Tallinn University
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Supporting Interaction Design Processes with Concept Mapping

Master Thesis

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Tallinn 2011

Author's Declaration

I declare that, apart from work whose authors are clearly acknowledged, this document is the result of my own and original work.

This work has not and is not being submitted for any other comparable academic degree.

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Abstract

This work focuses on the field of interaction design in the context of software development.

The paper addresses the problem of a lack of a transversal technique, which can be used to support interaction design processes through their various stages.

The research question focuses on assessing whether concept mapping is an adequate technique to support interaction design processes.

The purpose of this work is to design a new approach of using concept mapping to support elicitation, communication, representation and adaptation of knowledge through the overall interaction design processes.

The following work is classified as design research because research was specifically taken into the design process of the discussed case studies in order to understand whether concept mapping might serve as a viable answer to the formulated research question.

The research is based on a literature review and case studies, which illustrate the application of the proposed method in real-life projects.

The results indicate that concept mapping can indeed be applied in the field of interaction design and can successfully deliver on the established requirements.

Keywords

Concept, map, diagram, diagramming, knowledge, support, elicitation, visualization, communication, cognition, interaction, design, UML, state transition, decomposition.

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Chapter 1

Introduction

The field of interaction design has become increasingly important as more and more people attempt to build products and solutions, which are not only functional, but also appeal to customers as being easy to use and understand. This appears to be true of any new technology and as the maturing process occurs customers are no longer satisfied with the promises of the bright future the technology can bring and instead demand designs, which are understandable and workable. Naturally, companies cannot leave this tendency unnoticed and attempt to employ good designers to improve the quality of the products (D. Norman, 2002).

The need to create usable and understandable products can be seen as inevitably leading to a necessity of utilizing an established process with concrete principles and methodologies. Such a process is interaction design.

The topic of this work has been chosen because it appears to be very important to have a solid technique of eliciting, communicating, representing and adapting knowledge in order to design high quality and usable products and solutions.

- Elicitation is used in the sense of drawing forth or bringing out specific knowledge (The Free Merriam-Webster Dictionary, n.d.-c).

- Communication is used in the sense of transmitting knowledge between individuals by using a common system of symbols (The Free Merriam-Webster Dictionary, n.d.-b).
- Representation is used in the sense of bringing knowledge clearly before the mind (The Free Merriam-Webster Dictionary, n.d.-d).
- Adaptation is used in the sense of making knowledge fit for a new use by modification (The Free Merriam-Webster Dictionary, n.d.-a).

1.1 Existing Techniques to Support Interaction Design Processes

In their article, Karat and Dayton (1990) state that for a time there has been a *"search for a single holy Grail of design techniques"* to support interaction design processes.

According to Borchers (2000), a common problem in interaction design is that the concepts, tasks and terminology of a product environment need to be established. The multidisciplinary teams, participating in interaction design processes, quite often lack a common language to communicate product development knowledge to each other. Knowledge extraction and understanding of technological constraints is also very difficult.

Paula and Barbosa (2004) state that scenarios and prototypes are commonly used techniques for supporting communication in interaction design processes, yet quite often projects lack an integrated view, which may lead to issues and a general shortage of focus.

Karat and Dayton (1990) mention the use of conceptual specifications to facilitate agreement of team members in regards to the system, which is being developed. State charts can also be used to produce representations of interfaces after a designer has created them. Cognitive walkthroughs can be used to evaluate features of an interface. A User Action Notion can be utilized to capture behavioral information.

At the time of this writing, common techniques used for supporting interaction design processes are also UML (Unified Modeling Language), state transition and decomposition diagrams (Dix et al., 1993; M. G. Paula & Lucena, 2003).

Karat and Dayton remark that at one point the methods of software engineering were sufficient, but the introduction of cognitive psychology to the field of interaction design lead to a requirement of using many techniques to support the interaction design process (Karat & Dayton, 1990).

Paula, Silva, and Barbosa (2005) summarize the issue by stating, that many models and representations have been proposed to support design processes, however these deal only with specific fragments of the designed product. This can lead, for example, to difficulties in communicating design decisions.

1.2 Problem Statement

A problem can be seen in the absence of a technique, which can be used to support interaction design processes through all of their stages (see Figure 1.1). Such a technique should be easy to understand yet flexible enough to be adapted to specific context of a particular design stage. It is important for the technique not to be limited by any particular field.

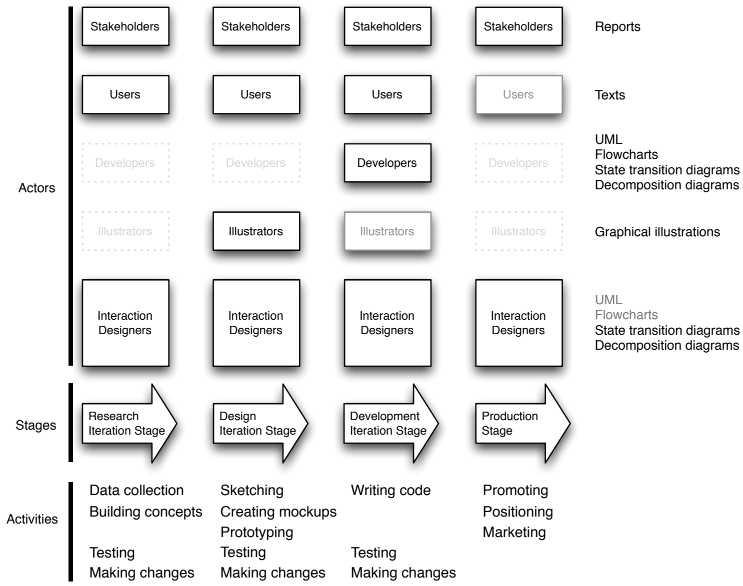

Figure 1.1: Model of an Interaction Design Process (see appendix A.1)

Figure 1.1 is based on the design stages proposed by Marcus and Gould (2000) and Yamazaki and Furuta (2007).

1.3 Research Question

A research question is put forth whether there exists such a technique, which could be used to support interaction design processes through various stages. Although Borchers (2000) presents an answer in the form of pattern languages, which turned out to be one of the most commonly proposed techniques, and Paula and Barbosa (2004) suggest the use of MoLIC (Modeling Language for Interaction as Conversation), the fact that at the time of this writing, none of these techniques have been widely adopted by the interaction design community leads to a conclusion, that the formulated research question has not been answered by other researchers.

This leads to the hypothesis that a technique called concept mapping, which originates from the field of learning, can be appropriate for this task, as it has been applied with good results in the domains of education, government and business.

1.4 Research Methodology

Design research has been chosen as the methodology for validating the hypothesis with the goal of improving the way the proposed design would operate in practice (Collins, Joseph, & Bielaczyc, 2004) and producing a contribution of knowledge (Zimmerman, Forlizzi, & Evenson, 2007). Several case studies were conducted, which focuse on designing various prototypes of mobile applications. Concept mapping has been applied in each of those case studies with the goal of researching its effectiveness as a form of support of interaction design processes. The technique was continuously refined from case study to case study in order to revise the design based on experience and work out all possible issues. Real-life projects were used as case studies in order to avoid distortions of resulting findings. At times, certain elements of the design were not working and needed to be modified to better fit the context. This corresponds to the description of a design research process as proposed by Collins et al. (2004).

1.5 Overview of Chapters

Chapter 2 focuses on establishing a cognitive framework in order to understand how humans in general gather and structure information to facilitate creative problem solving, such as conducting interaction design related work.

Chapter 3 offers a description of a technique called concept mapping, which is the proposed solution to the formulated research problem.

Chapter 4 describes the techniques, which are currently commonly used for documentation in interaction design projects. The discussed techniques are decomposition, state transition as well as UML (Unified Modeling Language) diagrams. The aim of the chapter is to establish the reasons, why existing documentation techniques are not suitable solutions to the formulated research problem.

Chapter 5 describes several case studies in order to illustrate the application of concept mapping in real-life interaction design projects of various scope and timeframes. Design research is used as the primary methodology in order to see how the technique performs in various scenarios.

Chapter 6 focuses on a proposal to enhance the structure of the interaction design process by utilizing concept mapping through various, modifying and reshaping them, depending on the context.

1.6 Closing Remarks

It appears that concept mapping can be a suitable answer to the formulated research problem. It can act as a support for eliciting, communicating, representing and adapting knowledge in an interaction design project from the beginning stages until the very end, when a final product is delivered. Another benefit of using concept mapping for interaction design is the fact that the technique is not tied up to a specific methodology. A concept map helps to illustrate the strengths and weakness of an idea through peer evaluation and possesses ease of displaying information as a picture instead of text or a complex modeling language (Barksdale & McCrickard, 2010).

Chapter 2

Cognitive Theory Framework

This chapter explores the ways humans collect, structure and reuse pieces of information to facilitate creative problem solving, such as conducting interaction design related work. The purpose of this exploration is to find commonalities, which are not related to specific fields or backgrounds, but are considered general to all people. This understanding can lead to discovering a technique, which can be used to support interaction design processes through their various stages.

2.1 Information Scraps

Among the messiness of daily life people tend to produce a large amount of disjoined pieces of information. These bits and pieces can be created amongst different work or learning related processes. M. Bernstein, Van Kleek, Karger, and Schraefel (2008) propose a term to define these chunks of information, stating that it is possible to refer to any piece of data not stored in a specific tool designed for managing it as an information scrap. Information scraps are considered to be short, self-contained and usually intended for personal use by their author. They can span a few words or consist of up to several sentences and can function as reminders, memory aids or hold incomplete thoughts (M. S. Bernstein, Van Kleek, schraefel, & Karger, 2007).

Information scraps can be of various types and are usually such ordinary things as text written on Post-its, messages and text files or scribbles on a piece of paper or even an email with a reminder sent to oneself.

From the previously mentioned examples a pattern emerges, based on which it can be inferred that the preferred tools for storing information scraps are less formal and less complete. Therefore, a plain text editor can be a preferred application for creating information scraps when compared to, for example, Microsoft Word (M. Bernstein, Van Kleek, et al., 2008).

An especially good example of a tool of preference for storing information scraps is plain paper. Paper has several crucial characteristics, which make it such a suitable candidate for serving as an information scrap manager. Paper allows for freedom over visual structure and enables sketching. It does not need to take time for booting up and is available for data input right away, unlike a computer. It can be reoriented in space and easily annotated and so is a great tool for collaboration. Finally, paper has the flexibility of navigation and is mostly considered a commodity, being cheap and available anywhere (M. Bernstein, Van Kleek, et al., 2008).

It might also prove useful to understand the purpose, which information scraps serve. People tend to use information scraps in various ways. These include being utilized as temporary storage, a tool for supporting a particular kind of a cognitive process, a reminder, a place for archiving information, or simply for recording an unusual piece of data for which the person has not yet been able to find an appropriate location. It is also important to note that the creators of information scraps expect them to obtain a certain degree of mobility, meaning the possibility to take them anywhere their owner goes and being easily transferable (M. Bernstein, Kleek, Schraefel, & Karger, 2008). Transferability is of a special importance for information scraps as there is a tendency to reuse them later as a basis or scaffolding for more complex data structures.

People usually create information scraps, when the cost of writing something down properly or finding a suitable location in a folder hierarchy is perceived to be too high. This can be seen in a situation where a person has reached a state of flow while being immersed in a particular task and does not wish to distract himself with an idea, which can be put on hold and dealt with later (M. Bernstein, Van Kleek, et al., 2008). Thus, the thought is quickly written down on a piece of paper, quite often in an abbreviated form.

One very powerful characteristic information scraps have is context and location. In fact, this very same property enables humans to use forms of abbreviation, because the context of that particular object may very well communicate the rest of the missing information. Blandford and Green (2001) and Gonçalves and Jorge (2004) discuss the importance of context in more detail.

In the research conducted by M. Bernstein, Van Kleek, et al. (2008), they have seen examples of test subjects sticking notes and labels directly to computer cases and mobile phones. These notes served as to-do items and reminders and having a particular context associated with them, there was simply no point for the test subject to thoroughly elaborate what needed to be done or file the reminder away in a personal information management application.

As described earlier, an information scrap can serve as a type of a memory prosthesis aimed at reminding the person of an original thought he did not have the time to deal with previously. This property is very interesting from a cognitive perspective, because humans can in essence use information scraps as a means of offloading information from their mind and onto external resources. Thus, even a simple paper with some information written on it can become a piece of cognitive technology, being a peripheral device on which important information is stored (Dror & Harnad, 2008). The person later reshapes and modifies this data in order to support problem solving, such as conducting interaction design related work.

Information scraps have their own distinct lifecycle. An important stage of that lifecycle is transfer, when the data from a particular scrap is ready to be migrated from a work in progress into a more structured representation (M. Bernstein, Van Kleek, et al., 2008).

2.2 Organism Plus Wideware

According to Clark (1998) humans tend to use parts of the external world as a kind of *"extra-neural memory store."* These parts of external world can essentially serve the role of information scraps. Examples of these external props may include not only pieces of paper or Post-its but also note-taking software in the computer, because using this software can essentially be seen as offloading information onto physical objects such as hard drives.

Humans put data into the physical world because eventually their heads become too cluttered with great amounts of trivial information, effectively limiting the capacity to complete even the simplest of tasks (D. A. Norman, 2010). The process of offloading data onto physical objects enables the saving of cognitive resources. It is not necessary to possess a rich inner representation of the world, the maintenance of which may be very demanding. Instead, there exists a capability to retrieve information fast and only when it is needed. In fact, human brains are used to taking into account all the external props and aids, which enables the inner processes to compliment and not replicate them. This property makes the work of a human brain much simpler and more economical (Clark, 1998).

These external cognitive helpers can be referred to as wideware, which is similar to software running on computers or wetware, which is a term for describing the human mind as a computing element.

It can be concluded that human beings rely on wideware as scaffolding, using it as a form of cognitive support to help with problem solving. During the research stage of the interaction design process wideware artifacts might get created all the time by means of making sketches, taking notes or drawing diagrams on the whiteboard. Later this information is expected to be reused as a basis for the design stage, where actual mockups and prototypes will be created.

2.3 Closing Remarks

This chapter introduces the concept of information scraps. It has been stated that humans use these pieces of the external world all the time to offload and store information, which enables saving of cognitive resources and not relying on memory, which can be faulty at times. Information scraps can have context associated with them, which enables a person to store data in an abbreviated form, effectively saving time at moments, when attention and available time for writing something down may be scarce.

The understanding of creating and managing of information scraps as a means of knowledge creation is necessary to find a technique, which can be used to support interaction design processes through their various stages.

Chapter 3

Concept Mapping

This chapter discusses concept mapping in the context of finding a technique, which can be used to extract, communicate, represent and adapt knowledge based on specific needs to facilitate creative problem solving, such as conducting interaction design work.

3.1 What Is Concept Mapping

A research team lead by Joseph Novak in the 1970s at Cornell University has created a technique called concept mapping. The main goal of the technique is to support meaningful learning, a process where a student is able to not only receive new information but also effectively incorporate it into the previously established cognitive structure (Novak & Cañas, 2006).

The technique proved to be successful and has been eventually applied as a means of representing expert knowledge in the fields of education, government and business (Novak, 2010a).

A concept map is a diagram, which enables the representation of relationships between ideas, images and words. Concept mapping encourages logical thinking by illustrating connections and helping visualize how *"individual ideas form a larger whole"* (Railroad Commission, n.d.).

Novak (2010b) states that a concept map is a hierarchical network, which is comprised of concept terms. These terms also act as nodes, which are connected by labeled linking lines. The labels of the links explain relationships between nodes.

Concept mapping can be used to organize pieces of wideware. An example Novak (2010a) puts forward is of teams using Post-its to create concept maps and later transferring them into a computer.

Structuring a concept map in a hierarchical way means dividing concepts into two large groups. One of them is the higher order group, which consists of concepts that are more general and the lower order group, which is usually populated with concepts that are more specific. It is also a possible to add cross-links, which show relationships between ideas in different segments of the diagram. Thus, certain concepts can form loops and not just straightforward linear connections. An exception might be a more hierarchical concept map with very little or no cross-links at all (Novak, 2010b).

An important value of concept maps is the ability to add a focus question, which helps the author use only the necessary ideas in order for the diagram to answer a formulated question (Novak, 2010b).

According to Novak and Cañas (2006), concept maps are flexible enough to show relationships among concepts of any type of a complex and structured domain. The maps can be built for any type of subject and can facilitate creative work in every discipline.

Figure 3.1 shows a concept map constructed for describing what a concept map is.

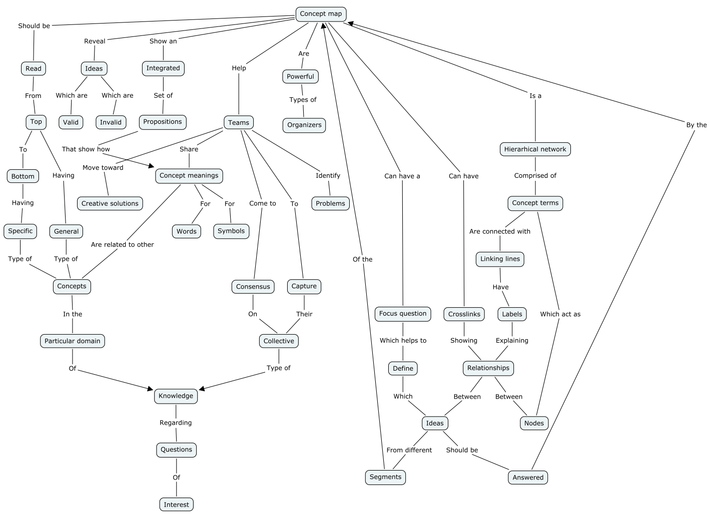

Figure 3.1: Explanation of a Concept Map (see appendix A.3)

3.2 A Way of Structuring Knowledge

The goal of concept mapping is to facilitate meaningful learning, which is a process characterized by a learner being in control of the acquired new knowledge. The person is then able to retain the knowledge longer and use it in creative thinking and as scaffolding in future learning.

Concept maps help establish an integrated framework of propositions and concepts, which are organized hierarchically to support problem solving.

Because creating a concept map for a particular domain of knowledge requires a person to structure and organize his ideas in a comprehensive and thorough way, concept maps can also easily surface both valid and invalid ideas. As a result, the creator of a concept map is able to see clearly, which ideas do not simply make sense and need reformulating or expanding (Novak, 2010a).

3.3 Facilitating Teamwork

Novak's research suggests that concept mapping is a great tool to be used in teams. Concept maps help groups move towards solutions that are more creative. Different members are able to share concept meanings for words and symbols and reach an agreement on how the information depicted in the diagram relates to other concepts from a particular domain of knowledge in regards to a certain question of interest to the group.

With the help of concept maps team members are able to reach a consensus and capture ideas collectively, thus reaching a new level of understanding and cooperation (Novak, 2010a). This can be especially important in interaction design processes, were there is a need to clearly communicate ideas between stakeholders and members of the design and development team.

3.4 Concept Mapping As a Visualization Tool

An important aspect of concept maps is that they enable visualization by creating visual artifacts, which can amplify cognition and reflect the process of internal construction in the mind. During the creation of a visual map of abstract data, the mind establishes certain mental models, helping a person to understand and expand that data. Through the benefit of visualization, it is possible to produce better information (Mazza, 2009).

A good visualization needs interesting data in order to produce a good picture. The aim of a good visualization in general and a good concept map in particular is to communicate ideas clearly, precisely and efficiently using the least amount of space and ink and in the shortest amount of time (Mazza, 2009).

3.5 Creating Good Concept Maps

In his book, Novak (2010b) proposes a particular algorithm for constructing good concept maps. The steps worth paying attention to are as following:

1. Identify a focus question addressing the problem, issue or domain of knowledge the author wishes to map.
2. Guided by the focus question 10 to 20 concepts related to the chosen topic should be selected.
3. The selected concepts should be ranked by placing the most general idea at the top.
4. A hierarchy is then created with more general topics positioned at the top and more specific ideas at the lower levels.
5. It is not recommended to place more than four concepts under any other concept. If the mapmaker comes across an issue of more than four nodes accumulating under a particular topic it usually means that it is possible to introduce an additional intermediate concept to level things out.
6. The concepts should be connected by lines, which are labeled with several linking words. The linking words tend to define the relationship between affiliated topics so that the link can be read as a valid statement.
7. It makes sense to look for cross-links between different segments of the diagram in order to surface new and unexpected relationships.
8. It is possible to create concept maps in many different forms reusing the same set of concepts. In this sense concept maps are very flexible, because there does not exist a single right way to draw them.

The described steps can also be represented as a concept map seen on Figure 3.2.

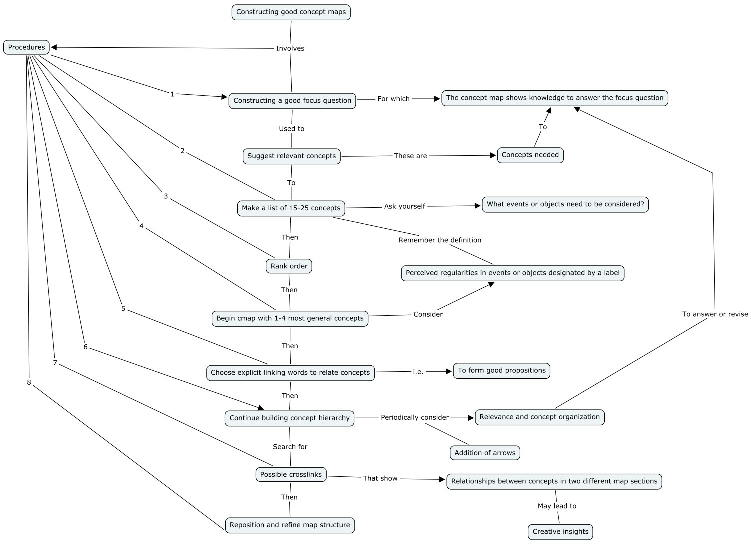

Figure 3.2: Constructing Good Concept Maps (Florida Institute for Human and Machine Cognition, n.d.-b) (see appendix A.4)

3.6 A Practical Example

It appears to make sense to provide a real world example of applying concept mapping for managing disjoined information pieces and it seems reasonable to use the writing of this document as a case study for proving the point of the method working in practice and not solely in theory.

Figure 3.3 is a concept map demonstrating the structure of this document as well as research problem, hypothesis and the selected research method.

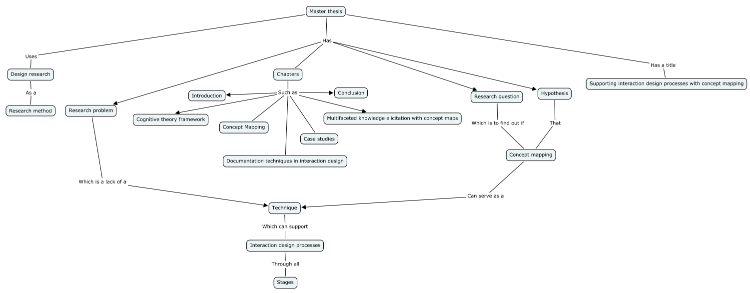

Figure 3.3: Master Thesis Concept Map (see appendix A.5)

The writing of this document began by conducting an overview of literature related to the subject in order to establish a solid theoretical foundation for the topics being discussed in these chapters. Several sources have been chosen, which covered the issues of cognition, information scraps and creating tools for managing them, information visualization, interface design and concept mapping. Out of all the available sources relevant parts and chapters were highlighted and later transferred to a single text file. Later only the relevant concepts and ideas were selected out of the chosen paragraphs and transferred onto a canvas.

The next step was to establish relationships between the selected concepts. Small groups of related ideas were formed, which were then integrated into larger ones. Like a puzzle, the big picture started coming together with concept mapping helping to bring out unexpected relationships between that, which at first seemed to be disjoined pieces of data. A sophisticated and interconnected structure has been built, which has also served as a basis or scaffolding for these particular chapters.

The described process represents the creation of a product as defined by Clark (1998): *"The brain then played a role in re-organizing this data, on clean sheets, adding new on-line reactions and ideas. The cycle of reading, responding and external re-organization is repeated. Finally, there is a product."*

The result of this work can be seen on Figure 3.4.

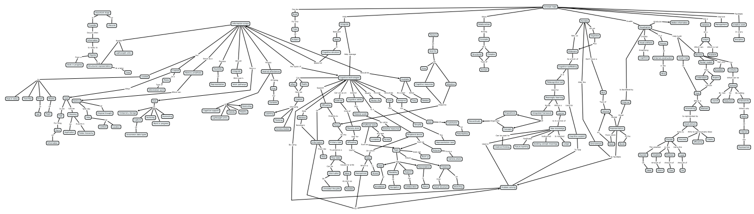

Figure 3.4: Cognitive Theory Framework Concept Map (see appendix A.6)

Reflecting back on the process it seems clear that a minor deficiency has been made. It would make much more sense to color code each of the nodes referring to a particular source. Although maintaining the risk of the concept map becoming too multicolored this would ensure an additional level of self-sufficiency. Otherwise, it was still necessary to consult the reference notes from time to time to remember the correct source of a concept or idea.

This brings up the question of speed and although creating a concept map in the first place might seem cumbersome and time-consuming, the benefits, which are reaped at a later stage of the creation process clearly outweigh such concerns. A concept map is able to reflect the hierarchical structuring of information as maintained by the brain, thus, at the point of creating the diagram the external and internal representations of data begin to mirror each other. Once the structure is set in place, the mapmaker is able to consult it very fast to bring up the necessary and relevant concepts and connections. The tool begins to enhance cognition (Mazza, 2009).

Concept mapping brings an additional benefit of reusability. It is possible to use the same structure in a different context to produce a new result with only slight modification. The concept map can also fulfill the role of cognitive scaffolding, enabling the mapmaker to build new ideas on top of it, expanding and modifying them along the way to reach a new level of discovery.

3.7 Closing Remarks

Humans live in a world of information. It can be argued that the ability to learn, communicate and think or essentially to cognize is one of the main characteristics of humans. However, the constraints of the physical brain do not necessarily limit cognition because of the ability to offload cognitive resources onto the external environment, effectively modifying it in the process. This offloading can take several forms and occur at different times and during different processes. As a result, various tools and outlets are used and, quite often, disjoined pieces or scraps of information are created. These scraps need to be flexible, mobile and easily transferable because at some point it might be decided to reuse and structure them in a completely different context. As thinkers and scholars have known for ages, nothing in the world is separate and everything is connected in one way or the other. The difficult part is to identify that connection.

This is where concept mapping can help. The technique can support establishing relationships between pieces of data and help see connections, which are not that obvious at a first glance. The process of creating a concept map also enables the creation of a hierarchical and thorough structure in the mind, which can later be used as a springboard for new and exciting ideas to emerge. All of this leads to innovative problem solving, and that is what human beings are best at doing.

Being a variation of a graph, concept maps have certain drawbacks in that they are not very scalable. At a certain point, a concept map can become too complex and not readable. Too many nodes and relationships can be introduced in the creation process and as a result, it might not be possible to visualize a concept map in a clear and understandable way (Mazza, 2009).

Several solutions to the problem of visualizing graphs are proposed and these methods can be applied to concept maps as well. A good starting point may be the reduction of the diagram. This can be achieved for example by hiding certain relationships, which are of lesser interest to the person using the concept map. A second option is to make use of a new layout or redistribution of the existing concept map. Finally, interactivity can be introduced, where only the points of interest to the user are represented. This would enable the creation of a dynamic concept map, which would encourage manipulation and exploration according to the needs of the user (Mazza, 2009).

One of the best ways to construct concept maps is by using a specialized tool, developed by Novak's research team, called CmapTools. CmapTools is a software toolkit, which enables collaboration and sharing during the construction of concept maps. CmapTools is fast and easy to understand but also sophisticated enough that both children in schools as well as scientists and researchers can use it (Florida Institute for Human and Machine Cognition, n.d.-a).

It is worth mentioning that CmapTools enables users to create a certain kind of dynamic concept maps represented as web pages. The concept maps are clickable and linked together. This enables the user to break up a big concept map into smaller chunks also having certain nodes serve as links between the different views. Clearly additional levels of interactivity can and should be introduced to address the issue of complexity, but this seems to be a limitation of the software used to create concept maps and not an issue with the technique itself.

Concept mapping appears to originate from a quite general background and is very useful for structuring and reusing knowledge in creative problem solving, such as designing new products and solutions as well as communicating that knowledge to colleagues and other team members.

This chapter described a technique called concept mapping with the aim to put forward a hypothesis that if concept mapping can be used to successfully extract, communicate and adapt knowledge to facilitate problem solving in the fields of learning, business and government, then it might also provide successful results in supporting interaction design processes.

Chapter 4

Documentation Techniques in Interaction Design

This chapter explores the techniques, which have historically been used in the field of software development to communicate ideas and structure knowledge. The aim is to understand why existing documentation techniques cannot be applied through all stages of interaction design processes.

According to Preece, Rogers, and Sharp (2007) functional requirements of a system have been traditionally analyzed and documented using such tools as data-flow diagrams, state and work-flow charts and others. It is also possible to use state and sequence diagrams.

Dix et al. (1993) mention that tools, such as state charts and flow diagrams can be used for dialogue design, which is similar to a script of a play in interaction design.

Shneiderman (1998) mentions transition diagrams as having wide applicability in user-interface design. Techniques such as user action notation are applied for describing user behavior and certain aspects of system responses.

4.1 Decomposition Diagrams

According to Chang and Lu (2009) decomposition diagrams can be used to create various system components, which can be later developed separately. Such diagrams also enable the author to divide the higher-level view of a system into smaller and more manageable blocks. With the help of decomposition diagrams one is able to manage various abstractions in a more productive way as well as the complexity in design of software.

A decomposition diagram can enable the representation of various decisions of design, which can be illustrated in a form of a hierarchical structure. However, this approach also has its shortcomings, since the single structure can result in various types of decisions and constraints being differentiated in an unclear and imprecise way. As a result, it might prove difficult to understand the influence of certain architectural requirements on the overall structure of the system. Usage of decomposition may also lead to failure in tracing the relationships between system requirements and design decisions.

An example of a decomposition diagram can be seen on Figure 4.1.

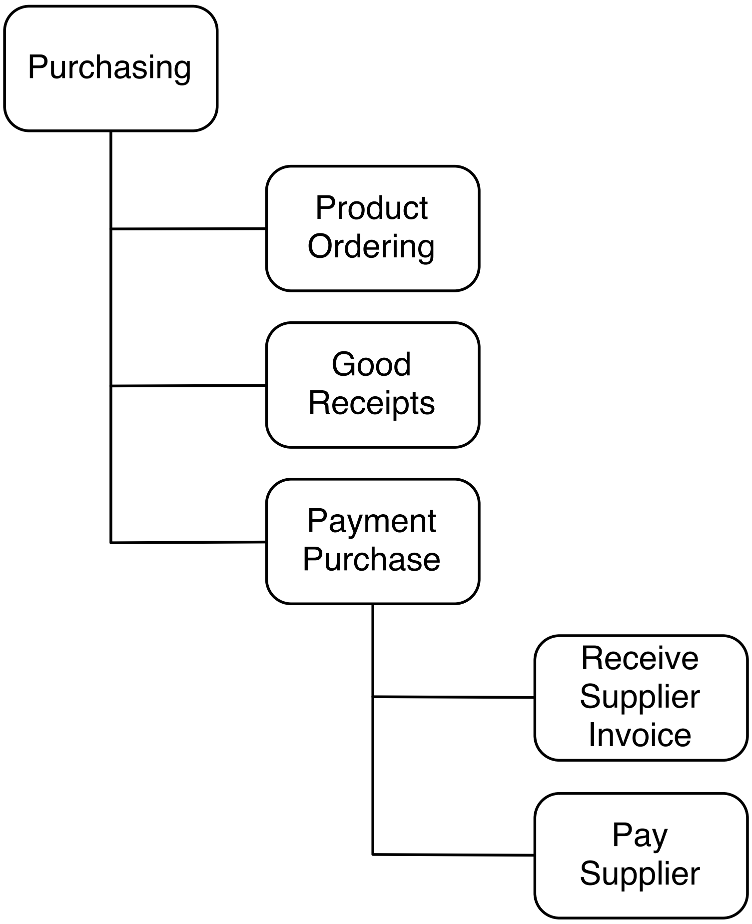

Figure 4.1: Example Decomposition Diagram (University of California, Davis, n.d.)

4.2 State Transition Diagrams

According to Wasserman (1985) state transition diagrams are essentially a network of nodes and directed arcs. Arcs usually represent transitions, which are based on user input. A circle might represent a stable state and a small square – an operation.

A state transition diagram begins at the entry point, which is usually a start node waiting for user input and continues all the way to the exit node

(Wasserman, 1985). A transition is a change in state, which is caused by an event of observable input (Bae & Chae, 2009).

Scanning of a transition diagram causes an associated type of operation to occur (Wasserman, 1985).

As stated by Bae and Chae (2009) a transition diagram can specify the dynamic behavior of individual objects by representing a sequence of operations in classes. State diagrams can be used for modeling of control and sequencing views of a particular system.

Maple, French, and Conrad (2003) report that transition diagrams can be used in interface design to "quantify and control surface level complexity." It is also possible to assess if the interface possesses any states, which are unstable or undefined. According to Bae and Chae (2009) it is also possible to identify states, which are missing or unnecessary. Test cases can be generated if a transition diagram is transformed into an extended finite state machine.

Although transition diagrams are widely used, their construction in a single step can take a lot of time and effort and drawing might prove to be a difficult challenge (Bae & Chae, 2009).

An example of a state transition diagram can be seen on Figure 4.2.

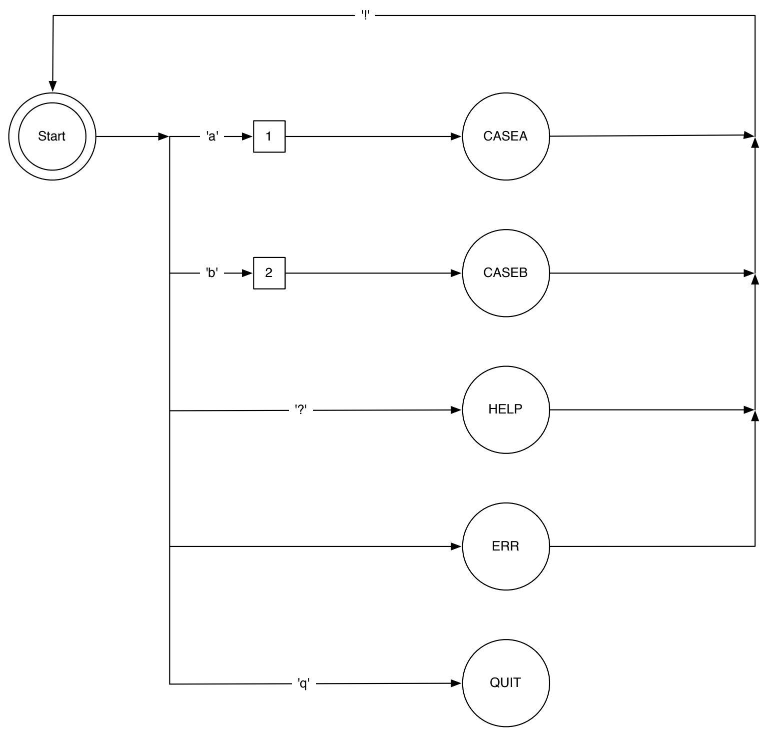

Figure 4.2: Example State Transition Diagram (Wasserman, 1985)

4.3 Unified Modeling Language

N. J. Nunes and Cunha (2000) state that the unified modeling language or UML has become the *"de-facto standard for object-oriented analysis and design."* It provides a common language, which helps to specify, visualize and document software intensive systems. It is important to note, that UML enables interoperability of tools at the semantic level.

UML can provide a framework of notations, which enables the integration of modeling of user interfaces with software engineering. Although native UML components do not have built-in support mechanisms for user interface modeling, due to inherent extensibility certain additions might be introduced to address that specific issue (Kovacevic, 1999).

One particular extension for describing the presentation aspects of user interfaces is proposed by N. Nunes (2003). The extension is called the Wisdom notation and it has support for modeling components of abstract user interfaces as well as “their contents, containment relationships and navigation.” It is also possible to model the behavior of a user interface. In regards to user interface patterns, Nunes states that both task and presentation aspects can be successfully depicted.

However, it is still considered that UML’s support for development of interactive systems is insufficient (N. J. Nunes & Cunha, 2000).

An example of a UML diagram can be seen on Figure 4.3.

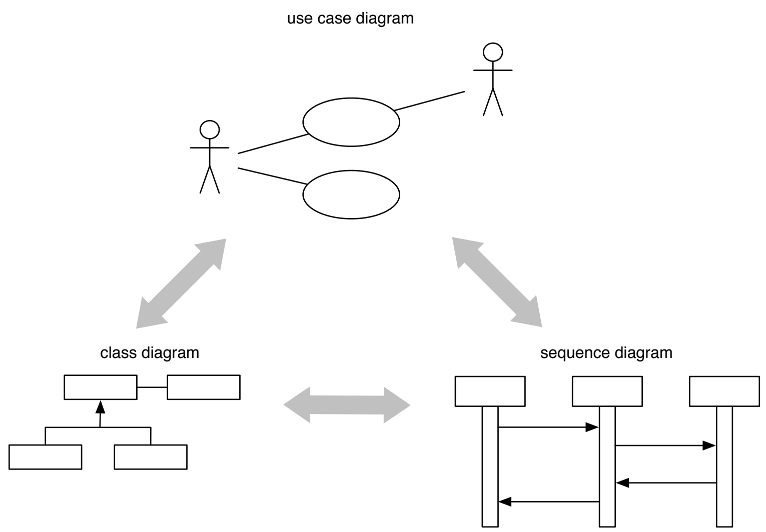

Figure 4.3: Example UML Diagram (M. G. Paula & Lucena, 2003)

4.4 Techniques for Software Development

In the 5th edition of the book “Designing the User Interface” Shneiderman, Plaisant, Cohen, and Jacobs (2010) state that although certain techniques have been applied by software developers consistently, they tend to be very poor when applied in the field of human-computer interaction in general and interaction design in particular for studying who the users are, what they need and how to create suitable interfaces for them. It is also stated that certain approaches tend to be successful only during particular stages of the design process. Table 4.1 provides an overview of the benefits and drawbacks of various software development documentation techniques from the perspective of interaction design. These techniques were discussed in the previous sections.

	Decomposition diagrams	**State transition diagrams**	**UML**
Usage	Creating various components, which can be later developed separately	Specifying dynamic behavior of individual objects, modeling of control and sequencing views	Specifying, visualizing and documenting software intensive systems
Benefits	Managing various abstractions	Assessing whether an interface possesses states, which are unstable or undefined	Native extensibility
Representation	Various design decisions in a hierarchical structure	Sequence of operations in classes	Behavior of a user interface
Drawbacks	Decisions differentiated unclearly and imprecisely. Failure of tracing relationships between system requirements and design decisions	Construction can take a lot of time and effort, drawing might prove to be difficult	Support for development of interactive systems is insufficient

Table 4.1: Overview of Software Development Documentation Techniques

4.5 Closing Remarks

After reviewing several books (Dix et al., 1993; Shneiderman et al., 2010; Shneiderman, 1998; Preece et al., 2007) covering the foundations of human-computer interaction and interaction design an assumption can be made that at the time of this writing wide-ranging documentation techniques, which could be used throughout the process of interaction design have not been yet established. Techniques, such as UML, decomposition and state transition diagrams originate from software engineering and do not serve well in the context of interaction design.

This chapter enables to put forward a notion that existing techniques can be utilized only at specific stages and lack the necessary properties to be used to support interaction design processes through their various stages.

Chapter 5

Case Studies

This chapter describes several interaction design related projects, which were developed prior to the writing of this document over a course of 8 months. The purpose of this chapter is to provide an understanding of how concept mapping can be used to support interaction design processes in real-life projects.

The deliverables created as a result of these projects are of various level of breadth and depth, all of them being prototypes for Apple's iPhone and iPad applications. Various methods were used during the development stages of these projects but concept mapping was applied everywhere in order to explore its full potential. The technique was refined from project to project and different observations and conclusions were made.

5.1 XYZ

XYZ (not the real name of the service) was the first interaction design project conducted with the use of concept mapping as a supporting technique. The purpose of the project was to assess the current state of things from the standpoint of the service, which the client provided. The content the service provided was initially available through a standard website and also in tourist information centers in Old City Tallinn and several other locations with the possibility to rent audio tour devices. The client wanted an opportunity to expand his offerings to mobile platforms in general and to smart phones in particular.

Specific concept maps relating to the project are not provided in this document in correspondence to the wish of the XYZ owner.

Concept mapping was specifically used during the research and design stages as the development and production stages were out of scope of the project.

The initial step was to assess the current possibilities and understand the ways of offering potential solutions to the client. A concept map was constructed to illustrate all of the background information. The produced diagram was large but also provided a comprehensive overview of the current ways the service was provided to customers as well as explored the potential aspects, which needed to be taken into account during the development of a mobile application. The result was presented to the client during a review meeting in order to establish common ground between all the involved parties.

During the latter stages of the project, a state transition diagram was utilized in order to illustrate the relationships between various screens of the application prototype and the paths, which the user would traverse while using the said application.

5.2 iRadio

The purpose of iRadio was to develop a working HTML prototype of an iPhone application during a course of several weeks. The team consisted of three people. One member of the team proposed and developed the idea as well as wrote the documentation. The second team member, serving as the interaction designer, created an initial concept map (see Figure 5.1), designed the application views and linked them together in a state transition diagram as well as wrote a part of the HTML and CSS code for the final prototype. The third team member fulfilled the role of the developer by writing the main bulk of the JavaScript code to make the application work seamlessly.

Concept mapping was used during the research and design stages of the project.

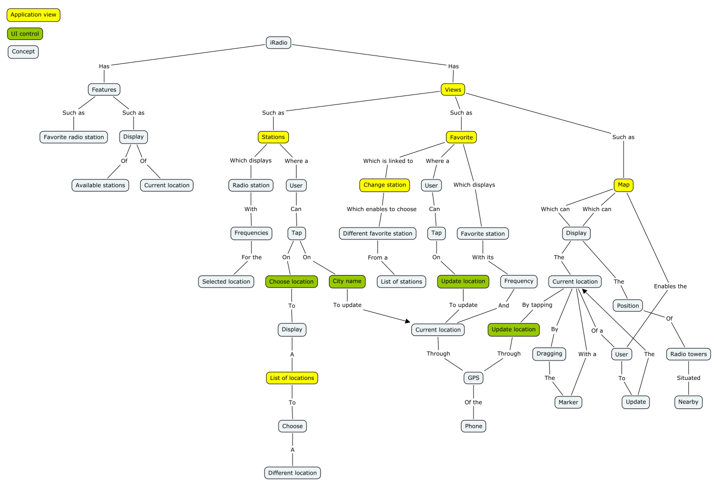

Figure 5.1: iRadio Concept Map (see appendix B.1)

The concept map developed for iRadio differs from the one produced for XYZ in several ways. The diagram itself is much more hierarchical and bends the rules of traditional concept mapping to better serve the purpose of the project. Several concepts are grouped together instead of being broken up into smaller pieces and cross-linked together to create a network. Such an approach has been tried and this severely degrades the readability of the diagram making it much harder to understand.

As the diagram represents not just concepts, but application views and user interface elements, these had to be color-coded and a legend explaining the meaning of each color needed to be introduced.

Looking back it can be said that concept mapping helped in the development process and communicating ideas between the team members to establish a common ground. This was crucial in a project with a very short timeframe as good decisions needed to be made from the very beginning in order to guarantee a successful result.

5.3 VisuaTweet

The VisuaTweet project was similar to iRadio by the fact that development time was limited and the team consisted of only three people. Concept mapping needed to be used to establish communication between team members in a limited amount of time. The team needed to come up with an idea for a mobile application, which could illustrate the principles of generative content creation. An initial brainstorming session was conducted and the results documented in Google Docs. It was decided to produce a prototype application for the iPad. The purpose of the solution would be to explore how Twitter has been used in major global events, trying to visualize the activity of tweets in a particular global region and seeing how those messages are spread through other world regions. A user could zoom in on a particular region and the application would display a flow of messages on the background of the said region. The text of messages would be mixed and mashed. The user could start seeing patterns of words and emotions people use to describe their experience.

Concept mapping was specifically used during the research and design stages as the development and production stages were out of scope of the project.

Once the basic idea was set, several concept maps needed to be created before the design stage of the prototype could start.

The purpose of the concept map seen on Figure 5.2 was to provide an overview of the application, mentioning the main idea behind it as well as the features of the application. This in turn helped to communicate the main idea of the project to other team members.

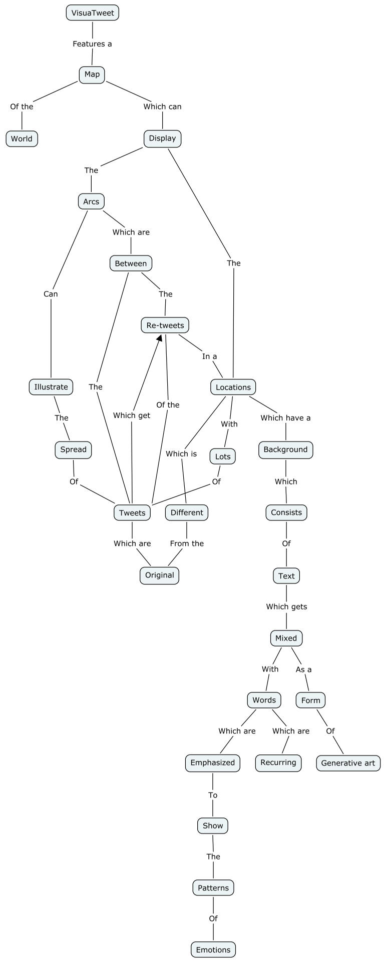

Figure 5.2: VisuaTweet Concept Map (see appendix C.1)

The purpose of the concept map seen on Figure 5.3 was to illustrate a use-case of the application, depicting what the user can actually do with the product and how he will interact with it. This was later used during writing of the final report in order to better describe how a person would actually use the application.

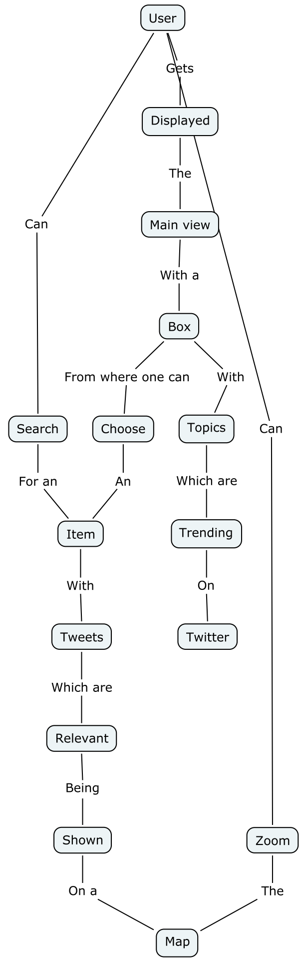

Figure 5.3: VisuaTweet Use-Case Concept Map (see appendix C.2)

The purpose of the concept map seen on Figure 5.4 was to describe the main user interface elements of the application by exploring how they might function together. This was later utilized while building the application screens and the prototype.

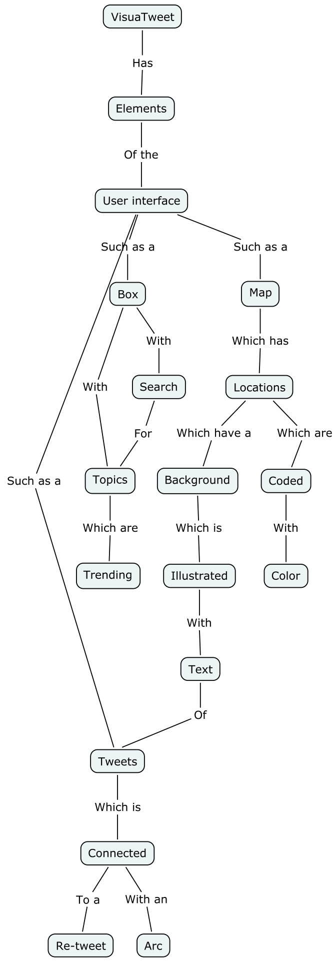

Figure 5.4: VisuaTweet User Interface Elements Concept Map (see appendix C.3)

As with the iRadio example, the concept maps illustrated above helped the team establish a common ground. This was especially important because the team members have not even once met in person during the cycle of the project.

After creating the concept maps and putting the knowledge base in place the team member, serving as the interaction designer for the project, was able to move towards the next stages by drawing sketches, producing mockups, linking them together in a state transition diagram and finally producing a clickable prototype of the application with Microsoft PowerPoint. The final stage of the project was to jointly write a comprehensive report, establishing the theoretical basis, schedule, rationale and various other aspects of the proposed product.

In retrospective it appears that the creation of the concept maps has enabled the project to run smoothly and be submitted on time with a thorough report and an interactive prototype serving as deliverables.

5.4 Mobile TLU

The mobile Tallinn University application, referred to as mobile TLU, has been one of the most recent interaction design projects, where the concept mapping method has been applied.

The new study information system (ÕIS) has been introduced to Tallinn University staff and students in the winter of 2011. The new system replaced the old solution, where different modules, such as registration to courses and exams, submitting applications for learning grants and various other studies related activities have been managed by different modules and have been mostly disjointed. The goal of ÕIS was to bring all of the pieces together in a single place although, as of the time of this writing, the system, which manages the booking and display of rooms for lectures, has not been integrated.

Although the premise of ÕIS has been a very good one and it has indeed simplified several common tasks, it was presumed that the solution could be made user-friendlier. A project has been proposed, where a mobile client would be created for ÕIS, which would serve as a gateway for the most commonly used tasks. The client would take a form of a smart-phone application, initially developed for the iOS platform as a pilot test.

Concept mapping was used during the research stage as the design, development and production stages were out of scope of this case study.

The project began with distributing a questionnaire to several Tallinn University lectors, students and staff members in order to assess whether users would be interested in the proposed solution and which of the functionalities should definitely be included in the application.

Based on the results of the survey several concept maps have been created.

The aim of the concept map seen on Figure 5.5 was to provide an overview of the functionalities the users expected to see in the application.

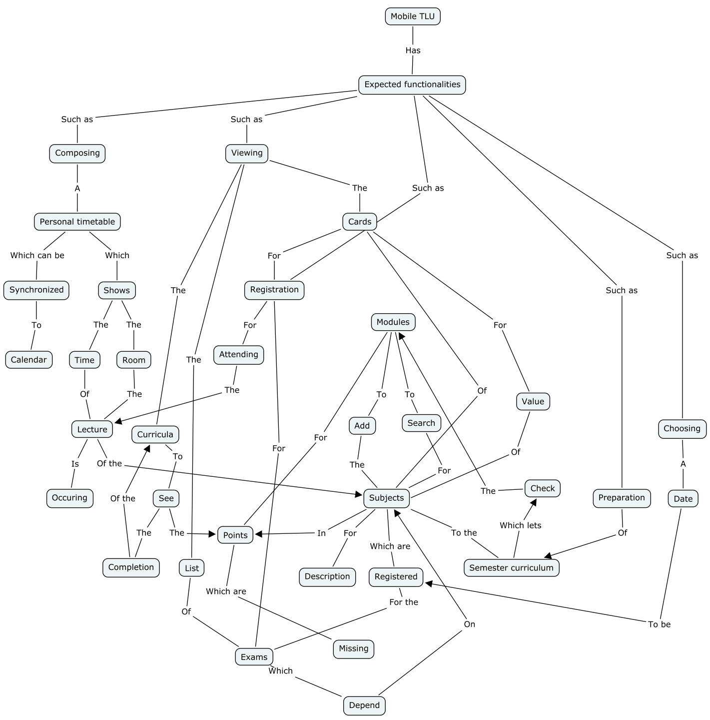

Figure 5.5: Mobile TLU Expected Functionalities Concept Map (see appendix D.1)

Although similar to the previous illustration, the concept map seen on Figure 5.6 focused on user requirements, bringing out aspects, which from the standpoint of the users should definitely be present in the final product.

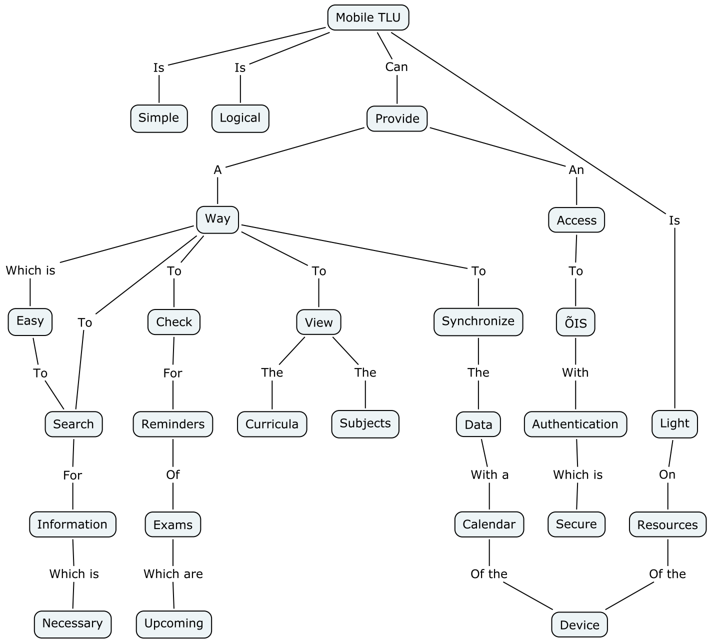

Figure 5.6: Mobile TLU User Requirements Concept Map (see appendix D.2)

With the help of the produced concept maps a project plan was composed and that would enable to move to the next stage of the product design process. Concept maps will serve as the basis for the project and can be modified as needed in the future.

5.5 Other Examples

Besides the case studies described above, concept mapping has been used in other interaction design related projects. One of the most recent examples includes a project, where a third party has conducted a usability analysis for an information system. A report of approximately 50 pages was produced as a result and it was necessary to create a concept map, which would eliminate the need to read the whole document each time some specific information would needed to be recalled in the later stages of the project. The constructed concept map helped not only present the findings of the analysis in a condensed way but also illustrated certain parts of the report, which needed to be elaborated due to not being clear enough. The diagram also helped establish better communication between the project manager and the interaction designer as both parties were seeing information in the same structured way.

At a later stage of the project a list of tasks needed to be compiled based on the conducted analysis. These tasks could be completed within a small development project, which would be scarce on both time and financial resources. Having the concept map previously created it only took approximately 30 minutes to assemble the list. The information was already compiled and structured and it was merely a question of highlighting the most relevant nodes of the diagram with a different color and then composing a list of tasks based on that.

This example illustrates that concept mapping can not only help uncover the shortcomings of a report ordered from a third party, but also can save time when conducting tasks, which require access to information in a digested and structured way.

5.6 Closing Remarks

This chapter provides an overview of several case studies, where concept mapping has been used to facilitate better structuring and management of information as well as communicating that knowledge between members of the teams participating in interaction design projects. The case studies demonstrate that concept mapping can indeed be used to support interaction design processes.

Chapter 6

Multifaceted Knowledge Support

The purpose of this chapter is to provide an understanding of whether concept mapping is flexible enough to be applied through various stages of interaction design processes.

The research and examples described in the previous chapters of this document aim to establish the current state of things in the field of cognitive science and interaction design. It is possible to gain understanding of the way humans gather and structure information from various bits and pieces and how it is crucial to establish a solid foundation in order to successfully build new knowledge as well as facilitate creative thinking and problem solving. It has also been established that the techniques, used for creating those diagrams in the field of interaction design originate from the software engineering discipline and thus might be applicable only in specific contexts of the interaction design process. This brings up a conclusion that there is a need to look someplace else to discover a technique, which could be used to support interaction design processes through their various stages.

It has been stated that such a potential technique does indeed exist, originating from the field of learning and education, being created by a team under the leadership of Joseph Novak. The technique is concept mapping and it has been applied and refined in various fields since the 1970s. Novak's research shows that concept mapping has been successfully applied by both schoolchildren and researchers and scholars with promising results and that the basics can be understood by both a child, attending the first grades at school as well as a scientist trying to figure out a new solution to a complex problem.

The case studies described in Chapter 5 illustrate that concept mapping can indeed be applied in the field of interaction design having such benefits as:

- Establishing a common language between different members of the team;
- Bridging the communications gap between people from different disciplines, who are not necessarily familiar with tools being used in software engineering;
- Being able to replicate the cognitive structure, which is established in the human mind during the process of gathering and structuring information during research and problem solving;
- Being flexible yet easy to use and understand;

Based on the knowledge and understanding acquired during the preparation and writing of this document, an enhanced structure of the interaction design process is proposed, which can be seen on Figure 6.1.

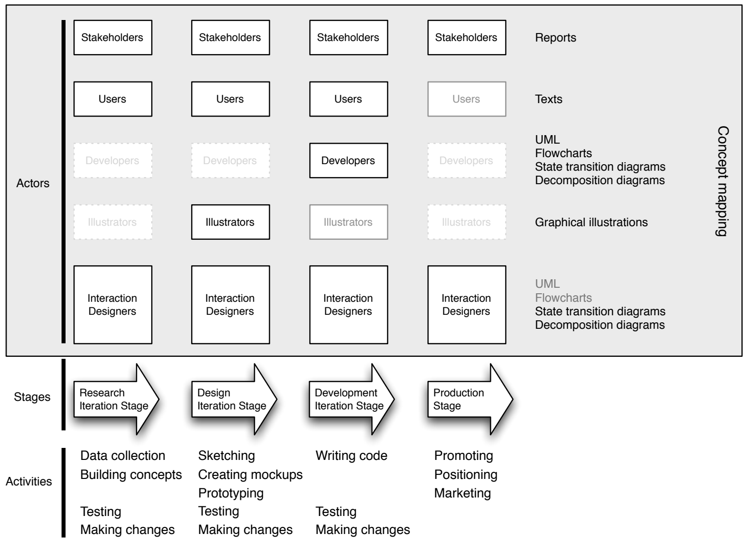

Figure 6.1: Proposed Structure of an Interaction Design Process (see appendix A.2)

Figure 6.1 shows concept mapping placed at the side of the interaction design process stages and being utilized throughout the whole process, acting as a crucial part of research, design, development and production. Once a solid theoretical foundation is established it is possible to move on to the next activities, such as creating sketches, mockups and prototypes, testing and modifying them according to user feedback, writing code and eventually shipping the product. Yet the core technique always stays in place, being refined depending on the requirements and context of a particular stage. This approach ensures that all the subsequent activities are based on a clear and well-defined understanding.

6.1 XYZ Interaction Design Process

The following section describes the concept maps created for the research and design stages of the XYZ case study. The specific concept maps are not reproduced in this document in respect to the wish of the XYZ owner.

The concept maps are composed according to the project structure proposed in Figure 6.1. The development and production stages are missing from this description as they were out of scope of the particular project.

6.1.1 XYZ Research Stage

Before beginning to design the actual mockups and prototype, research had to be conducted, in order to assess what similar applications existed on the market and what where the features they provided. As a result, a concept map for the project research stage has been created. The concept map provides an overview of the user interface features used for navigation as well as means of acquiring content and integration with other services. The produced concept map provides an overview of the features, which could be considered common to these types of applications and needed to be implemented in the designed product as well.

6.1.2 XYZ Design Stage

For the design stage of the project the original concept map from the research stage was used as the basis and then all the unnecessary concepts taken out. Only three concepts were left intact. These were “XYZ service”, “Application” and “App Store”. The selected concepts where moved to a “parking lot”, which is essentially a list of concepts, for which there is no clear understanding of where they fit in (Novak & Cañas, 2006).

Besides the three previously mentioned concepts, several additional ones were added, based on the features, which the interaction designer would like to see present in the final product. These concepts included integration with social networks, offering the user content in both audio and textual form as well as providing location specific information, such as images. Once the concepts were established, they were linked together to create a new concept map.

As the list of proposed functionalities was finalized and agreed upon by the client, the interaction designer was able to proceed to creating sketches and mockups of the application interface, following with a clickable prototype.

For prototyping a new concept map was created, focusing on aspects, such as:

- Hardware being known, which allows the developer to target specific hardware features and screen resolutions.
- The platform supports in-app purchases. The application can be then distributed free of charge, giving users the option to buy content they are interested in directly through the application with just one click.
- Being a global marketplace, Apple's App Store makes it easier to advertise the product. The application can be easily distributed to an international audience of iPhone users.

6.1.2.1 XYZ Process Stages Overview

Eventually the research, design and prototype creation concept maps were put together with the original nodes being marked with yellow, blue and red colors. Once duplicate nodes were found, these were merged together and assigned a new color. A combination of yellow and blue was marked as green. A combination of blue and red was marked as purple. A combination of yellow, blue and red was marked as white. As a result, a process stages overview concept map has been produced, which provides an overview of the application structure, the types of content available through the application and ways in which it can be acquired by the user as well as touching upon the means of distributing the said application.

6.1.2.2 First Pilot Testing Session

After the initial version of the prototype was created, two pilot testing sessions were conducted with users possessing expert knowledge in usability and interaction design. The aim of these tests was not only to highlight the most obvious mistakes, made during the creation of the prototype but also to see, whether the questionnaires, created for gathering tester feedback, needed to be modified as well.

A concept map has been created from the notes of the first pilot testing session, which uncovered many flaws made in the prototype and the documentation. This has also resulted in the concept map being very dense, as there were many aspects, which needed to be improved.

6.1.2.3 Second Pilot Testing Session

A new concept map has been created from the observation notes of the second pilot testing session. As many of the initial flaws have been dealt with, the comments tended to get more specific and focused on particular details of the application itself. The concept map also reflects that from the standpoint of the tester the flaws in the documentation have at that point been successfully resolved.

6.1.2.4 Pilot Testing Sessions Overview

After the pilot testing sessions were conducted and the corresponding concept maps created, these were in turn merged into a larger concept map, which provided an overview of the pilot testing process. The nodes from the original concept maps were colored with blue and yellow respectively. Once duplicate nodes were found and merged, the new node was assigned a green color, symbolizing the combination of yellow and blue.

6.1.2.5 First Testing Session

A concept map has been created for the first actual testing session, which was conducted after the two initial pilot tests were carried out and the received feedback incorporated into the prototype and its accompanying documentation. The resulting concept map is much smaller in size, which suggests that by that point a large number of prototype flaws has been removed. However, the concept map also reflects issues with the views, which the interaction designer was struggling with the most.

6.1.2.6 Second Testing Session

A concept map has been created from observation notes of the second testing session. The tester was an experienced iPhone user and the concept map reflects how his ideas and remarks were very concrete and specific to the iOS application experience. The tester was able to go into much more detail in regards to the application design but as the concept map demonstrates the tester was also having problems with the views, which the interaction designer was struggling with. At that point in the design process an optimal solution has not yet been found.

6.1.2.7 Third Testing Session

As more and more feedback was incorporated into the maturing prototype, the tester comments began to become more general, focusing on additional features, which could be potentially included in the final product.

A concept map produced for the third testing session was compiled from the review notes of the final tester. In this case, the concept map illustrates the tester's discussion on how easy it would be to use the application in bright light as well as how certain elements of the user interface were hard to notice.

6.1.2.8 Testing Sessions Overview

After the actual testing sessions were conducted and corresponding concept maps created, a testing sessions overview concept map was also produced. The nodes from the original concept maps were assigned yellow, blue and red colors. Once duplicate nodes were found, the combination of blue and red was marked purple and the combination of yellow, blue and red was marked as white. Green has not been used as no combination of blue and yellow nodes was found.

6.1.2.9 Findings

The examples featured in the previous sections illustrate the evolution of an iPhone application prototype. Looking back it is possible to say that at the initial stages once the tested prototype was very rough, there were lots of general flaws and defects, which needed to be fixed. As the iteration and testing stages progressed, the number of obvious flaws decreased and testers were able to focus more on particular concern-offering details of the prototype. Finally, as the solution reached its maturity, the testers were able to speculate on potential future additions to the product's functionality.

6.1.3 XYZ Development Stage

For the XYZ project, the development of a real working solution was out of scope and it was agreed upon that the client would conduct a separate project for the actual application to be created. For this stage additional concept maps might be created in order to reflect context specific information, such as a breakdown of the application features linked to concrete development techniques and solutions needed to make everything work. The core principles should still stay the same, with concept mapping serving as a means of establishing common ground between developers and the client.

6.2 Closing Remarks

The purpose of this chapter is to demonstrate that concept mapping possesses the flexibility to be applied through various stages of interaction design processes and can be modified depending on context.

Using the XYZ project as an example, concept maps were created for various stages of developing a prototype iPhone application up to the point of actually producing the said solution, which was out of this venture's scope.

Reflecting back on the XYZ project it can be said that concept mapping plays an important role in understanding the interaction design process. For example, during the testing sessions with users, observation notes can be taken while feedback is being collected and later used as a foundation for building corresponding concept maps. Although in the XYZ example the prototype was modified after each testing session, it appears that a better approach would be to collect all the corresponding concept maps and merge them as described in sections 6.1.2.4 and 6.1.2.8. As all the duplicate concepts are eliminated from the produced concept maps, this can in turn be used to communicate exactly the aspects of the prototype, which need to be improved according to user feedback. A very important aspect of such an approach is that it eliminates the possibility of the tester pointing out design decisions, which do not work for him in particular and which cannot be generalized.

An additional value of this information is that it is presented in a structured and visual way. Such a result would be difficult to achieve with only review notes from each testing session.

A process stages overview concept map provides a comprehensive structured overview of all the features of the XYZ application. Such a diagram is especially useful, when it is necessary to communicate the idea of the proposed application to stakeholders or other members of the design process. In regards to the latter group this is important, as such a diagram enables everyone to be on the same page and have a clear understanding of what exactly is being created.

Based on the foundation of the previous chapters Table 6.1 is provided with the goal of demonstrating the comparison of documentation techniques, used in the field of interaction design, with the addition of concept mapping. The purpose of this table is to present in a clear and concise way the benefits of using concept mapping in interaction design processes.

	Decomposition diagrams	**State transition diagrams**	**UML**	**Concept maps**
Usage	Creating various components, which can be later developed separately	Specifying dynamic behavior of individual objects, modeling of control and sequencing views	Specifying, visualizing and documenting software intensive systems	Eliciting, communicating, representing and adapting knowledge
Benefits	Managing various abstractions	Assessing whether an interface possesses states, which are unstable or undefined	Native extensibility	Is easy to learn and use and flexible for complex tasks
Representation	Various design decisions in a hierarchical structure	Sequence of operations in classes	Behavior of a user interface	Structural knowledge, meaning of concepts
Drawbacks	Decisions differentiated unclearly and imprecisely. Failure of tracing relationships between system requirements and design decisions	Construction can take a lot of time and effort, drawing might prove to be difficult	Support for development of interactive systems is insufficient	Is not easily scalable, a lot of nodes can make the diagram difficult to read

Table 6.1: Overview of Software Development Documentation Techniques With Addition of Concept Mapping

Chapter 7

Conclusion

The purpose of this paper is to design a new approach of using concept mapping to support interaction design processes, specifically focusing on elicitation, communication, representation and adaptation of knowledge.

This paper focuses on the problem found in the field of interaction design, where there is a lack of a transversal technique, which could be used to support interaction design processes through various stages. The issue is amplified by the fact that many different models, methods and representations have been previously proposed and utilized by researchers and practitioners, however these deal only with specific fragments of the designed product.

A research question has been put forward with the purpose of understanding, whether there exists a suitable technique for supporting interaction design processes through various stages.

A hypothesis has been formulated, that concept mapping could serve as the appropriate answer to the research question. Several steps were taken in order to test that hypothesis and design research was chosen as the primary methodology in order to improve the way the proposed technique will operate in practice and to produce a solid contribution of knowledge.

A cognitive theory framework has been provided with the purpose of understanding how humans collect and structure information to facilitate creative problem solving, such as conducting interaction design related work.

A description of a technique called concept mapping has been provided as a suitable means of supporting problem solving based on the gathered information.

An overview of the three commonly used documentation techniques in the field of interaction design has been provided with the purpose of demonstrating the drawbacks, which make these techniques unsuitable for providing an answer to the formulated research question.

Several case studies were described with the purpose of illustrating the application of concept mapping as a supporting technique in interaction design processes. Only real-life projects were used for the case studies in order to eliminate the distortion of the findings by unrealistic conditions. Following the design research methodology, the technique was continuously revised from case study to case study in order to improve the understanding of how concept mapping can be used to support interaction design processes through various stages.

Finally, an overview has been provided with the purpose of illustrating how exactly concept mapping can be used to support various stages of interaction design processes and how concept maps can be morphed and modified, depending on the context.

The result of this work is a design of a way of using concept mapping to support interaction design processes through various stages.

The research described in this document proves that concept mapping can indeed serve as a means of supporting interaction design processes through various stages, specifically aiding in such aspects as elicitation, communication, representation and adaptation of knowledge produced during the design process.

In several of the described case studies state transition diagrams have been used to link the application views together and demonstrate the sequence and relation of those views to each other. A future work direction includes the possibility to explore whether concept mapping can be used to substitute state transition diagrams with the aim of representing an application's logic and structure.

Kokkuvõtte

Käesolev magistritöö keskendub interaktsioonidisaini protsessidele tarkvaraarenduse kontekstis.

Uurimisprobleemina on välja toodud olukord, kus puudub ühtne meetod, mida oleks võimalik rakendada interaktsioonidisaini protsesside erinevates etappides. Sobiv meetod peab olema arusaadav ja paindlik ning kergelt kohandatav spetsiifilistes kontekstides. Otsitav meetod ei tohiks olla piiratud mõne üksikvaldkonnaga.

Uurimisküsimus on esitatud järgmiselt: kas mõistekaartide koostamine on sobiv meetod interaktsioonidisaini protsesside toetamiseks?

Töös on püstitatud hüpotees, et mõistekaartide koostamine võib pakkuda püstitatud uurimisküsimusele sobiva vastuse. Mõistekaardid olid loodud 1970-ndatel Cornell Ülikoolis ja on edukalt rakendatud läbi aastate hariduse-, äri- ja riigisektoris. Mõistekaartide koostamisest saavad lihtsalt aru nii koolilapsed kui teadlased. Mõistekaartide teel on võimalik esitada informatsiooni visuaalsel ja struktureeritud kujul. Väga tähtsaks on peetud mõistekaartidele omane võime välja tuua teatud idee tugevad ja nõrgad aspektid.

Käesoleva töö eesmärk on disainida uus lähenemine interaktsioonidisaini protsesside toetamiseks läbi mõistekaartide koostamise, kus toetamine tähendab informatsiooni esilekutsumist, kohandamist, esitust ja kommunikerimist.

Püstitatud eesmärgi saavutamiseks on tehtud kirjanduse ülevaade ning läbiviidud juhtumiuuringud, mille puhul on rakendatud rakendust loov uurimus.

Kirjanduse ülevaade algab kognitiivteooria raamistiku kirjeldamisest eesmärgiga välja tuua viise, kuidas inimesed koguvad ja struktureerivad informatsiooni selleks, et toetada loomingulist probleemide lahendamist, mille üheks näiteks võib käsitleda interaktsioonidisaini.

Järgmiselt kirjeldatakse mõistekaartide koostamist, kui lahendust püstitatud uurimisprobleemile.

On tehtud ülevaade dokumenteerimise meetoditest, mida tavaliselt kasutatakse interaktsioonidisaini projektides. Käsitletud meetodid on dekompositsiooni (decomposition), seisundi ülemineku (state transition) ja UML diagrammid koos põhjendusega, miks olemasolevad dokumenteerimise meetodid ei sobi püstitatud uurimisprobleemi lahendamiseks.

Juhtumiuuringutena on käsitletud projekte, mis olid läbiviidud 8 kuu jooksul. Kõik projektid keskenduvad mobiilsete rakenduste prototüüpide loomisele.

Peamiseks uurimismeetodiks on valitud rakendust loov uurimus, mille abil täiustati analüüsitavat meetodit projektist projektini eesmärgiga kõrvaldada kõik avastatud vead. Juhtumisuuringutena käsitleti ainult päriselu projekte selleks, et vältida tulemuste moonutust. Metoodika mittetoimivad elemendid muudeti vastavalt konteksti vajadustele.

Lõpuks on tehtud ettepanek täiendada interaktsioonidisaini protsessi rakendades mõistekaartide koostamist kõikides etappides, moonutades ja ümberkujundades neid vastavalt kontekstile.

Käesoleva töö tulemusena on disainitud uus meetod interaktsioonidisaini protsesside erinevate etappide toetamiseks mõistekaartide koostamise teel.

Osa juhtumiuuringute puhul on kasutatud seisundi ülemineku diagramme eesmärgiga illustreerida rakenduse vaadete seosed. Tuleviku töö raames on võimalik uurida, kas mõistekaartide koostamine võib asendada seisundi ülemineku diagrammide kasutamist eesmärgiga esindada rakenduse loogikat ja struktuuri.

Appendix A

Additional Diagrams

A.1 Model of an Interaction Design Process

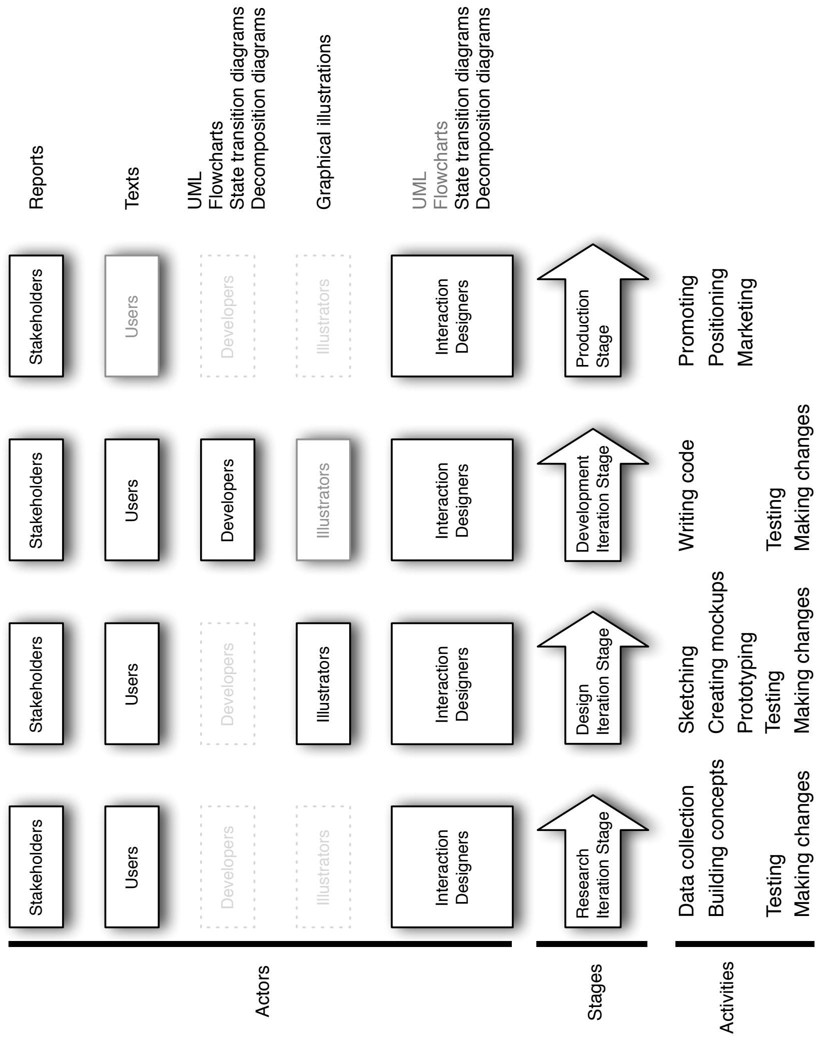

Figure A.1: Model of an Interaction Design Process

A.2 Proposed Structure of an Interaction Design Process

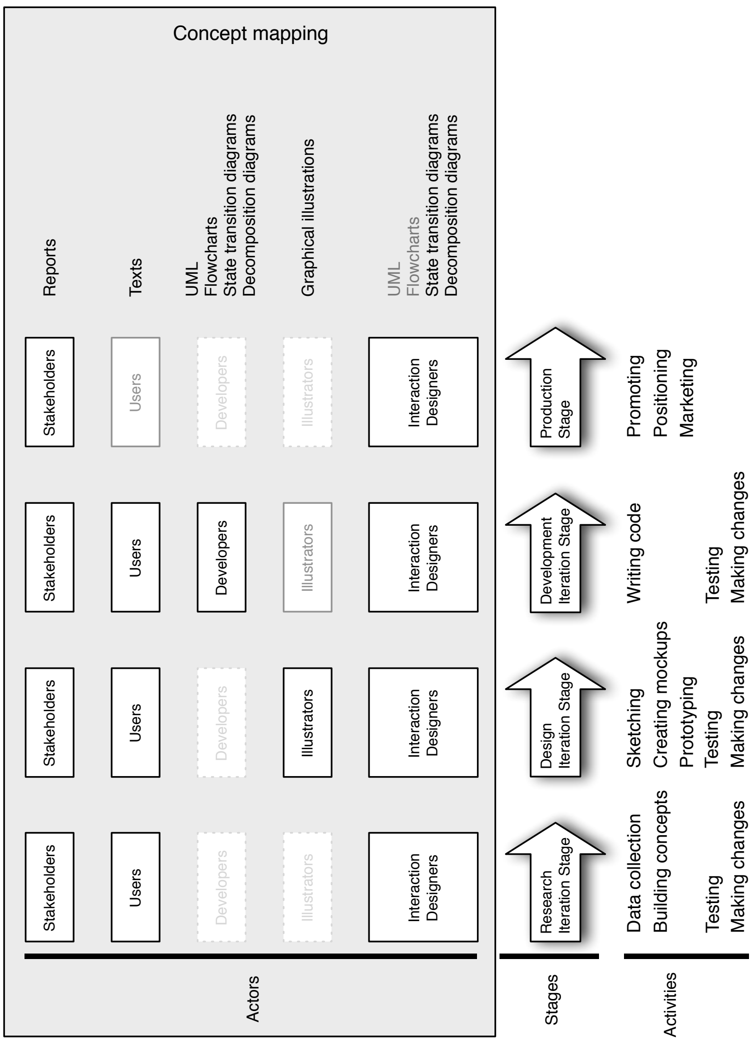

Figure A.2: Proposed Structure of an Interaction Design Process

A.3 Explanation of a Concept Map

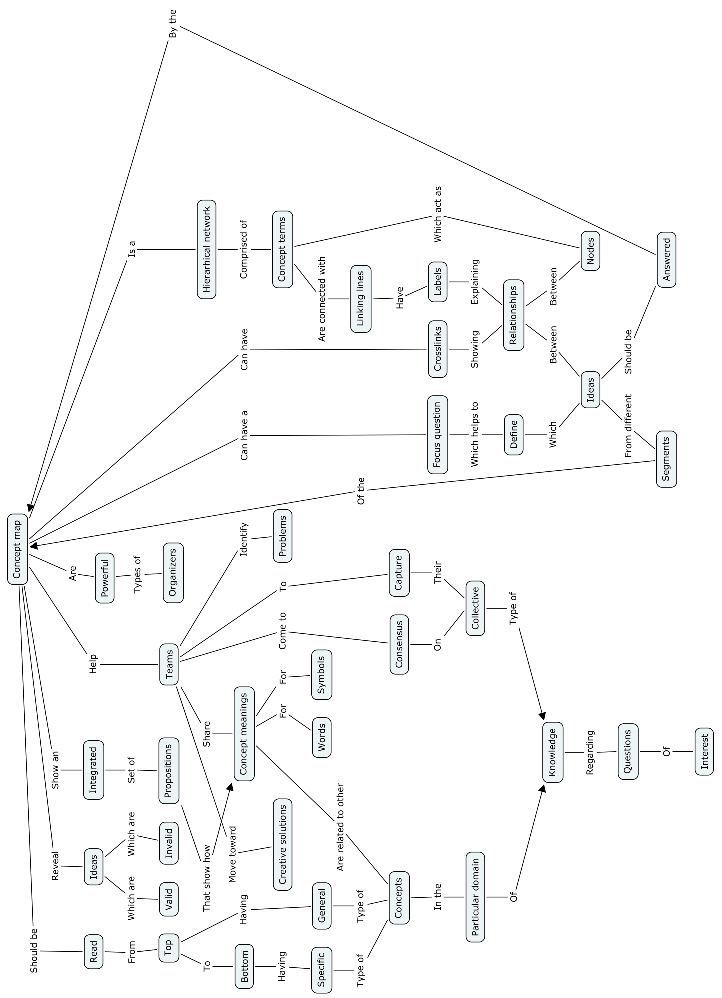

Figure A.3: Explanation of a Concept Map

A.4 Constructing Good Concept Maps (Florida Institute for Human and Machine Cognition, n.d.-b)

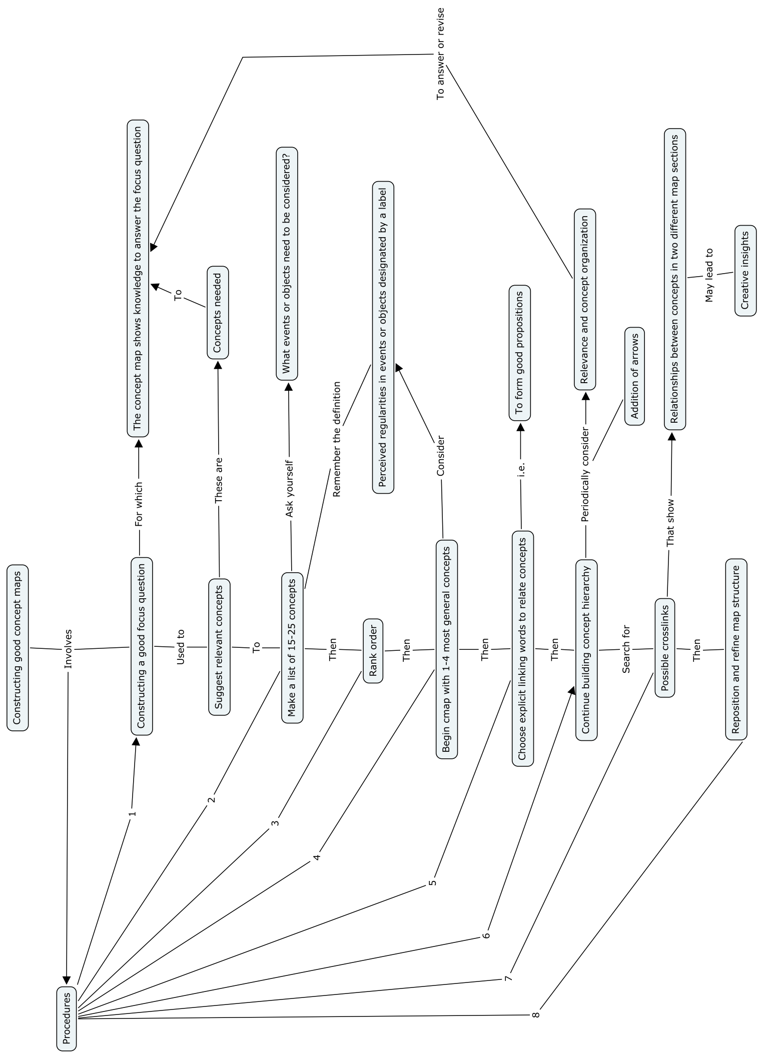

Figure A.4: Constructing Good Concept Maps (Florida Institute for Human and Machine Cognition, n.d.-b)

A.5 Master Thesis Concept Map

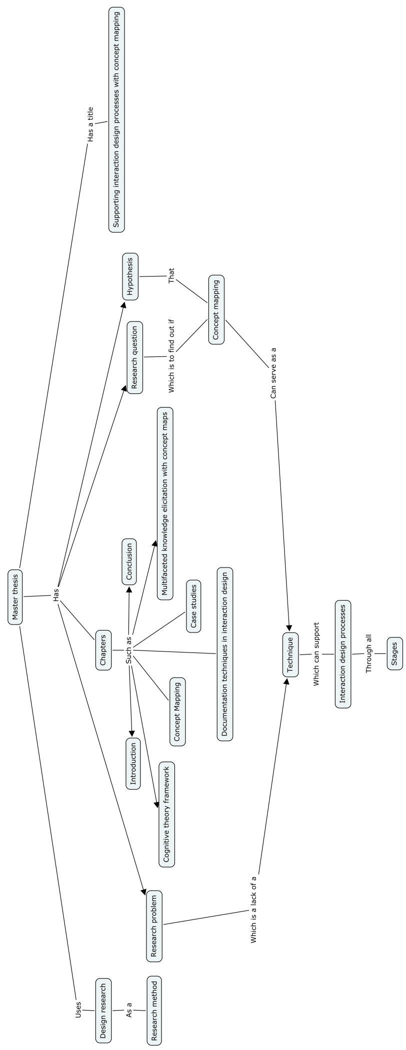

Figure A.5: Master Thesis Concept Map

A.6 Cognitive Theory Framework Concept Map

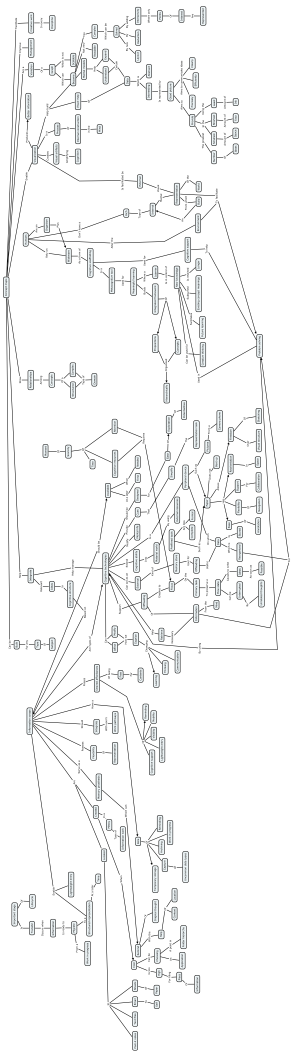

Figure A.6: Cognitive Theory Framework Concept Map

Appendix B

iRadio Diagrams

B.1 iRadio Concept Map

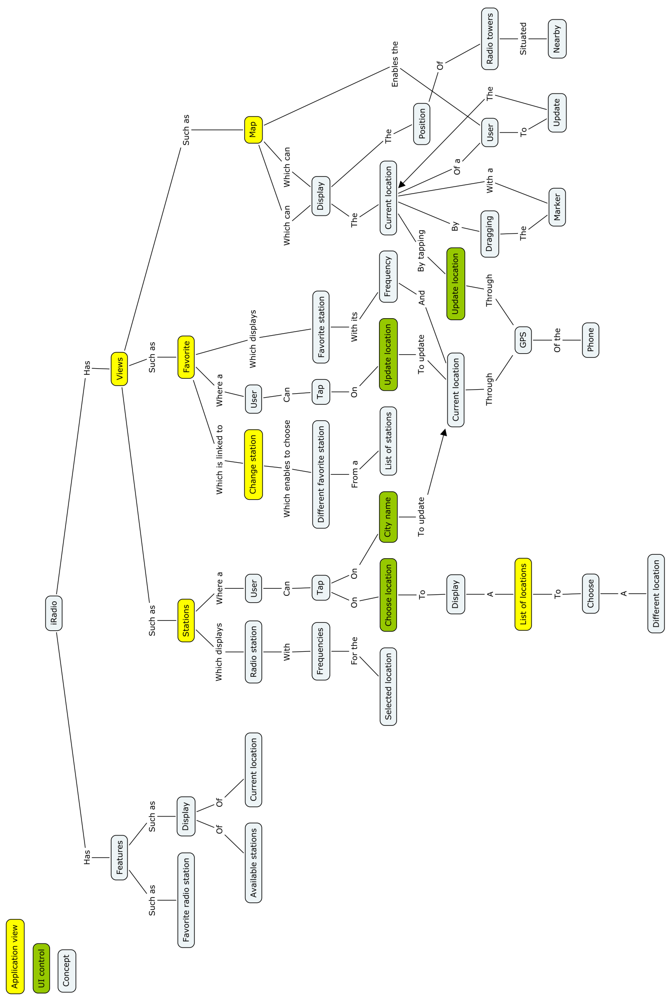

Figure B.1: iRadio Concept Map

Appendix C

VisuaTweet Diagrams

C.1 VisuaTweet Concept Map

C.2 VisuaTweet Use-Case Concept Map

C.3 VisuaTweet User Interface Elements Concept Map

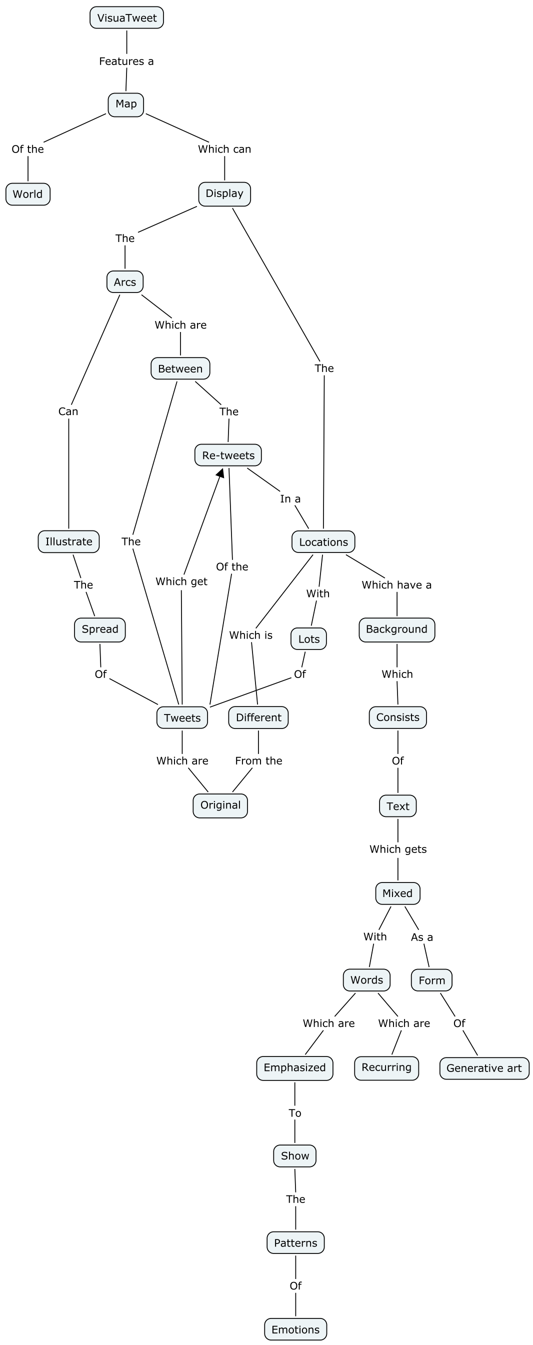

Figure C.1: VisuaTweet Concept Map

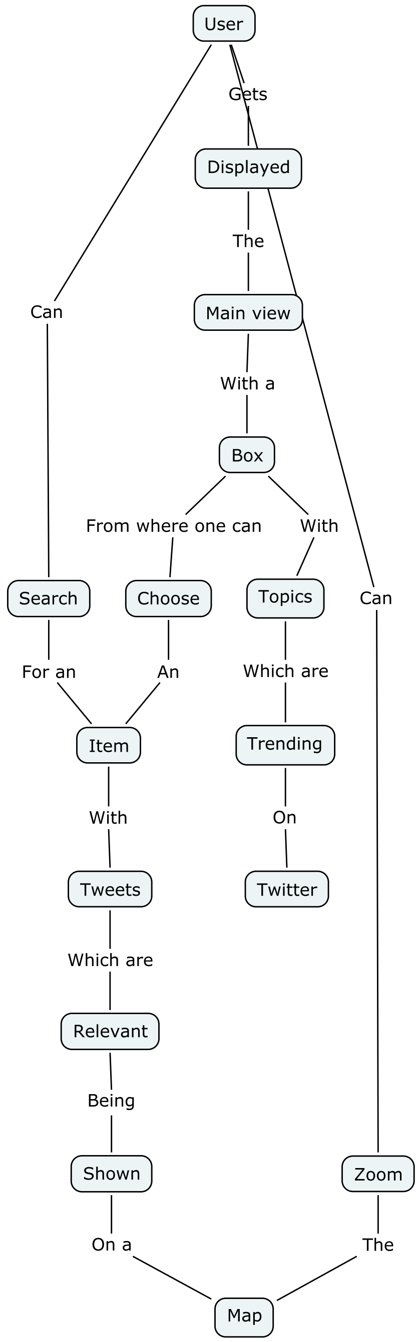

Figure C.2: VisuaTweet Use-Case Concept Map

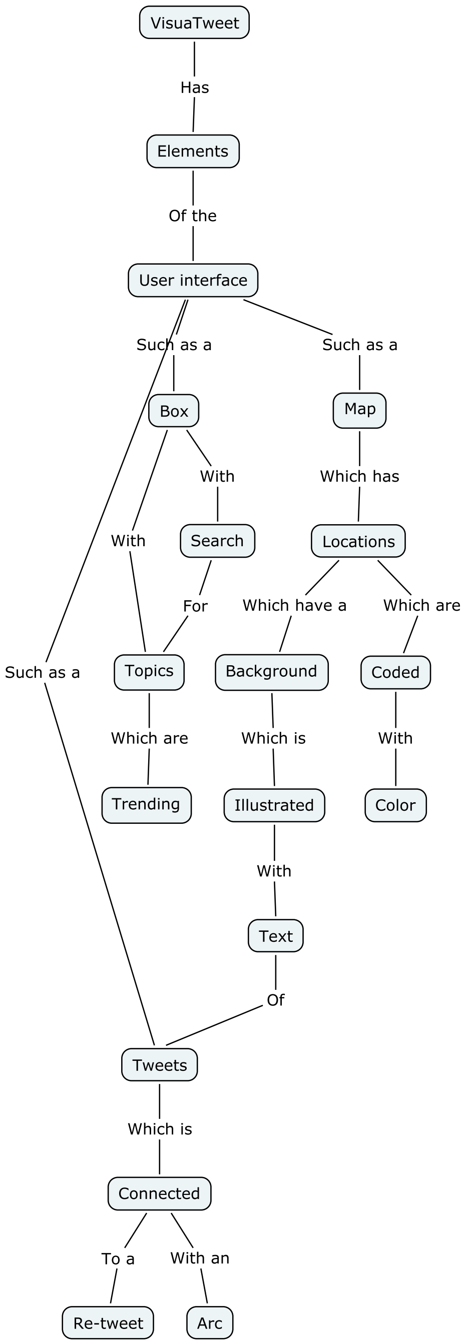

Figure C.3: VisuaTweet User Interface Elements Concept Map

Appendix D

Mobile TLU Diagrams

D.1 Mobile TLU expected functionalities concept map

D.2 Mobile TLU User Requirements Concept Map

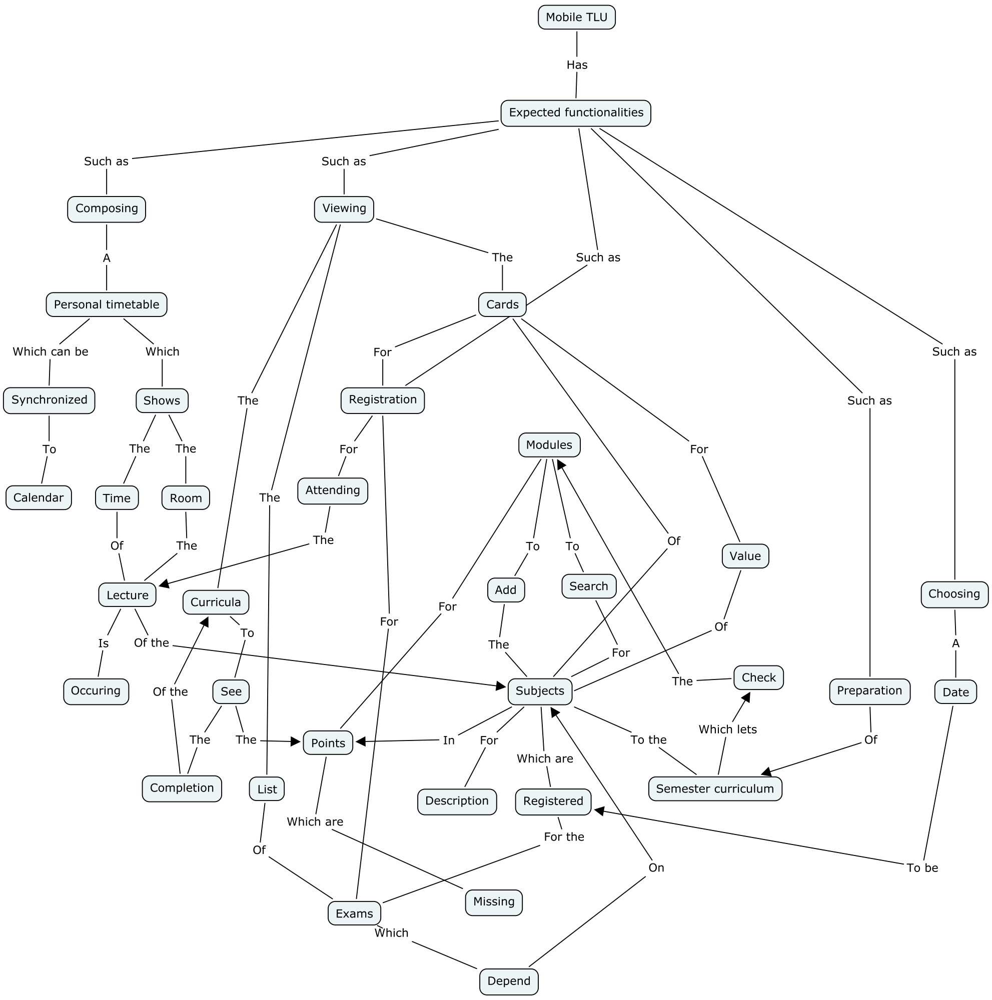

Figure D.1: Mobile TLU Expected Functionalities Concept Map

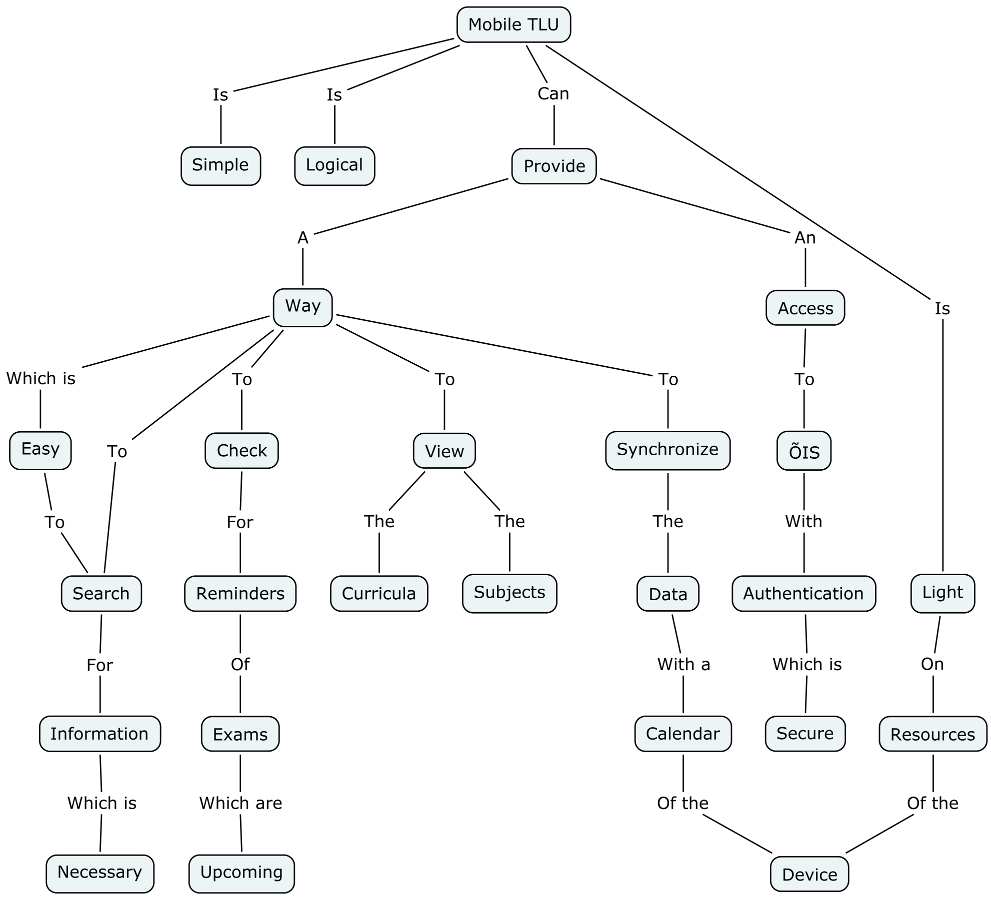

Figure D.2: Mobile TLU User Requirements Concept Map

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