every artwork they create.

There are many suggestions as to how icons can be grouped further, most of them using three or four categories. Rogers' (Rogers, 1989) approach has the categories resemblance, exemplar, symbolic and arbitrary. The first category, resemblance, has icons that picture something from real life, like the road sign for "Rocks falling", which shows just that – rocks tumbling down a hill. The exemplar category uses icons that picture something typical for what it represents, like a knife and fork to symbolize restaurant. Symbolic icons picture something at a different abstract level than the physical object itself, like a broken wineglass on a box with fragile content. The final category Rogers describes is arbitrary icons. These icons have nothing to do with their real life counterparts, and require you to learn them in order to understand them. One of the common symbols for peace, a white dove, is an example of this.

There have been attempts to create universal languages for use across cultural and lingual borders, consisting purely of symbols instead of text.

2.2 Universal languages

Semantography was presented by Charles Bliss between 1942 and 1965 (Bliss, 1965). This is a language with symbols that have a meaning on their own, and can be combined with other symbols to make words and sentences. For instance combining the symbol for man and tree would together mean park. Children testing this language were reported to write and

understand sentences without an hour after being presented with it. Some of the symbols are self explanatory, but most require learning to understand. As quoted from the book "Semantography", showing how Bliss visions Semantography as a language truly logical to anyone (Bliss, 1965, p. 8):

> "**No-noe argues to-day** whether 2 + 2 = 4 or perhaps 5. Later generations with a little training in this new "Algebra of Thought" will instantly recognize any illogic, ambiguity, fallacy and demagogy in any statement they hear, or read, or think".

Figures 2.1 and 2.2 shows examples of symbols used in Semantography.

Figure 2.1 - "Semantography" by C. K. Bliss (1965) p. 47.

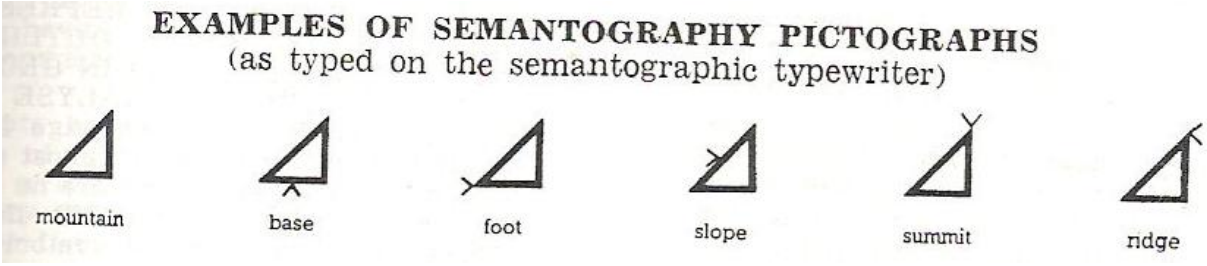

Figure 2.2 – "Semantography" by C. K. Bliss (1965) p.39.

A second language, the International System Of TYpographic Picture Education (ISOTYPE), consisted of more real life like icons, like the one in figure 2.3 which symbolizes car. ISOTYPE was invented by Otto Neurath in the early 1920's, and was hoped to be a global standard, "uniting humanity through one ordered, universally readable language of vision" (Lupton, 1986, p. 47). Neurath's idea behind the pictorial language was that images of things could never be differently interpreted because then you would see the things as they really were, unlike text or words describing the things, which were subjective, thus being less suited for education. ISOTYPE never got a broad use as a language, but is used in modern road signs and for representing statistics, as well as appearing as part of educations within artistic subjects. The symbols are very concrete, which makes them easy to understand. In the setting of making intuitive icons, concepts from ISOTYPE become present. For example the idea that images of real things can never be subjective is similar to that of using concrete depictions in

icons to reduce the chance of them being misinterpreted (Pappachan & Ziefle, 2008; Schröder & Ziefle, 2008; Rogers, 1989).

Figure 2.3 – ISOTYPE car.

While Semantography requires learning to understand, ISOTYPE is an example of the opposite; concrete depictions that are intuitive to the user because of their resemblance to the real world. Semantography uses principles that are today adapted as tools for icon design, which is addition of elements to change their meaning (Heim, 2008), like the numbers in figure 2.1 and the indicators in figure 2.2.

2.3 HCI

Human-computer interaction as a field of study is not easily defined, because it uses theory from many fields, such as computer science, behavioral science, psychology, anthropology, organizational science and more.

> Human-computer interaction is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them.
>
> (Hewett, et al., 1992, p. 6)

This definition gives an overview of the field, without further specifying all factors involved. In all simplicity, HCI studies the interaction between one or more humans and one or more computers or computational devices. This study falls under the HCI category, as it aims to make a design that is used by humans while interacting with a mobile phone, and it includes computer science, with the making of a prototype, and anthropology, which is the study of how humans behave; in this context how they interpret pictorial meanings. Anthropological questions will not be answered in this study, though, as this is an entire field of its own. Therefore anthropological factors will for the most part be answered through research that has already been performed, where the results were relevant to the questions that need to be answered in this study.

2.3.1 Interaction design

To explain the term interaction design, we start by looking at interaction separately. Interaction is the action of interfering or with, or using something, be it a VCR player, a mobile phone or a ballpoint pen. Interaction design is the art of designing an interface to have as good usability as possible. Reece, Rogers & Sharp (2002, p 6) defines it as:

> "Designing interactive products to support people in their everyday and working lives"

This differs from the earlier engineering point of view, which was to make solutions that worked, without incorporating the user factor. Acknowledging the different needs and ways of use between different users is an important aspect of interaction design, making its values appropriate for this study, where the goal is to make an interface for a specific user group. Usability goals include:

- Effectiveness
- Efficiency
- Safety
- Utility
- Learnability
- Memorability

Effectiveness refers to how good the system is to do what it is supposed to be doing. Efficiency is how good the system is to support the user in performing their tasks. Safety can include both physical hazards when using the system, as well as the risk of making mistakes causing loss of data or unexpected behavior. Utility means whether the system provides the right functions for the user to perform their tasks. Learnability refers to how easy it is for the user to learn how to use the system. Last, the memorability goal is how easy the system is to remember once it is learned. As well as the usability goals, interaction design includes goals concerning user experience. The user experience goals relevant to this context are "helpful" and "rewarding".

Design principles of interaction design are a set of prescriptions for use by designers in the creation process of interfaces. The principles in themselves do not provide specific solutions,

but instead act as reminders of what should be thought of in the design process. Here are the design principles as described by Reece, Rogers & Sharp (2002, p. 21-25)

- Visibility
- Feedback
- Constraints
    - Physical
    - Logical
    - Cultural
- Mapping
- Consistency
- Affordance

Visibility underlines the importance of keeping available options visible. Users are more likely to know what to do next if they can see the available functions, as opposed to having to dig through menus and submenus to find them. By giving the user feedback to their actions, be it a movement on the button to signalize that it has changed, or something to show the user what step of the process they are currently interacting with, they will know at all times where they are and how much is left of the process they are trying to complete. The feedback provided should also be in line with the user's expectation; a button should be pressed down when clicked. Constraints are limits that are set in order to prevent the user from making wrong choices or mistakes. Norman (in Reece, Rogers & Sharp, 2002) specifies physical, logical and cultural constraints. Physical constraints can be objects shaped in such a way that they only fit together if you put them down correctly, like hard drives. The example with grayed out menu options is an example of a logical constraint. Cultural specific constraints consist of arbitrary signs or symbols, and assume that the user knows the meaning behind it. Examples are red for warning and certain sounds signalizing danger. Mapping refers to the arrangement of controls in relation to the objects they affect. The example below shows an example of poor mapping, where it is difficult for the user to know what switch controls the correct plate on the stove.

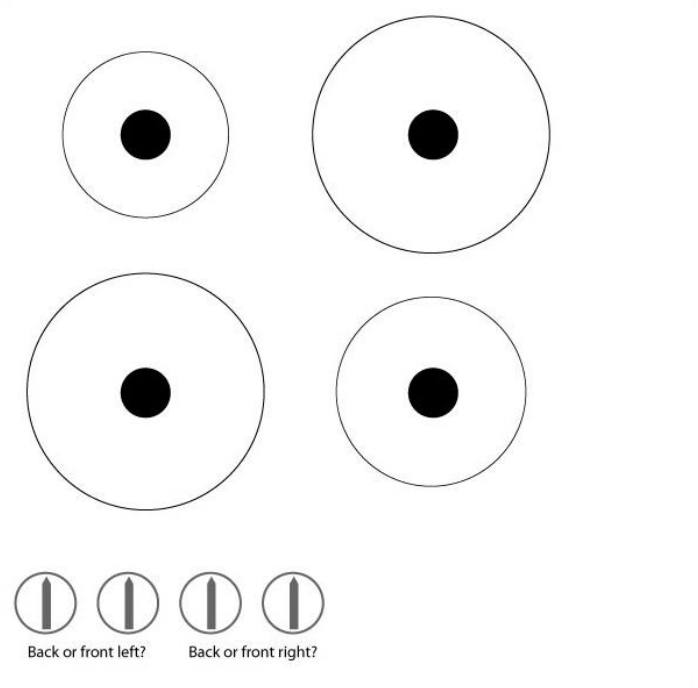

Figure 2.4 – Mapping on a stove (Interaction design blog, 2008).

Adding consistency to an interface lessens the amount of information the user has to learn. Placing a button on the same place whenever it is visible, like the return-button or the File-option in the menu, makes it easier to locate, and saves time for the user. The last design principle by Norman (ibid) is affordance. If an object is designed in such a way that users intuitively understand what to do with it, it has good affordance. An example can be mouse buttons or door handles; they afford pushing and pulling respectively.

2.3.2 Research methods in HCI

Due to the nature of the HCI field – across several fields – it is not possible to define a right way to execute projects. Every project needs to be adapted to the task at hand, taking into consideration which topics will be touched and who the target group is, before determining what approaches to use in regard to data collection and analysis, creation of artifacts et cetera. "*Research methods for Human-Computer Interaction"* (Cairns & Cox, 2008) introduces different approaches commonly used in HCI projects, such as ways of gathering data through controlled experiments, use of questionnaires and interviews and eye tracking devices. These methods are all very focused on communication with the user, who is in a valuable resource in this field. In addition to these approaches, use of video footage can be a helpful tool as it allows the data to be stored objectively, and analyzed by multiple researchers in a better way

than the subjective observations and reports of the person originally performing the observation. This method is yet very little used compared to its potential (Heath & Hindmarsh, 2004). Cairns & Cox (2008) also introduces topics regarding analysis of data; cognitive modeling, state charts and use of statistics to present both qualitative and quantitative forms of data.

Methods based on gathering information from end users, and involving them throughout the process, are referred to as user-centered approaches. Users can be involved in the early process of a project or take part of the design process themselves by evaluating prototypes of the product and complete it by making iterations based on user input. User-centered development is likely to increase the products acceptance amongst the final users (Preece, Rogers, & Sharp, 2002; Schuler & Namioka, 1993).

Involving end users in the early stage is a means of gathering requirements from them. By using observation or queries like questionnaires or interviews, the developers will get information straight from the source, and can have their input readily available during the whole development to make sure the end product is in line with the users' expectations and needs.

User involvement in the design phase is based on letting them test prototypes and early versions of the product to observe how it is used, and what areas might need change to be better suited for the actual users. It is, however, important to remember that users are not experts in software development or design, and their requests and suggested improvements are not necessarily good solutions for a given system. Heinbokel et. al (in Preece, Rogers & Sharp, 2002) found that projects with high degree of user involvement throughout a project lead to fewer innovations and lower overall success. They named these four factors for the limited success:

- Users developed more sophisticated ideas later in the project which they wanted incorporated in the design
- Users were afraid of losing their jobs to the new system, and so their participation was not constructive
- Users were not sympathetic to the development process, and wanted to make major changes when the test phase was due

- User orientation in the designers may lead to higher aspirations, increasing the level of stress

These points show that even though users involved in the development process are a great resource to increase the chances of a product's success, their involvement should not be overdone, to an extent where they are allowed to override the professional developers' knowledge and experience in the field of system development and design.

2.3.3 Design science

Research within the information science discipline is, according to Hevner, March, Park, & Ram (2004) dominated by two paradigms: behavioral science and design science. Behavioral science springs out from the research methods used in natural science, where the goal is to develop and justify theories explaining or predicting phenomena within a certain field of research. In an organizational setting, researchers get the information they need from these theories, letting them know what has to be done in order to reach the desired goals. Design science, on the other hand, is based on engineering, and is seen as a problem solving paradigm. The goal here is to make artifacts as solutions to problems, defining the theoretical basis through a product instead of a theory (Hevner, March, Park, & Ram, 2004)

In the design science approach there is both a process and a product. The product is designed as a result of expert activities. The artifact is then evaluated, giving feedback about what is good or bad about it, telling the researchers what can be done to improve it, and gives further understanding of the problem. These steps are looped through until the artifact is made in a satisfying way. It is important that the researchers are creative and flexible enough to adjust their state of mind based on the results of the evaluations.

The design science research in information science produces two processes and four design artifacts (March & Smith, 1995). The processes are 'build' and 'evaluate', and the artifacts are 'constructs', 'models', 'methods' and 'instantiations'. During the mentioned processes an artifact is created as a solution to an unsolved problem, and its success is measured by evaluating how well it solves the problem the artifact was addressed at.

2.3.4 Prototyping

Prototypes are versions of the finished products with limited functionality, designed to test solutions and get feedback either from users or experts, who are able to see how the design

works in practice (Preece, Rogers, & Sharp, 2002). Prototypes come in many different variants; paper-based, electronic, interfaces with or without underlying functionality, programs with only a few bits of functionality working. In the case of the mobile phone interface developed in this study, prototyping helped see how the size of icons worked, and whether the elements were easy to recognize, amongst other things. Iterations went from low- to high fidelity prototypes throughout the process, which will be shown in chapter four.

2.3.5 Intuitive interfaces

In order to understand intuitive interfaces, intuition will be defined. Compact Oxford English Dictionaries (2008) define intuition as "the ability to understand or know something immediately, without conscious reasoning". Translated to this context, an intuitive interface is an interface that the user can understand immediately, without conscious reasoning. Bærentsen (2000, p. 29) further defines it "While operating the device, navigation and manipulation of the system interface should proceed without the need for conscious awareness of the sensory- motor operational aspects of the interface."

In Human-Computer Interaction, intuitive often refers to "easy to learn", and it is argued that there is no such thing as a truly intuitive interface, only familiar interfaces where understanding is based on the user's previous knowledge, from where they are able to link their knowledge with the interaction method, and operate the interface correctly (Raskin, 1994). There is no knowledge that everyone can be expected to have, because it varies between individuals and cultures. Because of this, the intuitive interface for illiterate users must be based on their recognition, and ability to see what the icons represent, and then understand the underlying functions.

In this study, the text-free interface will be explored; hence the icons themselves must communicate all the information necessary to understand what function the buttons serve. Intuitive will therefore be used as *being able to understand the function represented through the icon without any textual or verbal help*.

Benefits from having an intuitive interface are that users don't have to learn how to use the interface in advance, there is no need for guidance when performing tasks, and ideally there is no need for manuals or different versions with different languages. These factors will reduce development costs because translations take up manpower that in theory could be cut if there were no need for more versions than one.

Making an intuitive interface is more of a challenge when there should be no text present in the interface to help describe the components. Studies have given results indicating that icon-based interfaces are faster to use than their textual counterparts once they are learned (Schröder & Ziefle, 2008) opening up for wider use, and possibly also more research on the field of text free interfaces, which consequently may lead to better solutions for illiterate as well as literate users. This does, however, require that the interface components are understood by the user.

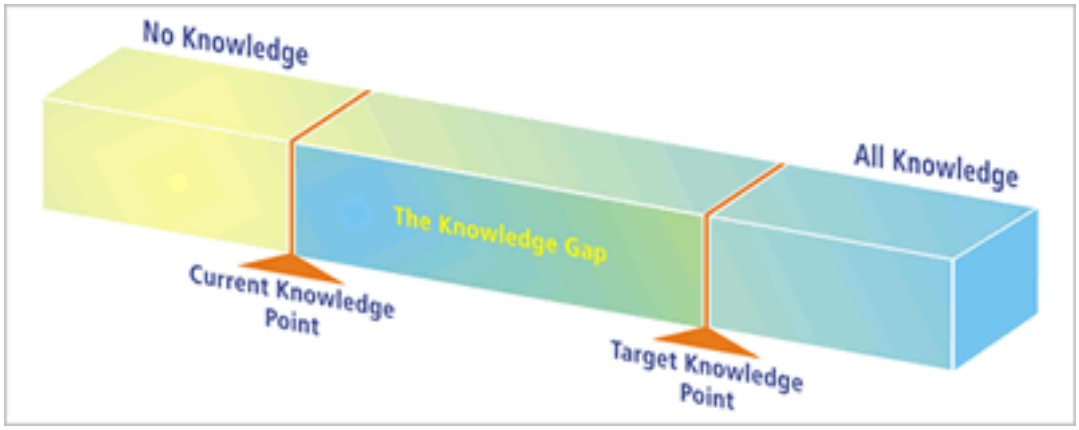

Figure 2.5 – The knowledge gap in intuitive interfaces (Spool, 2005).

Jared M. Spool (2005) uses the figure above to illustrate how intuitive interfaces work. Users are at the left side of the bar (without knowledge), and designers are on the right side of the bar (with all knowledge). The goal of the design is to close the gap between "Current knowledge point", which is what the users currently know, and the "Target knowledge point", which is the amount of knowledge the user needs to understand how to operate the interface. Available options for closing the gap are to train the users, or to reduce the knowledge needed by making less complex designs. When looking at the model in figure 2.5 the goal of this study is to close the knowledge gap by designing in such a way that the "Target knowledge point" is pushed far enough towards the left side to make the interface usable with little to no previous knowledge.

2.3.6 Heuristic evaluation method

Heuristics are design principles put to practice. When applied in the process of designing an artifact, they are combined with former experience and the right context, leading to a theoretically better result. Heuristics were originally a single set of guidelines for evaluating

screen-based products, but with time the need for heuristics specially adapted to evaluating mobile devices, collaborative technologies and more, became present (Preece, Rogers, & Sharp, 2002). When performing this kind of evaluation, it is estimated that the most beneficial number of expert evaluators is five. According to Nielsen & Mack (1994) this amount will reveal 75 % of all usability problems, and the cost of increasing the number of evaluators will not be proportional to the extra amount of errors that will be revealed, due to the high amount of redundancy between evaluators. Expert consultants are adopting this technique, thus being able to evaluate products by themselves. Heuristic evaluation is sometimes referred to as discount evaluation because it is inexpensive compared to other evaluation methods; there is no need for users or special facilities to perform this kind of evaluation.

A heuristic evaluation has three stages: briefing session, evaluation period and debriefing session. Briefing the testers makes sure they all get the same information, and debriefing is a session where finds are discussed, and solutions are suggested. How the evaluation period looks depends on whether the artifact being evaluated is a functioning product or not. In the case of evaluating a functioning product, as with the prototype being evaluated in this study, specific tasks should be made, giving testers something concrete to look for, and to see how the product runs in the intended environment (Preece, Rogers, & Sharp, 2002). This method allows testers to use the product in the right context, giving a better impression of its functionality than an evaluating looking at each part individually.

	Advantages	Disadvantages
Heuristic evaluation	Identifies many more problems Identifies more serious problems Low cost	Requires UI expertise Requires several evaluators
Usability testing	Identifies serious and recurring problems Avoids low-priority problems	Requires UI expertise High cost Misses consistency problems
Guidelines	Identifies recurring and general problems Can be used by software developers	Misses some severe problems
Cognitive Walk-through	Helps define users' goals and assumptions Can be used by software developers	Needs task definition methodology Tedious Misses general and recurring problems

Figure 2.6 – Overview of strength and weaknesses with different evaluation methods (Jeffries, Miller, Wharton, & Uyeda, 1991).

Figure 2.6 shows strengths and weaknesses with four different evaluation methods. Results from a study performed by Jeffries, Miller, Wharton, & Uyeda (1991) indicate that heuristic evaluation reveals more core problems than the other three methods, but they all have different strengths and weaknesses. Tests performed during the study showed that an heuristic approach revealed 57 % of the problems, while the method coming second on the list revealed 15 % of the problems. The results presented show that heuristic evaluation is a good method, but results can vary depending on the field it is used, and whether or not the heuristics are adjusted correctly to the context of where it is used.

Weaknesses of heuristic evaluation are that expert users are needed in order to perform the evaluation. They can be hard to acquire, especially as more than one is needed, and many of the errors found are specific and low-priority (Jeffries, Miller, Wharton, & Uyeda, 1991). Without a set of heuristics that is adjusted to the product being evaluated, experts may locate

general interface design errors, but risk overlooking those more specific to the current product, reducing the value of a heuristic evaluation.

2.3.7 Context

Introducing an interface or parts of it outside of the right context can lead to it being misinterpreted by the users, and get negative feedback. Icons may not give any meaning outside of their intended context, and they do not necessarily have to mean anything individually. An example of this is the icons in word processing applications such as Microsoft Word; **B,** ***I,*** **U**. These are three icons which occur in the task bar. In any other context, a bold letter B, or either of the other two examples, would not mean much, but when using a word processing application, they represent text manipulation functions (Heim, 2008).

The goal is to make icons that support the users at the right place, and helps them understand what options they have with the interface. Heuristic evaluation of a product should be done by performing tasks with the actual interface, because then every icon is presented to the tester in the same context as the end users will see them, and gives a more realistic basis for evaluation.

2.4 Mobile phone penetration

Mobile phone penetration worldwide is increasing every year. By 2002 the amount of mobile subscriptions surpassed fixed line connections on a world basis. According to the International Telecommunication Union (ITU) the global penetration reached 50 % at the beginning of 2008, and was expected to climb to over 60 % by the end of the year, which would mean over 4 billion subscriptions. Users with multiple subscriptions are not factored into these numbers, so in reality the penetration is lower. In Africa alone, there were 375 million subscriptions by the end of 2008, nearly three times as many as in 2005. Bangladesh has network coverage of 98 %, but the mobile phone penetration is only 13 %, compared to a land-wide penetration of around 20 %, or 280 million subscriptions.

The widespread of telephones in a country is directly proportional to its (Waverman, Meschi, & Fuss, n.d). In developing countries such as Morocco the expand in landlines stopped around 1995, whereas the mobile phones have taken over and now have a six times higher penetration. This is typical for all countries, seeing as it is estimated to be 50 % cheaper per connection to expand the mobile network with extra masts than building landlines. Synchronous, distributed communication is important for economic growth because of the

benefits it provides. Communicating with suppliers to get the best offers, sellers for information about where the best prices can be had, and access to information regarding business operations, whether it is farming or knowledge based business. For many countries in the African region, income from telecom services contributes between 5 and 10 % of the GDP, as well as generating many new jobs, both directly and indirectly of the telecom companies (Zibi, 2009).

2.5 Icons across cultures

Icons were long seen as universal and intercultural, and were believed to allow communication across the limits we face with normal language. Some researchers have argued that there are differences in how one interprets the meaning of an icon, depending on what culture they come from (Pappachan & Ziefle, 2008; Lalji & Good, 2008; Lansdale, 1988 in Schröder & Ziefle, 2008), even though they might understand what is depicted.

2.5.1 Culturally specific icons

Teasley, Leventhal, Blumenthal, Instone, & Stone (1994) argues that is it impossible to create an interface especially for cultures, and that factors that differ between cultures, such as color schemes, don't make a difference in the design of an interface. However, the correlation between the pictorial transparency and the semantic transparency was mapped in the study "Cultural influences on the comprehensibility of icons in mobile-computer interaction" (Pappachan & Ziefle, 2008). Participants in the study were given a set of icons; some original icons used in mobile phones, a variation of alternative icons ranging from simple to complex level of detail, and finally one suggestion made by the writers. They were then asked to answer what they thought was depicted (pictorial transparency) and what function they thought the icon served (semantic transparency). By executing the same study first in Germany, then later in India, the researchers were able to identify cultural differences from the results.

Responses for Indians (17–69 years) and Germans (young: 20–25 years; older adult, 40–69 years).

Targets	Indians		Germans			
	Pictorial transparency (correct responses %)	Semantic transparency (correct responses %)	Pictorial transparency (correct responses %)		Semantic transparency (correct responses %)	
			Young	Older	Young	Older
	58	17	100	86	100	86
	75	50	100	85	100	77

Figure 2.7 – Cultural difference in transparency of icons standardized in western cultures (Pappachan & Ziefle, 2008).

The figure above is from the said study, and shows the difference in how members of the two cultures interpreted the two icons differently. 93 % of the German subjects understood the pictorial meaning of the slashed note vs. 58 % of the Indian subjects, and 92,5 % of the German subjects understood the pictorial meaning of the letter, in contrast to 75 % of the Indian subjects. Overall, the semantic transparency of the slashed note received a very low score in India, only 17 %, against 93 % in Germany. The letter scored 50 % in India against 88,5 % in Germany. These results can be explained by the fact that Indian culture does not use written symbols for music, and letters have different shapes in India (Pappachan & Ziefle, 2008). Differences like these must be accounted for when the target group is decided if one wants to successfully make an interface for people from different cultures. Commonly used cultural specific icons today are arrows for “next” and “previous”, pointing right and left respectively, and a right arrows is often also used for the function “start”, “go” or “process”. For persons in western societies this is intuitive as they read from left to right, but Arabic text is read from the right to left, so going right would mean going backwards.

Another result from this study was that of icons depicting something concrete, which has a real life counterpart, had higher pictorial transparency than those which did not have such a counterpart. This confirms results from other sources (Schröder & Ziefle, 2008; Heim, 2008, Neurath in Lupton, 1986).

Callahan (2005, p. 284) lists three questions that the designers must ask themselves when creating icons applied to different cultures: “Will the symbol be understood?”, “Is the symbol appropriate?” and “Will the symbol be culturally acceptable?” Testing every icon intended for use in an interface is a process that will take much time and resources. Therefore it is

important for researchers to explore which symbols may have a different meaning, and avoid those in favor of neutral icons.

2.5.2 Culturally unspecific factors

Icons contain both cultural specific and cultural unspecific factors. Cultural unspecific factors include things that are perceived in the same way no matter where you are from. These include:

- Level of detail
- Color
- Size and shape
- Placement

The level of detail can be high or low. By using the high end of the scale, a lot of information can be passed on through an icon, but it also requires the receiver to interpret everything correctly. Icons with less detail will carry less information, but at the same time be easier to separate and understand, an advantage if you make icons that have no explaining text accompanying them (Heim, 2008).

Colors may help with enhancing certain parts of an icon to emphasize what it means, but at the same time Munch (1987), Marcus (1995) and Galitz (2002) (in Heim, 2008) suggests that you use a maximum of seven colors in one icon to prevent confusion. Second, there is the factor of colorblindness. 8 % of all men and around 1 % of all women suffer from this, which equals approximately 68 million of all illiterates, based on UESCO's estimate of around 759 million illiterate adults on a world basis (UNESCO, 2010). The phone menu for illiterates should thus ideally be using icons that make it easier for persons with normal vision to understand, and still be perfectly understandable if one can't take advantage of the colors. Differences in how colors are used across cultures have been identified, and colors should therefore be used with caution to avoid misinterpretation by the user (Teasley, Leventhal, Blumenthal, Instone, & Stone, 1994).

Size and shape of an icon may enhance some of its features, and on small screens such as mobile phones, this should not be overlooked. Being persistent with placement of certain icons will give consistency, and lessen the need to understand the same icons multiple times,

such as placing the “return” button at the same place in different menus. It is also important to consider how icons are mapped according to their function. Placing the “scroll down” button at the bottom of the screen will give it a more intuitive position, and make it easier to locate for the user (Preece, Rogers, & Sharp, 2002).

An article that is not specifically aimed at mobile phones for the illiterate, but still relevant to the topic, is “Making a Completely Icon-based Menu in Mobile Devices to become True: A User-centered Design Approach for its Development” (Schröder & Ziefle, 2008). As the title suggest, the researchers create a prototype of a mobile phone with a menu where all text in the menu is replaced by icons. Their approach towards the problem was to collect drawings from 56 participants who made drawings representing functions used in mobile phones. Results from the drawing schemas showed a high degree of stereotypicality for functions with a concrete counterpart in the real world, like “camera” and “alarm clock”, but more abstract phenomenas like “show” and “communication” had more varied feedback because they relied more on the participants own metaphors. Icons were later evaluated by a new set of users, by having them match icons with textual functions, and to describe with own words their understanding of a given icon to map peoples understanding of them.

ISO9186 is a standard for testing the understandability of graphical symbols. It specifies methods for evaluating icons in order to find out whether they are good enough to be used. For instance testing of an icon should reveal a certain understandability rate for it to be correctly interpreted without it having any accompanying text (ISO, 2010). In the study by Schröder & Ziefle (2008), icons with an understanding of 66 % or higher, which is recommended by ISO9186, were used, others were remodelled. After evaluating the icons, they were deployed into a prototype which was tested by 40 participants. There were 4 different prototypes. 1 with icons only, 1 with a combination of icons and text and 2 with text only. 10 participants were asked to perform 10 tasks on each of the prototypes. Results from the final testing showed that while the icon-based menu had longer processing times and more errors during the first operations, the learning curve was steeper for the participants with these menus, and by task 8 they outperformed their textual counterparts. This shows that mobile phones based on icons are not only useful for allowing illiterate people to access and use them, but may also outperform regular, textbased phones over time in terms of time required to perform tasks.

2.6 Technology for illiterate users

Adapting technology to different groups of people is a challenge for software as well as hardware producers. With an increasing amount of technology available to the users comes the need to adapt it to most people, be it to allow new users to take part in the technological expansion or to capture larger portions of the market. During the recent years, there have been attempts to make customized mobile phones for various groups; low-tech, large-font, loud-volume versions to suit the elder citizens (LydogBilde, 2010) as well as voice-guided, non-textual versions with reduced functionality for markets in developing countries (Planet Omni, 2009). Common for these products are that they approach a market that previously has not been focused on, to give the user groups increased chances of successfully using a mobile phone.

Making a customized product is one thing – making a customized product that works is something else. Approaching the field of mobile phones for the illiterate touches the fields of anthropology, human-computer interaction and interaction design. The anthropological challenge is to find out how the illiterate would use a mobile phone, what they would use it for and the cultural obstacles that will differentiate the product needs from the already existing products. From the information gathered, designers will be able to determine what functions will be needed on the final product, adapting the menus to suit the user's needs, and making solutions to meet the culture specific needs.

Lalji & Good (2008) wrote an article on mobile phones for illiterate people based on their findings from a field study performed in India. During the initial part of the study, the researchers interviewed five participants to map out what the final users would want from a mobile phone, and what it would need in order for them to want to buy one themselves. The interviews also included questions about their calling habits and ability to cope with numbers. Next, the researchers had their participants draw example icons for common mobile phone functions like telephone diary, torch and voice mail.

Findings from the study up until this point were translated into a prototype of a mobile phone that was tested by the participants. There were multiple iterations of the prototype, including versions that matched colors on the screen with colored buttons on the keypad, as some participants found it hard to cope with numbers. When comparing the usability of both the hardboard prototype and a Nokia 6610i, the participants found the number keys easier to read than those of the Nokia model, possibly because of the lack of letters next to the digit, and

higher contrast between the button and the digit. Also, the Nokia phone has some buttons with different functions depending on where you press the button; pressing the upper part of it scrolls upwards, while pressing the lower part of the button scrolls downwards. This was confusing for the participants.

The last phase of the study consisted of user tests of the live prototype in three different versions implemented on an existing phone, a Nokia 6881, with some physical modifications to comply with the findings concerning keypad understandability. With increasing complexity, the three versions of the menu allowed for testing of the participants understanding of the menu concept, ranging from simple to more complex, hierarchical solutions. Coupled with the icon based menu were voice instructions to assist the users while performing the required operations.

Findings from the first part of the study revealed information about the illiterates needs when it comes to mobile phones. They want to be able to use mobile phones because it will make it easier to stay in touch with family members, and because it may improve business. As of now, the interviewees coordinate with their neighbors that their family members will call at a specific time, and are allowed to borrow the phone accordingly. Another find was related to the alphanumeric keypad. Some participants had trouble understanding all the numbers, and would confuse 6 with 9, 2 with 7, but could recognize the numbers on a bus saying which line it is. Features such as the radio and torch were welcomed as they would no longer have to worry about buying batteries for those.

Running tests with the prototype showed that the subjects had trouble separating the speaker icon, symbolizing volume, from a torch, and musical notes were mistaken for birds, as they did not know this concept. Using musical notes to write down music is a western concept, and is not used in some parts of the world, showing us that the cultural differences may also play a role when it comes to understandability of the concepts in the icons. As mentioned above, the buttons that give a reaction depending on what side of the button you press were confusing for the subjects, and thus should be avoided in prototypes for this product.

In the high fidelity prototypes tested, menus included highlights to show objects currently selected. However this did not have the desired effect, as participants would press the select button right away when the option they wanted was shown on the screen, regardless of where the highlight was. Voice walkthroughs caused some confusion amongst the participants. First, they did not remember the instructions even after hearing them several times. Second, if there

were no instructions they would often not perform any actions, waiting for the phone to tell them what to do. Third, they would often perform any task the phone told them to, simply because "they were told to do so". From this we can conclude that voice guides should be used with caution and if possible disabled over time as the user learns how to act on their own.

Nokia has an ongoing process of increasing the mobile phone market by making new models continuously. One area they are exploring is that of making technology available to illiterate users (NOKIA, 2010). Their research results indicate that illiterate persons mostly have no problems switching on a phone or answering a phone call. However it is often limited to this, thus not allowing the buyer to utilize the full potential of the tools available through the mobile phone. Though you might not think about it, the utility offered by text messages, making notes, adding calendar events, generally functions that require an understanding of text and numbers are helpful in the everyday life. It can often make paper based notebooks obsolete as the user has the option to store most of the information he or she needs in one device instead of an almanac or similar that would come in addition to the phone itself. Researchers at the Nokia Research Center states that user interfaces with iconic help, verbal help or down-tuned models with only the core functions are all just workarounds for the issue, and not fully grown solutions.

> "Whilst it is true that richer iconic support could assist a textually non-literate user, this is a long way from suggesting to design a mobile phone relying totally on an iconic interface. Icons by themselves are not the answer."
>
> (NOKIA, 2010).

This conclusion is based on arguments against icon based interfaces, stating that icons are best coupled with a textual description, that there are too many icons that just don't have a visual match, like configuring GPRS-settings, and last that it would take too many test persons to successfully conclude with a complete interface that is understood by everyone in the target group. However, when designing interfaces for illiterate persons, one can't expect them to be able to read and understand textual descriptions, and thus should not be included unless the goal is to help them learn to read by starting with simple words coupled with a function. Second, many functions, like GPRS-settings, are not necessary to give an illiterate person a helpful tool. Making a compromise between functions *needed* and *additional* functions to reduce the interface complexity should not take away the field of use for a mobile phone that is developed more as a tool than a gadget. Lastly, any project aiming for mobile phones for

illiterate persons will need a lot of testing, and icon-based interfaces should not be discarded before it is thoroughly explored.

Looking away from iconic interfaces, Nokia have made suggestions as to what should be included in new mobile phone models aimed at illiterate users:

- Automatic phone settings, reducing the amount of tasks a user has to understand and perform on his own, like time and date settings
- Camera to capture objects that the user needs help understanding, allowing them to show it to a third person
- Answering machine function, allowing the user to receive voice messages instead of text messages
- Phone models should not be notably different from regular phones, to avoid social stigma coupled with illiteracy

Research performed by Microsoft exploring the possibility of *"a user interface designed such that even novice, illiterate users required absolutely no intervention from anyone at all to use"* (Medhi, Sagar, & Toyama, 2005, p. 1). Being aimed at computer- and not mobile phone interfaces, the research still provided important discoveries that are helpful across platforms. First, the researchers discovered that despite being illiterate, many of the subjects could recognize and separate numbers, i.e. not being innumerate. The interface was based around drawings and photographs instead of text. Participants were best able to interpret and understand semi-abstract cartoons and photos better than complex abstract graphics. One example is that the test subjects were not able to understand arrows signalizing if a road was one or two-way driven, but when the arrows were replaced with icons depicting cars, they were easier to understand. Also, some abstractions were taken too literally, such as the color of a road on an interactive map changing from black to yellow when highlighted; "roads can never be yellow they are always black!" (Medhi, Sagar, & Toyama, 2005, p. 39) . Abstractions proved to be a good option when referring to general concepts such as hospital, but not so good when referring to a specific instance of the concept, in this case the Jayangar Hospital. Photos of the building were used to work around this problem (Medhi, Sagar, & Toyama, 2005). As for representing actions, the researchers found that icons that indicated

motion were better than icons representing the objects alone. Without the action element of, say, running water or flames under a kettle, icons would be interpreted as locations or objects, rather than the intended meaning, which in this case would be doing dishes or cooking. This is in accordance with Horton's (in Heim, 2008:439) graphic dynamics, where adding action indicators turn nouns into verbs.

When looking to profit organizations like Nokia and Microsoft there is always a risk that facts presented are influenced by their desire to generate income, and their agenda might not, in this case, be solely to help illiterate users. As with research material in general, a critical view and discussion around the data presented may help prevent biased information being spread. Material from private actors used in this study is by no means excluded from a critical view.

2.7 Digital divide

With the introduction of information and communication technology, the gap between industrialized and developing countries will increase to a bigger extent than it is today, since the technology and benefits are only available to those with the necessary equipment. New technology grants access to services via the mobile network; banking, information, even shopping is possible by using a mobile phone (Varis, 2007). By giving a new user group, the illiterate users, the opportunity to take advantage of mobile features, the divide between industrialized and developing countries will be reduced. Access to new services and information may help the developing countries expand economically as well as technologically. Claiming that illiteracy is the sole reason why members of the target group are unable to use mobile phones would be bombastic, and is not what is intended. Multiple factors, such as network coverage, economy and likely many more play a part. However, making specially adapted mobile phones for illiterate users which can allow them to benefit more from buying a mobile phone might rise interest and encourage more people to buy them. This will not be speculated further in this study.

2.8 Illiteracy

Literacy can be defined as the ability to read, write and understand short written sentences in everyday life. Illiterate, or non-literate, individuals lack this ability, thus making them incapable of doing many things literate persons can. Using technical devices, such as mobile

phones and computers, are often limited to literate persons, as they require you to either read menus and manuals, or interpret icons that often give little or no help as to understand the functions behind them, except the text following them. In some countries, for example Burkina Faso and Chad, the literacy rates are as low as 30 % for the population over 15 years of age. For the world as a whole, UNESCO estimates that around 20 % of all adults lack a minimum of literacy skills, or around 759 million (UNESCO, 2004). There is an ongoing struggle towards eliminating illiteracy worldwide, but the estimate for the end of 2010 is that 17 % of the world's population is still illiterate (Welle-Strand & Thune, 2009).

There is no universal definition of what illiteracy is, and you will find the word being used in many different settings. In its basic form illiteracy means "the inability to read and write", but to capture the variations of illiteracy, and showing how much the term illiteracy can cover, UNESCO uses this definition:

> "Literacy is the ability to identify, understand, interpret, create, communicate and compute, using printed and written materials associated with varying contexts. Literacy involves a continuum of learning in enabling individuals to achieve their goals, to develop their knowledge and potential, and to participate fully in their community and wider society."
>
> (UNESCO, 2004, p. 13)

UNESCOs definition includes many aspects of illiteracy, and focuses more on functional illiteracy than the true meaning of the word. When used in everyday life, the term illiteracy is often referring to functional illiteracy, which means that a person can't understand the meaning of what he or she is reading and writing and therefore not function at a decent level in the society. The definition will vary between contexts. The democratic republic of Congo uses this definition: "age 15 and over can read and write French, Lingala, Kingwana, or Tshiluba", while in Albania, the definition is "age 9 and over can read and write" (CIA, 2010). China uses yet another different definition, which even takes into account national differences: "One who can recognize more than 1500 Chinese characters (for a farmer) and 2000 characters (for an office worker or urban resident)."

In this study, the definition used for illiteracy is, unless otherwise specified, "The inability to read or write".

2.9 Digital literacy

Definitions of literacy, and thereby also illiteracy, changes over time, as time changes the set of skills needed to function in the society. We don't have to look many years back to find that skills in operating digital devices were not a necessity, which it often is today. As the definitions differ over time, it should also differ geographically. Information technology skills required to stay competitive in industrialized countries is at a different level than in developing countries, because of the economic situation, affecting the availability of technological devices. Fjuk, Furberg, Geirbo, & Helmersen (2008) argue that when digital literacy is discusses, it is not taken into account the differences between cultures and geography, but rather a static definition is used. Development of an artifact is, according to Säljö (in Fjuk, Furberg, Geirbo, & Helmersen, 2008), based on the people's particular needs. In this case, the need can be seen as mobile phone that allow illiterate persons access to the advantages provided through technology. Through focus on the concept of digital literacy, chances of creating new technology that is adjusted to the users' needs and demands are increased, resulting in better usability for the users.

2.10 Chapter summary

Chapter two introduces studies done in the field of interfaces for illiterate users, and lays the theoretical base that will be used later in this study. Human-Computer Interaction, the field in which this study is based, was introduced, together with the relevant topics within this field: interaction design, research methods in Human-Computer Interaction, design science, prototyping, intuitive interfaces, heuristic evaluation and context. Theory presented includes attempts to make international sign languages, research regarding cultural differences and indifferences when interpreting icons as well as attempts to make mobile phones for illiterate users.

3 Research design

This chapter introduces research related topics that are relevant in the process of answering the problem of the study. First up is the human-computer interaction (HCI) field. To answer the research question, a prototype will be made with focus on the user interface, and how this can be made as intuitive as possible. HCI is relevant to this because it provides theories and knowledge about making good interfaces for computational devices. While also focusing on making good, interactive interfaces, interaction design provides frameworks and principles for making interaction optimized for the user. Research in HCI covers a wide span of methods, and those relevant to solving the problem will be introduced. This chapter covers the research question and the process that will be done to solve it, and lastly there will be a discussion around theory used to sole the research question, leading to design of the prototype in chapter four.

3.1 Approaches to data collection

Knowledge about different methods for collecting data is important as it gives a better understanding of what methods are suited for the different situations the researchers will face during a research project (Cairns & Cox, 2008). When should the researchers use a qualitative approach instead of a quantitative, should the study include primary or secondary information? When working on a HCI project, collecting data can be much more of a challenge than in other disciplines due to the many fields involved, as was discussed in a previous section.

3.3.1 Quantitative approach

A quantitative approach to collecting data is useful when the goal is to generalize answers and make statistics from the replies of a large pool of samples. This approach allows researchers to make statistical analyses or test hypothesizes by utilizing tools such as forms and measuring equipment. Quantitative methods for data collection can have the form of questionnaires, structured interviews or structured observation. In these cases, the researchers already know what they want to answer.

Using these methods can risk generating vague data if the questions asked are not properly defined. For instance if the goal is to find out about students' life quality, it needs to be properly defined what life quality is, and what conditions help improving or decreasing it. In

this study, questionnaires were used to gather drawings from the persons participating in the survey to get as much input as possible.

3.3.2 Qualitative approach

Qualitative analysis is about finding deeper meanings and understandings than what one can get from a quantitative analysis; the goal is depth instead of width. Using this method, the researchers themselves are the tools. Ways to perform qualitative data collection include semi structured or unstructured interviews, observation or field work and text- or image analysis – secondary research. These methods are useful when you have little previous knowledge about the field being researched or in combination with quantitative research when there is a need to elaborate the answers further to gain insight in the data collected. In the field of HCI it is often close to impossible to know what the problem is before the research has begun, and therefore it can be argued if it is even possible to define the variables needed for a quantitative study (Cairns & Cox, 2008).

According to Cairns & Cox (2008) one of the main pitfalls researchers face when using a qualitative approach is subjectivity. Critique against these kinds of studies often focus on the researchers' subjectivity when collecting data, both when it comes to asking the right questions, interpretation of the data, and producing the results. Input both from participants in this study and from previous studies was analyzed qualitatively in order to evaluate what should be included in the design of the prototype. There is a risk that the researchers' subjectivity came into play when deciding what factors were important and which weren't when evaluating the drawings; however a professional point of view was maintained throughout the process.

3.2 Sampling and access

Putting together a sample group for a research project is a process that involves multiple factors, such as the method will be used for data collection, the size of the group and the composition of the persons involved, as well as the questions the project seeks answers to. Matters related to the method used for data collection are decided by the nature of the project. Some studies aim to make generalizations for a society, while other studies are limited to smaller groups. The first example means that you want a sample group that is large enough to properly represent the rest of the population who did not participate in the study, while the latter may only need a few data samples to give the results you want.

The size of the sample group is closely related to the method, as the method indirectly puts restrictions regarding the amount of persons involved. As an example, the interview is a method that can be used to gather data from a theoretically unlimited sample group, but at a certain point they will be too expensive and time consuming to perform in proportion to the resources available (Johannesen, Tufte, & Kristoffersen, 2008).

This project seeks solutions that have a theoretical worldwide user group, and in response should gather data from as many participants as possible representing the correct group. Factors limiting the amount of persons participating are:

- They are per definition illiterate
- Economy

While there is a considerable amount of illiterate people worldwide, there are very few in Norway, where the study is being carried out. This means that: a) it is important to have all the participants finish the study to reduce the amount of unfilled forms, and b) it is important to find and use data from previous research regarding the same topics, as new data will be hard to come by. To acquire as many suitable candidates as possible, contact with refuge reception centers, and schools for immigrants was established, however with less than ideal returns.

Economy is another limiting factor for the project as all communication with the participants in the project has to go through an interpreter. To keep costs at the subsided level, communication was planned for ahead, making sure all suitable candidates were informed at the same time, thus reducing the fees for interpreters over multiple sessions.

There are defined ways of deciding who is suitable for participation in a study, and where they can be found (Johannesen, Tufte, & Kristoffersen, 2008). In this case, the methods used are:

- Criteria-based sampling
    - Samples need to fulfill certain criteria to participate in the study.

- Random sampling
    - If the goal is to study satisfaction of a public service, the researchers can go to the particular service and ask random users if they want to participate in the study.

The criterion was that that the subjects had to be illiterate. This alone narrows the pool down by a considerable amount, and also set some vague boundaries for where the subjects could be recruited from with the economic aspect in mind. Locating the clusters of possible participants lead to a school for immigrants, where the method shifted into a way of random sampling, where all persons defined as illiterate were asked if they wanted to participate in the study.

Informative meetings, such as was held at the location, is the next step after finding out who and where, namely the recruiting method. In this case,

- Personal recruiting
    - Visiting places where the persons of interest will be present. The researchers are then able to get in personal contact with the persons asked, which may have a positive effect as one can often read the body language and see insecurity, and then follow up with more information and use visual effects as aid. The drawbacks of this method are that it is time consuming and may also be costly, and bad chemistry between the researchers and the person of interest may have effect on the outcome.

Being able to see the listeners' reactions enabled the researchers to fill in extra information where it seemed suited, and also get a feel of the general level of interest. However, when talking through an interpreter, much of the signals were "lost in translation", as the crowd did not direct themselves to the speaker, only the interpreter.

3.3 Drawing-session

A group of illiterate students at a school for immigrants in Norway were invited to participate in the study to get user input for the prototype which is created during this project. Prior to performing the study, communication with the school board was established, and the students were, by the school, defined as illiterate, participating in the Alpha classes. These classes are for immigrants who have little to no prior education, and aims at preparing them for the society by teaching literacy skills. Before the actual drawing session, an informative meeting with the interested participants was held, explaining the purpose of the drawing session. Two interpreters were used during this meeting; Arabic and Somali. These languages covered most of the students from the classes, and it was decided that bringing in more interpreters would not be cost efficient. While being skeptical at first, there was also obvious interest amongst the approximately 20 attending students concerning the significance of the project when told about the mobile phone. Some questions directed were similar to those described in Lalji & Good (2008, p. 12); "What if we can't do this? Will we get any help?", "Will the project be executed during our regular teaching hours?" and "Can I discuss the drawings with my family first?" Others were interested in the final product itself; "Will we be able to buy this phone?", "Will [the phone] be sold all over the world?", "How much will the phone cost?" and "Will this be a new type of mobile phone?"

A few questions were asked during this session: How many owned a mobile phone, are they able to use mobile phones, if they found them hard to use, and what they used the mobile phones for.

Surprisingly enough, most of the students reported that they own mobile phones and are able to use them, but some also said they were hard to use and that they would be interested in a phone that was easier to use. One interesting find was that some of the students answered they used their mobile phone to send text messages. From this it can be concluded that these people are not fully illiterate, and can read and write, even if only at a basic level that enables them to send and receive text messages. However they were all at different levels of illiteracy because of different schooling background and other factors that are not possible to establish, and due to the nature of a group meeting there was no opportunity to speak with them one by one, meaning that the persons who did speak up might also only be representative for the most literate amongst the group. Another factor was communication through the interpreters, making it hard to see who participated actively when the students discussed the questions amongst themselves, as they spoke towards the interpreter, who then translated it.

The group of students participating in the drawing session consisted of 5 persons with different background. Participants were between 21 and 46 years old, average 34 years. They had between 0 and 7 years of schooling, average 2, 6 years. Two of the participants were from Iraq, one from Palestine, one from Sudan and one from Eritrea. While not being representative for the population of their country of origin, and not numerous enough to represent the illiterate population, the participants providing input to this study represent a variety of different cultures, which is positive in terms of finding icons that are understandable across cultures, providing data which reflect opinions of people from different cultures.

Through interpreters the participants were asked to draw suggestions for icons that were to be used when designing the menu for the mobile phone later in the project. According to administration at the school, the student were unfamiliar with using pencils, which would make it hard for them to draw, but this did not seem to be a limiting factor, as for the most part it was easy to see what they tried to express with the drawings. Figure 3.1 below is one participant's suggestion for "Take picture", and figure 3.2 depicts "Set time".

Figure 3.1 – Take picture

Figure 3.2 – Set time.

As with the drawings from other participants a person performing the action is included in many of the drawings, holding or pressing buttons on a phone or adjusting a wristwatch. Another observation made from the drawings was the participants' tendency to write down numbers or names to make an object represent a list or list item.

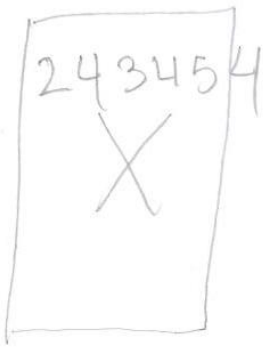

Figure 3.3 – Delete contact.

Figure 3.4– Add contact (Edited to hide phone number).

As some of them had mobile phones, a few drawings were bound to be influenced by their current phones. Figure 3.5 below shows a drawing to the function "No", with the word no spelled with text on the place where you would normally find that option on a phone. In comparison, the same participant's suggestion for the function "Yes" was similar, only the word "Yes" was spelled on the button opposite to the one in figure 3.5.

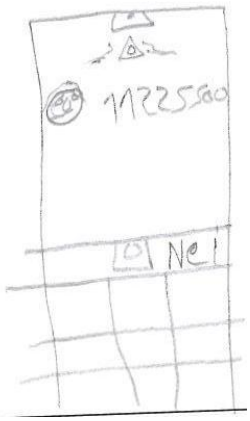

Figure 3.5 – No.

Other drawings show a person holding a phone, but it is not possible to tell from the drawing itself what the person is doing with it, and much less separate it from other similar drawings representing other function.

The downside of this is that they may be influenced by the icons on the phones they are currently using, and that this might be reflected on the schemas they will be asked to fill out during the data collection phase. However, they represent different cultures and languages from the Arabic and African part of the world. This is positive, considering that the end product is aimed at illiterate people and a large portion of them live in African countries (UNESCO, 2010).

Some of the participants said they were already using mobile phones and sending text messages. As concluded earlier, this means that they are not completely illiterate, and are able to read and write, at least single words and maybe up to short sentences. However they are all at different levels of illiteracy, and due to the nature of the session it was not possible to question every attendant more thoroughly to map the exact phone usage.

3.4 Research question

The goal of this study is to further explore the text free interface, and to make a prototype of an icon based menu for mobile phones that will support illiterate users through an interface that does not require reading skills to understand or use. The research question is then:

How can an icon-based interface for mobile phones be designed to support use by illiterate people?

Approaching the research question, there will be a discussion of what factors limiting illiterate people from using mobile phones today can be solved by making a model that is based on icons, thus not requiring them to know how to read. What steps needs to be taken in order to create icons that are suitable for this model, and what icons would be able to fulfill the task are topics that will be discussed before the design can start.

Finding solutions to the question above requires an understanding of what factors are involved in interface design, and what factors are specific for the target group.

After the prototype has been designed, a heuristic evaluation will be performed in order to get expert users' feedback based on heuristics for design and heuristics suggested for this study, which are based on theory.

3.5 Approach to answering the question

Answering the research question will be done by creating a prototype of a mobile phone that will, based on findings in this study, support illiterate users when interacting with it, by having no text, which eliminates the need for knowing how to read in order to use it.

Discussion around design issues, which includes establishing what factors limit illiterate users from operating mobile phones can be solved by making a specially adapted model for illiterates, factors that need to be considered when making icons for a menu for illiterate users, and which icons need to be included, will be based on theory, previous research results as well as icons drawn by illiterate users as part of this study.

Subsequently, an overview of the development of the prototype will be given. This will include reviews of the different prototype versions and the fundament for changes and improvements that were made in order for the prototype to be a solution to the problem in this study.

Progression will be similar to principles of User-centered design and Design science. As presented earlier, user-centered approaches emphasize design based on user involvement. Though there is no direct user involvement in the design process of this study, it will be based on user expectations and input provided through preliminary research results gathered both through analysis of old material and in acquisition of new data. Design science aims towards functional products rather than theoretical knowledge. Results presented here will consist of a functional prototype presented as a hands-on solution to the problem, in combination with a theoretical basis to account for the design choices made. Developing a prototype makes it easier to see the theoretical finds put to practice and compare with current products available.

Input from users is gathered through questionnaires and communication with illiterate subjects participating in the study. By drawing suggestions for icons, they provide the foundation for icons that can be evaluated together with input from previous research in order to make a prototype based on icons drawn by illiterates. Assessment of which icons are suitable for implementation to the prototype will be done by the researchers, while the rest will be created. Digitalized versions of the drawings will be used to create an interactive prototype.

Heuristic evaluation by expert users will establish whether the prototype fulfills the requirements found throughout this study, resulting in whether the research question was answered positively. Results from the heuristic evaluation will reveal if the prototype has answered the research question or not.

3.6 Design-related discussion

Findings from this discussion will be used to illustrate the development of a prototype putting the theory to use in an interface that will hold the elements needed to be easier to understand for illiterate users than current available interfaces.

Mobile phones today often rely a great deal on textual descriptions of icons and functions that the user needs to read in order to understand. However, this does not mean that availability of mobile phones they can operate is the only thing limiting them from owning one already. Factors such as network coverage and economy will not be affected by making available a new mobile phone model. There will not be any speculations as to what factors that do play a role in whether an illiterate person can use a mobile phone or not, except those that can be

solved by answering the research question at hand, but it should be kept in mind that there are things outside the scope of this study that plays a role in this matter.

Mobile phones today consist of a large portion text. Many models have icons for many functions, but these are for the most part accompanied by text describing the function, and further down in the menu hierarchy the icons are sometimes completely absent. In order for someone to be able to take advantage of all the functions on a mobile phone, they have to be able to read. This means that text is the main factor limiting illiterate users from taking advantage of mobile phones.

Second, different cultures interpret and understand icons differently. As was discovered, some of the icons that are commonly understood in Europe do not make sense to someone from India (Pappachan & Ziefle, 2008). Mobile phones are distributed with the same icons on a worldwide basis, with the text being different depending on what language setting is chosen. Be it in Norway or India, the icon for message is still shaped as a western letter design, and music is symbolized by a tone symbol. As discussed in chapter 2, the tone was misinterpreted by most of the participants in the study (ibid), since this symbol is not used in that culture. Without being able to read the text describing its function, there is little chance of someone being able to interpret a function's icon correctly if the image depicted is unfamiliar to them. The tone symbol is an example of an abstract icon. These are less likely to be interpreted correctly than their concrete counterparts (Schröder & Ziefle, 2008; Pappachan & Ziefle, 2008). Making a completely icon based mobile phone would be the quick fix to the problem with illiterate people not understanding the text. The obstacle would be to make a phone with icons that are easier for them to understand than the current alternative.

User experience researchers at Nokia claim that:

> "Whilst it is true that richer iconic support could assist a textually non-literate user, this is a long way from suggesting to design a mobile phone relying totally on an iconic interface. Icons by themselves are not the answer." (NOKIA, 2010).

This conclusion is based on arguments against icon based interfaces, stating that icons are best coupled with a textual description, that there are too many icons that just don't have a visual match, like configuring GPRS-settings, and last that it would take too many test persons to successfully conclude with a complete interface that is understood by everyone in the target group. However, when designing interfaces for illiterate persons, one can't expect them to be able to read and understand textual descriptions, and thus should not be included unless the

goal is to help them learn to read by starting with simple words coupled with a function. Second, many functions, like GPRS-settings, are not necessary to give an illiterate person a helpful tool. Making a compromise between functions *needed* and *additional* functions to reduce the interface complexity should not take away the field of use for a mobile phone that is developed more as a tool than a gadget. Lastly, any project aiming for mobile phones for illiterate persons will need a lot of testing, and icon-based interfaces should not be discarded without thorough testing.

Thus the first step is to determine what functions are necessary on a mobile phone for illiterate users. Possibility to make and receive calls goes without saying. Second, there should be a contact list with pictures for each contact. To get these pictures, there must also be a camera included and an option to link pictures to contacts. Users should be able to see who called, what calls were made, and missed calls; the call log. Last, a clock with alarm functions. As far as unnecessary functions go, there is no need for SMS support. This device is not intended to teach reading or writing. Nor is there need for internet connection, as the internet in large requires one to read. Limiting the amount of configurations available will reduce the chance of users changing settings that they are not able to revert, making it safer to use. To summarize:

- Make and receive calls
- Call log
- Possibility to take pictures and link them to contacts
- Clock with alarm clock function
- No function for sending or receiving text messages
- No internet option
- Limiting settings accessible to the user

Previous studies have already established necessary factors linked to icons for illiterates, meaning that they are not accompanied by a textual description to help understand the depicted function. Wording these factors differently gives us a set of guidelines for icons that are to be interpreted alone:

- Use icons that depict real objects as much as possible to avoid giving room for subjective interpretations (concreteness)
- Use icons that include actions
- Avoid too high level of detail – cartoon style is preferred
- Use real colors to avoid confusion

Concrete icons are easier and more likely to be understood because they have a real world counterpart, such as for example a clock or a camera, while abstract icons are less likely to be understood as intended because they rely on the individual's way of interpretation. By using only concrete icons in a phone for illiterate users, the chances of them being able to correctly understand the function connected to the icons are increased. After excluding the problem with finding abstract symbols that are indifferent across cultures, the challenge is to find out whether objects look the same, or at least similar enough to avoid misunderstandings. One example is the letter icon which was misunderstood in India since their letters have a different shape than in the western world. Some objects, such as "Call log" and "Contact list", may also have a different physical appearance between different people, and are amongst the icons that need further testing before it can be determined whether or not they are universally understood.

A user-centered approach presumes input from users in one way or the other. While this study uses mainly secondary data, the data collection session described in 4.1 allowed for testing the empirical data through a control group. The group was asked to make drawings for the mobile phone functions. While the group not being large enough to represent neither the world population of illiterates nor illiterates from the attendants' country of origin, it was useful as a small scale check of current knowledge, and could in the future theoretically escalate to a larger study. As described more thoroughly above, results from the tests showed the following:

- Drawings represented actions
- Humans performing actions were highly represented in the data
- Concrete pictures

These findings correspond to the previous knowledge, and confirm their validity. Persons performing an action were common amongst the drawings. By adding a person performing an action, the icon itself may become more understandable and should not be overlooked as a tool when making icons that are easier to understand.

When looking at an icon, the factors deciding whether it is understood correctly are separated in two categories: culture dependant and culture independent factors (Pappachan & Ziefle, 2008). The culture dependant factors are based on the individual's background, values and previous knowledge. Far too many different cultures exist, and even individuals with different understandings within the cultures, to include representatives from them all when making a new design. Instead, development should work towards solutions that do not dig deep into any specific cultural settings, but rather stay at a level that as many as possible have the prerequisites to understand.

On the other hand there are cultural independent factors. These can be optimized, and should be the foundation for icons created. In doing so, researchers may focus on mapping and developing understanding of different cultures, working towards the goal of icons that everyone can understand.

- Details add more meaning, but too much detail may be counterproductive
- Size and shape matters
- Intuitive placement of icons
- Maximum 7 different colors in a single icon

Communicating action through a symbol was a problem first encountered with Semantography. The answer was to add motion symbols, such as exclamation mark to add power to a word; ear plus exclamation mark would be "listen", and eye plus exclamation mark would be "see". Horton (in Heim, 2008, p. 439) places speed lines, shake lines and ghost images under the term graphic dynamics, and describes four ways of combining symbols to give them additional meaning: overlap, addition, antithesis and specification. Overlap uses more symbols in one icon, such as multiple tools to symbolize toolbox instead of just a saw which alone would be perceived as just that. Addition means adding an extra element, as with the exclamation mark above. Antithesis is use of contrasts to symbolize

inverting, like with invert colors on a picture. Specification means adding elements like a slider under a sun to imply that you may adjust the lighting.

These methods may prove useful in the creating of icons for a text free mobile phone. As discussed in previous chapters, the element of action in an icon is what separates it from being a picture of an object, and many functions are formulated as actions; “Take picture”, “Add contact”, “Show”. Figure 3.6 is an early version of the icon for “Take picture”, with shake lines to symbolize the action of pressing the button.

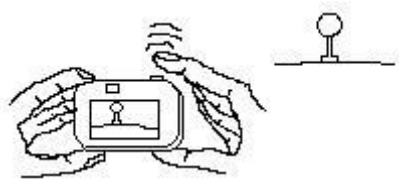

Figure 3.6 – Take picture.

Including a person performing an action in the icon design can improve its understandability, as it gives a more detailed impression of what action is connected to the icon by putting it in a context. When working with mobile phone interfaces, there is a limited amount of space available on the screen, which in turn requires the icons to be small. Not only would it take up a lot of space in an icon if persons were to be included in them, but it would also take away focus from what the icon is really depicting.

Figure 3.7– Person manipulating a wristwatch.

Like with figure 3.7 above, the drawing is very concrete in that one would hold their hands like that to adjust time on a wristwatch. One can't, however, easily see that the person is fiddling with a wristwatch unless they knew it in advance. This would make it less ideal for an icon, because it is not very intuitive.

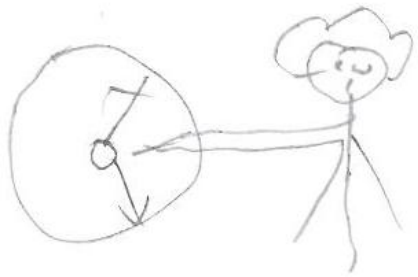

Figure 3.8 – Person manipulating a clock.

Another participant suggested the icon shown in figure 3.8 for adjusting the time. By using a larger clock and a person pushing its hands it becomes easier to see what the person is in fact manipulating; a clock. Theory tells us that for people who are unfamiliar with technological advances like mobile phones might misunderstand details in icons that are not realistic (Medhi, Sagar, & Toyama, 2005). To cope with this, the final icon for adjust time was changed to emphasize the clock more, but still kept the factor of a human manipulating it, by adding a hand with shake lines to illustrate the manipulation of the clock. The amount of detail could be further increased by adding digits in the clock, but it was decided to be unnecessary as it would interfere with the hands and arrows already in the icon, in addition to giving the impression of adjusting the clock from a more specific time, instead of representing a general action (Heim, 2008); adjust the time.

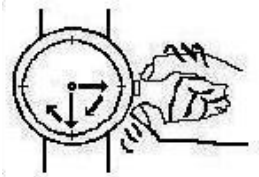

Figure 3.9 – Final icon for "Adjust time".

While being important in developing new interfaces, user involvement can only be useful to a certain point. After that, the designers have to use their expertise to make the final product, because the users involved do not have the needed expertise complete the design in the same way the professionals do (Preece, Rogers & Sharp, 2002). Therefore, icons used in the prototype created during this study have been adjusted to correspond with empirical results from previous research and theory.

In this case of making a mobile interface, sizing the icons appropriately is important, because there is limited space available, but reducing the size too much will result in details getting lost or misperceived. Basing the prototype on a touch screen phone gives a larger area to work with, compared to the models where the numeric keypad takes up a lot of space. By taking advantage of the full screen size, and planning the menu structure to avoid too many menu choices available at the same time, there should never be a need to scroll to find menu options. Where there is a need to scroll, for instance when the user enters the phone book or call logs, the buttons enabling them to do so should be placed at the bottom and at the top of the screen to be as intuitive as possible.

Colors are listed as a culture independent factor for icons (Heim, 2008). On one hand, colors can be used to separate details in an icon by coloring them differently, and to make objects more realistic. On the other hand, colors may communicate different meanings between cultures. Red, which is commonly used as danger or alert in the western cultures, may not be used the same way elsewhere (developer.nokia.com). Because of this, colors should not be used in abstract settings. Where they are used, icons should not have elements which have different colors than those of their real world counterparts.

Drawn data gathered in this study, as described in chapter 4.1, showed that logs were often drawn as a square with listings from their own phones. Attempts to implement this into the prototype were done by making dynamic lists, which change according to the content in the log. For example the “Missed calls” icon should update according to the last few missed calls. Instead of just having an arrow pointing at a crossed out phone, which symbolizes a call not answered, a list with the contact picture of the last missed callers is added to the icon, like in the figure below.

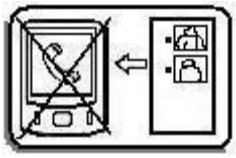

Figure 3.10 – Missed calls.

This effect personalizes the icon according to the information held in the “Missed calls” function, and can help the user understand what the icon symbolizes based on their memory.

3.7 Chapter summary

By putting together results from the questions discussed in this chapter, we can approach the question that the study seeks to answer: make a prototype of an icon-based interface for mobile phones that supports use by illiterate users.

Mobile phones today are not designed for people who can't read or write, and the interfaces oftentimes require the user to read descriptions or texts in order to understand how to operate them, thus creating the barrier for illiterate users. Icons used are also not adjusted to all cultures, and are likely to be misinterpreted by many users from non-western cultures.

Exploring the use of intuitive icons in a text-free interface can be advantageous not only in the current context, but also for the mobile phone industry as a whole, according to tests measuring time spent for literate users when performing tasks on an icon-based versus a text-based interface, with results in favor of the icon-based version (Schröder & Ziefle, 2008).

For the mobile phone to be useful to someone, it does not have to include all settings and functions that are available from today's most high tech models, such as internet connection and hundreds of ringtones. Cutting down to the essential functionalities will provide illiterate users with a basic mobile phone and at the same time help keeping the costs down. Design of the interface itself must follow guidelines for making icons that are more likely to be understood by everyone, regardless of their cultural understandings. The guidelines include:

- Concrete icons
- Icons with actions through action-elements

- Avoid too much details
- Intuitive placement of buttons

Principles within human-computer interaction and interaction design dictate best practices when developing interfaces. Even though the interface for illiterate users is still not as explored and well established as other arenas like web interfaces, the input from these guidelines provides a set of factors that should be included when making the interface. Feedback and consistency are examples of guidelines that are universal for any interface, and therefore also suitable for the interface designed in this study.

In addition, findings that came present from the data collected in this study were that human elements can make some phenomenon more understandable, such as a hand manipulating a wristwatch to give it a context that may be more recognizable. Next, there was a tendency that logs and lists were drawn with names and numbers from their own phones. Incorporating this can be done by having dynamic icons which change according to what the latest addition to the "Missed calls" was. The next chapter will show the development of a prototype putting to use the information gathered to this point, answering the problem of this study.

4 Design

In chapter five the theory and knowledge from previous chapters will be put to practice in the making of a prototype. The mobile phone prototype is based on a touch screen mobile phone with icons that, according to the theory presented, are easier to understand than traditional icons used in phones. Prototyping makes it easier to see if, and how, the solutions work in practice by allowing them to be tested in the right context.

Icons are for the most part digitalized versions of the original drawings done by students, who attended the drawing session described in chapter three. Some changes were made to the icons to make them fit within the size available on the screen, but also to give the right focus within the icons. There were also some concepts which were adopted for use, but not necessarily in the same icons as they were originally drawn for.

This chapter will give an overview of the prototype version history, starting with the earliest, ending with the final product, to describe the process of making the prototype and adjusting it to correspond with the guidelines for making an interface that is easier to understand for illiterate users. Prototypes one and two were made before new data for the study was gathered, and is therefore based on placeholder icons.

4.1.1 Version 1

The first prototype, a low fidelity version, was made prior to meeting with the board at the school where input for this study was gathered. By giving them something concrete to look at, they were able to get a better understanding of the project goal, and how the data would be used. The first prototype did not support interaction, was made with Microsoft PowerPoint, and included standard icons from existing mobile phones, as well as clip art from PowerPoint, as illustrated below. Combined icons, more specifically additions, were used to illustrate the functions connected to elements on the mobile phone. The figure below shows how the icon for phone log stays the same, but have other icons added to it to represent the choices available to the user: a plus sign to represent “add”, a magnifying glass representing “look at”, and a cross to represent “delete”. By combining the elements like this, the demand for users to remember which sub-menu of the hierarchy they are currently at is eliminated, because like in this example the icon for phone book is present to show what is being manipulated by the functionality linked with the icons.

Figure 4.1 – Screenshot from a submenu in the first iteration of the prototype.

The iteration was based on a mobile phone with all buttons as part of the phones hardware. This eliminated the need for functions in the software, as the hardware buttons could have the same function across all screens, but would at the same time take up space on the already limited screen space due to the need for button explanation.

4.1.2 Version 2

To test ideas for the final product, a new prototype was made. It was based on the same hardware and used many of the same concepts, such as the magnifying glass to represent zoom or detail. However new functionality was added. There was a marker over the selected icon to give feedback to the user, and had the "return" icon moved down to the bottom of the screen as it would be bound to the same button at all times, increasing its consistency. Feedback and consistency are design principles, and should be thought through in designs. By adding the marker, users will at all time be aware of what menu option that is currently selected, and reduce the chance of anything unexpected happening. Being consistent with functions where possible, such as with the return button reduces the amount of learning needed, because "users have to learn only a single mode of operation that is applicable to all objects" (Preece, Rogers, & Sharp, 2002, s. 24).

It was discussed whether, in the gallery section, it would be viable to combine each picture in the gallery with a descriptive function, such as "delete", "detail" and "add picture to contact", to make sure the user would fully understand what picture was being edited. Doing so would increase the visibility of the interface, and make it more consistent with the other menus, where icons combining, as an example, a phone book and a plus sign, are common. This change was, however, discarded after seeing the result, as in figure 4.2 and 4.3 below. What

in theory sounded like an improvement, turned out to make the interface overcrowded, and with an addition to all the miniature pictures, they can be confused with each other, and thought to be different.

Figure 4.2 – Alternative gallery display.

Figure 4.3 - Traditional gallery

This version of the prototype had support for interaction, but was however still made in PowerPoint, limiting the amount of functionality that could be added. The figures above illustrate how ideas which appear to be conceptually viable, give a different impression when put to practice in a prototype.

For version 3 of the prototype, Adobe Flash Professional was used to add further functionality to the prototype. This is a suitable tool for making interactive applications, and has good support for adding and manipulating images for use in the applications. In addition, Flash movies can easily be uploaded to web pages and thus be accessed from any location where internet is available (adobe.com).

4.1.3 Version 3

After dialogue with the supervisor, the possibility of a version based on a touch phone should also be tested. The pros with this were:

- Larger screen with room for more larger icons
- Remove the need to map buttons to icons on the screen
- Less room for mistakes; fewer buttons to press equals fewer wrong choices that can be made

Cons:

- Lack of hardware buttons might confuse users if their expectations of a mobile phone is the kind with hardware buttons
- Users might hesitate to use it if their hands are dirty (Lalji & Good, 2008)

At this point in the iterative process, icons drawn by the illiterates participating in the data collection were designed and added to the prototype. The prototype created was originally going to be made entirely from icons collected during the study. Because of the lack of participants, and the bad transferability of some ideas drawn, as in not being possible to downsize to what is required to fit on the screen, external ideas has to be included in the prototype. Below are a few drawings that were digitalized and changed to be usable in the prototype.

Figure 4.4 - Two drawings of "Set time" plus the digitalized version used in the final prototype.

Drawings for the icon representing "Set time" all included a clock in one way, either a big clock, like the leftmost drawing, or a person adjusting a wristwatch, like in the middle drawing in figure 4.4. Persons are represented in 3 of the 5 drawings gathered, and clocks in

all 5. The natural thing would then be to include a clock and a person. One of the drawings include a person the same size as the clock, pushing the clocks hands, and as was discovered in chapter 4, unrealistic elements in a picture can lead to misinterpretation from the user if they are not familiar with the concepts depicted (Medhi, Sagar, & Toyama, 2005).

When making icons for a mobile phone there is already limited space, and in order for a clock to be proportionally sized compared to a human, the icon would have to be of great size, and it is likely that focus would be drawn away from the clock itself, and over to the person that is occupying most of the icon area. Many of the drawings gathered included persons performing actions, and to include the "human factor" in the "Set time" icon, a hand with shake-lines was included, to symbolize turning the wheel on the side of clocks, which is how analogue watches are set. These factors combined lead to a concrete icon with a clock being manipulated by a proportionally sized human hand, which has shake-lines to symbolize the action, fulfilling the requirements of an icon that is easy to understand.

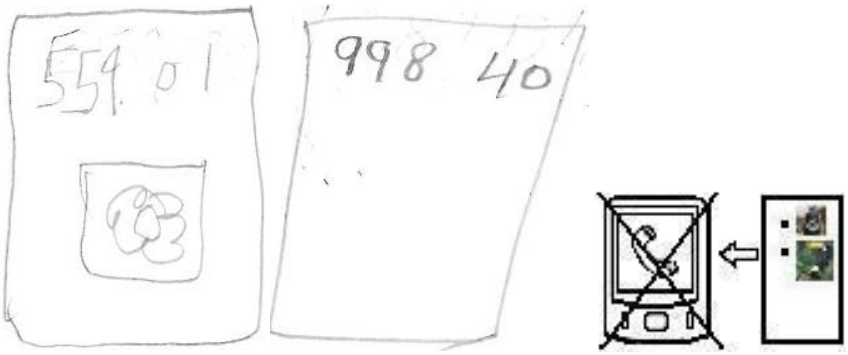

Figure 4.5 – Drawings of "Missed calls" plus the digitalized version used in the final prototype.

Some drawings for the function "Missed calls" were, as shown in figure 4.5, lists with numbers. This was also seen in drawings for "Made calls". One way to utilize this idea is by making dynamic icons for "Made calls", "Missed calls" and "Received calls". As discussed in chapter four, this allows the users to utilize their memory when looking at the icons, and if they do remember who the last caller was, it will help them select the right icon, or exclude those which they know are wrong.

Making a concrete icon of a call log is challenging because there is not one universal design for a physical call log. Some people write it down on any piece of paper that is nearby, while

others write it down in books. And how can one write down missed calls? In this case the result is a list pointing to or from a mobile phone with the same design as the hardware. The list refers to the paper where callers are written down, and the arrow points to the phone in the case of incoming calls, and away from the phone for outgoing calls. Call log icons are less abstract than others, because they do not consist entirely of concrete objects. Unfortunately there is no real world counterpart for all functions available through a mobile phone, making it unlikely to fulfill the guidelines for intuitive icons in every case.

After successfully creating the first version of a touch screen prototype, it was thought of as the better option from the two, with the main reason being that the icons would not fit in one screen of the first phone model, and the user would have to scroll down to find the options on the main menu, as opposed to the new prototype, where menu screens display all the buttons at once, eliminating the need to scroll in order to access functions.

Version 3 of the prototype, the first touch based version, included all the icons digitalized from data gathered during the study.

Figure 4.6 – Prototype version 3, touch screen.

As seen in figure 4.6 all options available to the user are displayed on the screen at the same time. Pressing icons directly instead of navigating to them through hardware buttons eliminates the need for the user to understand button mapping, and saves time. Results from previous studies indicate that people who are new to mobile phones may not respond correctly to highlighting of menu items, and instead of cycling through menus until the marker is hovering over the correct option, they click the access button as soon as their option becomes visible on the screen, regardless of the marker's position (Lalji & Good, 2008).

4.1.4 Version 4

Affordance is an important principle in interaction design, and maybe especially when talking about intuitive functions. Affordance is defined as how well an object invites to be used in the correct way, such as a button inviting to be pressed in a larger degree than just a flat image on a background (Preece, Rogers, & Sharp, 2002).

The frames around the icons were added to better separate the icons, and guide the user to where he or she can press to access the different functions. A simple shade effect was created around the button to create the feeling of it hovering and inviting to be pressed, thus signalizing that it is a button. This effect is demonstrated below.

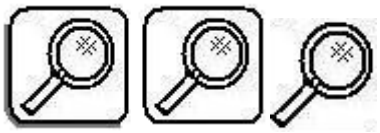

Figure 4.7– **The effect of adding shade to make an icon hover.**

Adding these effects also makes the feedback given when pressing the button more as what one would expect; the button being pressed down. This is not possible if the icon is flat on the background.

Version 4, shown in figure 4.8, which is also the final version of the prototype, had all icons made to look like buttons. In addition to showing the users where they can click to access the functions, it also creates a structure on the interface, making it look more organized.

Figure 4.8– Touch screen based prototype: main menu.

More screenshots from the final prototype of the mobile phone can be seen in appendix B.

4.2 Chapter summary

In this chapter, the prototype development has been presented, from the early versions throughout to the final version which is to be evaluated. Different versions were evaluated and developed further through evaluation by the designers, and discussion with external parts. Improvements were added for each version based on theory about good practices, and inclusion of icons gathered through user input.

5 Evaluation

Deciding whether an interface is easier to use for illiterate persons or not is an extensive task, because there are so many different illiterate individuals, and there is no single solution that is best practice for everyone. Testing the interface on every person who might use the interface is not possible, so a different approach must be taken. Options are user testing or expert testing. User testing can be done by testing the interface on a smaller group, representing the end user group. Since users are sometimes hard to acquire, or for other reasons not available for assisting with product testing, expert users can function as evaluators through walkthroughs or heuristic evaluation. In this study, evaluation will be done by expert users through a heuristic evaluation.

Benefits of heuristic evaluations come in terms of time- and cost efficiency; in contrast to engaging users and setting up a test location, heuristic evaluations can be done informally over a few hours, and without the need for special a setting (Nielsen & Mack, 1994).

Studies evaluating icons often see them individually in order to find out how well they are interpreted according to their intended meanings (Pappachan & Ziefle, 2008; Schröder & Ziefle, 2008). In this study however, the goal is not to make an interface with icons that are understood separately out of context, as they will never occur individually to the user. In the interface, icons can be interpreted through the meaning they convey individually, or they can be interpreted through their meaning in the context they occur (Heim, 2008). Hence the prototype will be tested as a complete device instead of testing the pieces individually. If the icons' functions can be augmented through the right context when testing, it is also likely that it will help end users similarly when presented with this product's interface.

5.1 Heuristics

Heuristics were at first developed to evaluate screen based web content, thus often reflect guidelines for how web sites should be designed. As more technology is becoming available in various forms, such as mobile technology, interactive toys, wearable computers and more, heuristics must vary in accordance with the development. New heuristics should consider Nielsen's (1994) heuristics, requirement analyses, design guidelines and market research in order to be optimized (Preece, Rogers, & Sharp, 2002).

Evaluation of the mobile phone prototype in this study will be based on Nielsen's ten heuristics for user interface design in addition to new ones, found through discussion in previous chapters. The ten heuristics for interface design are:

1) Visibility of system status: The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.

2) Match between system and the real world: The system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.

3) User control and freedom: Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.

4) Consistency and standards: Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.

5) Error prevention: Even better than good error messages is a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.

6) Recognition rather than recall: Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily

	retrievable whenever appropriate.
7) Flexibility and efficiency of use:	Accelerators -- unseen by the novice user -- may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.
8) Aesthetic and minimalist design:	Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.
9) Help users recognize, diagnose and recover from errors:	Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.
10) Help and documentation:	Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

Heuristics should be used according to the product or interface they are used to evaluate. Not all of the ten heuristics listed above are relevant to this particular interface and will be excluded during the evaluation. Heuristic number seven: “flexibility and efficiency of use” presupposes shortcuts and possibility of tailoring the interface to adjust according to functions used most often. In the interface being evaluated in this study, amount of steps available for different functions is already reduced, and there is no room for shortcuts. User interfaces for illiterate users should also have as few settings available for change as possible to prevent the amount of possible unplanned changes to be made; hence there are no options for adjusting the interface.

In addition to these heuristics, the ones that apply to interfaces for illiterate users to increase their chance of being correctly understood include:

1) Icons with high concreteness:	Icons should have high similarity to the depicted object's real world counterpart
2) Icons without too much details:	Icons should not be too detailed, to avoid confusion and misreading of depicted items
3) Action-elements in icons with action:	In order to interpret icons representing actions, action-elements such as shake lines and movement lines should be used to avoid icons from being interpreted as nouns
4) Icons with the human factor:	Using a person in icons can help place it in the right context, such as a hand manipulating the wheel on a wristwatch to indicate "set time" instead of just a watch, which would indicate "time".
5) Limit the amount of possible changes:	More options means more chances of making the wrong choice, which can result in frustration and confusion. Limiting the amount of settings a user can change is a means of preventing errors.
6) Low complexity:	Keeping the menu hierarchy's depth at a minimum will help prevent users from getting lost when looking to change some settings.

The last six heuristics listed here overlap somewhat with Nielsen's (1994) heuristics, but are used never the less, to discover as many errors as possible.

In chapter four, additional guidelines were listed; intuitive placement of icons, consistency and exclusion of functions that are not necessary. These are covered by Nielsen's heuristics number two, four and eight respectively.

5.2 Evaluation process

Expert evaluators are asked to perform tasks on the prototype. These sequences require the testers to explore as much of the interface as possible, aiming to reveal as many errors as possible. The tasks are as follows:

1. Find detailed information about a contact in the phone book
2. Delete a contact from the phone book
3. Edit saved information about a contact
4. Find out who made the last call that was not answered
5. Take a picture and view it in the gallery
6. Delete a picture from the gallery
7. Add a picture from the gallery to an existing contact
8. Set the time for the alarm clock to give a notification

The evaluators will write down their findings in accordance to the heuristics. In addition, they will be observed when performing given tasks, to register the amount of wrong choices made. Evaluators were also asked about the icons used to find out their impression of how easy icons were to understand.

5.3 Evaluation results

Task	Evaluators 1 through 5				
1	1	1	1	1	1
2	1	1	1	1	1
3	2	1	1	1	2
4	1	1	1	1	1
5	1	1	1	1	1
6	1	1	1	1	2
7	1	1	1	2	2
8	1	1	2	1	1

Table 6.1 – Attempts needed per evaluator to complete the 8 tasks.

Table 6.1 shows how many attempts each of the testers needed to complete the task given. Only 6 of the total 48 tasks were completed after more than one attempt, with the remaining 42 tasks completed on first attempt.

Feedback from evaluators after exploring the interface revealed a range of errors, but some occurred more often than others. Four testers reported lack of help-functions and documentation. The “Edit contact”-icon was evaluated as bad by three users; however they

were able to find it during the test. Through discussion and observation, this can be explained by their expectation of where to find this function, coupled with their own reasoning that none of the other icons appeared to serve this function. Visibility of system status was commented negatively; especially difficult was separating phonebook and gallery from inside the menus. System complexity was reported as low, with few steps needed to complete tasks and few unnecessary functions.

Summarizing main findings from the heuristic evaluation, we find that a shallow menu hierarchy is positive in terms of making the phone less complex. Of the icons which received negative feedback regarding unclear meaning, most represented abstract phenomenon, such as the "Edit contact information" and "Call contact" buttons. Concrete icons, such as the "Phone book" and "Gallery" were criticized for being too similar, or being too small, though the meaning was clear. This further proves results from previous studies showing that concrete icons are easier to recognize than abstract icons. One problem with abstract icons is that there are no clear conventions for many of them. Such as the "Edit contact information" icon, which is an "Edit" button available as an option for each contact; it has no counterpart in the real world.

For icons using human factor, such as "Take picture", "Set time" and "Set alarm clock" the response was positive save one evaluator, who thought the first of the three icons was too detailed, which can be a result of the hands taking up too much space in the icon, taking focus away from the camera itself. No negative comments were given of the "Set time" and "Set alarm clock" in regard to the hand manipulating the wristwatch.

Four evaluators noted the lack of help- or assist possibilities when using the interface. Voice walkthroughs were not used for the prototype created in this study for reasons discusses in chapter two. A new challenge for the future arises: Is it possible to create iconic walkthroughs for devices made to support illiterate users?

Last, testers solved some of the tasks through reasoning, both by eliminating buttons, and through expectations from similar interfaces. While being able to solve the tasks correctly with this method, it can be difficult for someone who are not accustomed to using mobile phone, thus not sure what to expect from one. Future testing should include end users in order to answer that problem.

Icons used in the prototype were at an early phase, and smoother details would perhaps allow testers to understand the icons better. However, the icons were mostly identified correctly by the testers, indicating that the concept communicated through the icon was understood. Appendix A shows all icons in the prototype.

5.4 Chapter summary

Heuristic evaluation was used to evaluate the prototype. Five expert users were given tasks to complete as part of the evaluation process, before exploring the interface critically with the heuristics. Nielsen's (1994) heuristics for interface design were used, in addition to a set of heuristics for interfaces for illiterate users, created as part of this study with basis in previous research. Results showed that tasks were mostly completed on the first attempt, which indicates that the interface is easy to use. Evaluators revealed that when they were unsure of where to click, reasoning and expectations were used to figure out which icon was that right one. For further testing, end users should be included in the process.

6 Future work and discussion

In this study, the mobile interface supporting use by illiterate persons has been explored. Taking advantage of previous research and adding it to new data has resulted in a prototype presenting new ideas, while also taking advantage of practices that have been evaluated as functional for the relevant target group. Expert evaluation has been used for heuristic evaluation of the prototype to uncover flaws and errors with the prototype, preparing for a future round of iteration and testing.

6.1 Future research

The digital divide between those who can read and those who can't is a barrier yet to be passed in order for illiterate users to take advantage of technology in the same way as literate persons. Research reveals progress in terms of universal icons, but new challenges arise on the way. Discussion regarding the benefits of increased mobile phone penetration has more than one aspect; personal and a social. The personal aspect focuses on what benefits individuals gain from being able to use a mobile phone, while the social aspect gives answers to how an increased mobile phone penetration, thus an increased communication network, will benefit societies.

Topics that will be discusses in this section are benefits of increased mobile phone penetration and how further exploration of intuitive interfaces can be beneficial for mobile technology, whether there is an interest amongst illiterate people to get mobile phones that are easier to use, what factors that limit illiterate people from using mobile phones today can be solved by making a model that does not require them to be able to read, how suitable icons for such a phone can be designed, and what icons would be suitable in such an interface?

There will also be a discussion of how research regarding intuitive interfaces can benefit mobile technology. Establishing whether there is an interest amongst illiterate people to start using a mobile phone that was easier to use than current models is another step towards justifying this research.

6.1.1 Personal reasons

Previous research on this area tells us that persons not currently using mobile phones would like to own one for one or more reasons. First there is the business factor. Interviewees

participating in a study by Lalji & Good (2008) answered that a mobile phone would be good for business, and named this as a reason for wanting one. Response given by one of the participants was:

> ‘‘. . . My neighbor, a door to door vendor got an inexpensive mobile phone and gave his number to customers. Now he has a cart in the market and additional help for home deliveries. . .”
>
> (ibid, p. 576)

The answer can be interpreted in such a way that the participant blamed the success of his neighbors business entirely on the acquisition of a mobile phone. Secondly the study showed that keeping in contact with families was another main reason for wanting a phone. Indian houses are not all connected by landlines, and for some the process of making a phone call relies on borrowing a neighbor’s phone or visiting a public call office. By acquiring either a phone for themselves, or for their family members, there will be an increased availability of communication. This will ease the process of actually making a call, and reduce both the time it takes to get to a phone, and the time lost if the receiver is not available at the time. As a result, the same study concluded that mobile phones for illiterate users would improve their quality of life (ibid). During an informal conversation with the students at the school for illiterates, some of them replied to the question of whether a mobile phone designed for illiterate users would be helpful to them, that it would be beneficial, though they did not specify their answer further.

Designing mobile phones for illiterate users will increase their chances of being able to use more of the functions than those available to them via the text based menus (research.nokia.com, 2010). Though writing shopping lists on the phone or sending text messages may not be available to them until they learn to write and read, adapted menus will enable them to navigate to other functions such as the alarm clock and the phone book.

6.1.2 Economic reasons

Apart from the benefits for the single person, there are also more holistic benefits through increasing the widespread of mobile technology. Studies show that a country’s GDP is proportional to its telecommunication penetration (Waverman, Meschi, & Fuss, n.d). Lack of communication, and no infrastructure to support it, is bad for business. Instead of making a phone call to determine prices and product availability, the alternative is physical transport, resulting in a high cost for information retrieval compared to having the information retrieved by phone. This supports the findings from Lalji & Good (2008) where having a mobile phone

was good for one man's business, but can also be translated to having effect on a whole country's economy. Findings from Waverman, Meschi & Fuss (n.d) are not necessarily arguments for making mobile phones accessible to illiterate users, but benefits from increased telecommunication penetration do not only apply to literate persons.

In order for illiterate users to want to use new information technology there must be clear benefits to their way of life which they may acquire if they use the new technology (Heuenerfauth, 2002). Making new technology available does not necessarily mean that people in the product's target group will want to buy or own it. One major challenge is making users aware of the benefits provided through having a mobile phone, thus getting access to information and communication. Huenerfauth (2002) describes cases where access to information technology can be crucial. For example urgent calls if someone is urgently ill, or being informed about diseases and treatment for these, in addition to the other reasons mentioned earlier for wanting to have a phone. These arguments become valid, however, if there is no awareness around what benefits there are to being able to use mobile phones. Investing in a mobile phone can have a significant impact on someone's economy in countries with low wages and standards (Lalji & Good, 2008), and illiteracy is in most cases linked with low income. Hence products made available to this market must be sold at a low cost in order for it to be accessible to the target group. Disregarding the financial aspect, there did seem to be an interest in mobile phones amongst the people asked in India (Ibid).

Allowing more people to use mobile phones is beneficial not only to the persons who use it, but also on a bigger scale. Exploring intuitive interfaces may lead to innovations not only in the field of mobile phones for illiterate users, but may also inspire designers of regular mobile phones to focus more on icon-based solutions, as tests indicate better time efficiency when operating these menus than text-based alternatives. If illiterate people who are unaware of phones and their potential usefulness are going to want to spend money on a mobile phone, they will need to see clear indications of how it can affect their lives in practice; else they are not likely going to be interested in the investment. These conclusions justify the effort done in the process of creating mobile phones that are easier for illiterate users to understand and use.

From the topics discussed above we know that it would be beneficial to increase the mobile penetration rate, and that the effort to make mobile phones that is easier to use for illiterate users can be justified. Making mobile phones available to persons who currently are unable to take advantage of the technology because of the literacy barrier will help them communicate

with their family and friends in an easier way than what is currently available, and it can also help improve their business possibilities through making them more available and opening up for more insight to the market for raised profits. On a larger scale, countries will be able to raise their GDP through increased penetration, and it is more economical based on cost per connection to do so by mobile technology instead of landlines.

6.2 Conclusions

This study sought answer to how an iconic interface for mobile phones could be designed to support use by illiterate persons. Previous research and theory was presented to introduce topics that were discusses throughout the study, and place the study in the right context; a Human-Computer Interaction research study. Second, design issues were discussed as part of the design research, explaining the process that took place to solve the research question. Current best practices were applied to new data gathered in this study, resulting in the basis for a prototype utilizing best practices, exploring new ways of applying them to technology. Discussion revealed what factors are necessary in order for an iconic interface to have best possible chance of being correctly understood. Concreteness, proper amount of detail, intuitive placement of icons and icons with actions are factors that affect any user of the interface. For the interface to be usable by as many as possible, icons that do not place limitations upon the user because of their cultural background must be used. Concrete icons can only be created for so many phenomena, leaving future research to find solutions to how icons can be made that allow for non-subjective interpretation of abstract images.

A prototype was designed as an answer to the research question, and was then put through a heuristic evaluation by expert users, deciding how well it fulfilled the guidelines for interface design and interfaces for illiterate users. Conclusions were then extracted from the results given by the evaluators, and presented.

Design and evaluation of the prototype created in this study showed similar results to those of former research. Icons that were hardest to recognize were those of abstract phenomenon, such as Edit, and evaluators had little trouble identifying concrete icons. Depicting hands performing tasks helped put some icons in context, and may prove to be a valuable supplement for future icon designs. Icons combining elements from different functions in the prototype, such as an arrow pointing to the phone book, implying “Add contact”, were mostly

thought of as a good idea to evaluators, however better details should be included in future prototypes to exclude flawed details as a factor when interpreting an icon.

Using heuristic evaluation is two-sided for evaluating design like the one in this study, as with other products. Sets of heuristics made specifically for interfaces for illiterate users can relieve researchers in the future from finding solutions that already have good practices, allowing more focus to be put on better icons. On the other hand, expert evaluations can only get to a certain point, from where users should be included in the testing to see how the interface is interpreted and used by those who may not be accustomed to technology in the same ways as a team of researchers.

Summarized, the contribution from this study is:

1) Further underlining the importance of high concreteness in icons.

Research shows again that concrete icons are easier to understand than abstract icons. When making icon-based interfaces for illiterate users, concrete icons should be used as large as possible to avoid the misinterpretation that is more likely to occur with icons that do not have a counterpart in the real world.

2) Evaluation showing that action-elements in icons improve their understandability.

Heuristic evaluation of the prototype created in this study shows that action-elements giving life to icons was positively responded to by evaluators as making icons easier to understand.

3) Testing the effect of human elements in icons.

Based on material gathered through this study, adding human elements, such as hands performing actions, can place icons in a context, thus increasing their chance of being interpreted correctly.

4) Use of heuristic evaluation on icon-based interfaces for illiterate users.

A heuristic approach was used in the evaluation of the prototype. While the set of heuristics for interface design is applicable to this kind of interface, new heuristics aimed specifically at this kind of interfaces should be made to assist researchers in the future.

5) Reasoning and expectations

Evaluators solved some of the tasks given by reasoning; where did they expect the function to be found, and which icons were not representing the intended meaning? If such an interface is available to users who are uncertain of how a mobile phone functions and what options can be expected to be found where. This can be partly solved through thorough information to the users as to what the benefits of acquiring a mobile phone.

6) Availability of help and assistance functions

As noted by four of the evaluators, there is no help function available when stuck. In textual interfaces, a few words explaining the function can be of good use, but that was not available in this prototype. Ideally the interface is intuitive enough for the user to never need help with operating it, however it is unlike that no one will need guidance when using the interface. Therefore effort should be made an assistance function for a text-free interface without introducing voice segments.

In order to advance further with this project, the prototype should be tested by end users in in a live setting. Effort should also be made to further investigate culture unspecific icons, by gathering data from larger sets of user groups. Mobile phones that allow illiterate users to take advantage of them in the same way as literate users do is a means of reducing the digital divide, and should thus be pursued.

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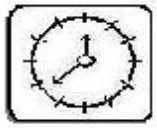
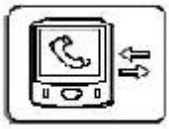
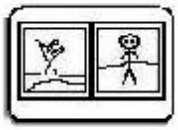
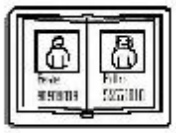
Appendix A – Icons used.


- Clock


- Call log


- Gallery


- Use camera


- Phonebook

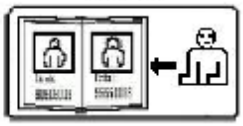

- Call

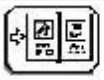

- Show details

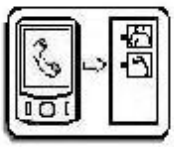

- Delete contact

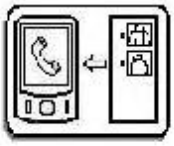

- Delete

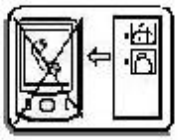

- Edit contact

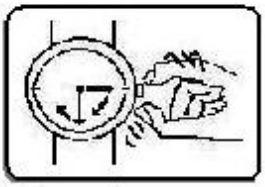

- Add contact

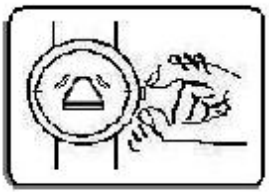

- Add picture to contact


- Made calls


- Answered calls


- Missed calls


- Set time


- Set alarmclock

Appendix B – Screenshots from the final prototype.

From top left to bottom right:

1) Starting screen 2) Phone book 3) Details about contact

4) Call log 5) Gallery 6) Clock

7) “Are you sure you want to delete this picture?”