Proceedings of the Federated Conference on
Computer Science and Information Systems pp. 711–718

ISBN 978-83-60810-51-4

Novice User involvement in information architecture for a mobile tablet application through card sorting

Chrysoula Gatsou
School of Applied Arts
Hellenic Open University
Patra , Greece
Email: cgatsou@teiath.gr

Anastasios Politis
Graphic Arts Technology
Faculty of Fine Arts and Design,
TEI of Athens
Athens, Greece
Email: politisresearch@techlink.gr

Dimitrios Zevgolis
School of Applied Arts
Hellenic Open University
Patra, Greece
Email: zevgolis@eap.gr

***Abstract*—The purpose of this paper is to describe the process, analysis, results and implications of a card-sorting usability study. The study was conducted in order to investigate user-behavior during the design of a mobile tablet application for inexperienced users centred on the topic of "first aid". Card sorting is a participant-based knowledge elicitation technique for grouping information into categorical domains. We identified nine categories of cards and three cards were used by a small percentage of users. The categories showed indications of grouping by shared words and task. Differences in grouping were probably due to various mental representations on the part of users. Novices tend to group cards in one level without sub-groupings. Participants made many suggestions regarding possible new content.**

I. Introduction

CARD sorting is a user-centered design tool capable of increasing the usability of a system and of improving the design of interactive systems. Users sort cards that describe their picture, understanding and their mental image of concepts, workflows and information knowledge . The term 'card sorting' applies to a wide range of activities involving the naming of objects or concepts and their grouping [1]. It is a methodology that can be used to capture users' mental models of how information is organized in a software interface. According to Morville and Rosenfeld, card sorting "can provide insight into users' mental models, illuminating the way that they often tacitly group, sort and label tasks and content within their own heads." [2]. One of the main goals of a mobile interface is to relate function and operation to the elements of interaction that are performed well [3]. The challenge is to structure these elements in such a way that the product and system is useful, meaningful and easy to understand and to use.

With the increase in the use of new technologies and of use of the Internet at home, the numbers of novice users, that is, of ordinary people who lack skills in computer science and who are drawn from a wide range of backgrounds, has grown exponentially. Such persons face difficulties in operating computers. Ordinary people, however, are now the main target of the market, which produces new applications very rapidly[4].

Thus applications can be easy to use when the application conforms to the users' mental models. A good tool that enables one to see and understand this process is card sorting. Sorting is a natural method of classification and is an everyday activity for software, mobile applications and website content. The results that arise can lead to suggestions regarding navigation, the design of menus and taxonomies and ideas for interface design for specific target audiences [5,6]. Content categorization is significant for many reasons. The main advantage is that the method provides maximum information with minimal cognitive effort [7]. Card sorting may have a fruitful impact on either the overall structure of the software or on specific components of the organization of the design. As a method, card sorting is a knowledge elicitation technique designed to reveal the conceptual structures or categorizations applied by targeted individuals [8].

The goal of this study is to investigate ways for novice user to find and interact with the information content of a tablet mobile application. Thus, in order to improve the effectiveness of interaction on the part of novices users in a mobile tablet application oriented around the topic of first aid, we performed a card sorting session to gather information with the following aims in mind:

- To generate categories for a mobile tablet application with specific content
- To identify how novices structure information and
- To gain ideas regarding potential information architecture for novices.

To present the results of this study, this paper opens with a literature review which establishes the theoretical background for our study. It then describes the research methodology employed. It analyses the data and offers results, which are discussed, before offering some conclusions.

II. Background

Mental models

The term "mental model" has been used in many contexts and for many purposes. It was first mentioned by Craik in his 1943 book, *The Nature of Explanation* [9]. Leiser argues that a mental model of a user interface consists of a set of representations of the relationship between user

actions and system responses [10]. This view rests on Johnson-Laird's view of mental models as a form of knowledge representation and their manipulation as a form of reasoning, in which a mental model is regarded as the set of possible representations of the available information [11]. Mental models have been used in human-computer interaction and in increasing usability. Staggers and Norcio propose definitions of users' mental models that base the users' models of a system on their experience of it [12]. Users may not always have optimal mental models [13]. Designing a system based on defective user mental models can clearly hamper user performance.

Norman suggests that the usability, functionality and learnability of the conceptualized model of the designer depend on the degree of alignment between the conceptualized model of the designer and the mental models of the user. He argues that *"Mental models are naturally evolving models. That is, through interaction with a target system, people formulate mental models of that system. These models need not be technically accurate, but they must be functional"* [14].

Usability is strongly tied to the extent to which a user's mental model matches and predicts the action of a system[15]. However, sometimes it happens that the features of a system display no similarity to objects in the world.

Nielsen argues that user interfaces should "speak the user's language", which includes the presence of good mappings between the user's mental model of the system and the computer's interface for it [16]. Knowing the representative users' mental model with respect to the structure of a software is obviously very important, because it allows designers to construct the content according to users' expectations, thus making the resulting design as intuitive as possible for the users[17].

The importance of information architecture

The organization of information is one of the most powerful factors that influence the way in which users think about and interact with interfaces [18].

In the view of the Institute of Information, architecture is the art and science of organizing and labeling websites, intranets, online communities and software to support usability [19]. In the 1970s, Richard Soul Wurman created and gave the term "Information Architecture" wide circulation. Wurman was trained as an architect, but was also a skilled graphic designer. His definition of information architects emphasizes the organization and presentation of information.

"Information architect. (1) the individual who organizes the patterns inherent in data, making the complex clear. (2) a person who creates the structure or map of information which allows others to find their personal paths to knowledge. (3) the emerging 21st century professional occupation addressing the needs of the age focused upon clarity, human understanding, and the science of the organization of information" [20].

In the view of Ding and Lin, information architecture involves a number of activities. It concerns organizing and simplifying information, designing, integrating and aggregating information spaces/systems; creating ways for people to find, understand, exchange and manage information, thus staying on top of it and making the right decisions [21].

Information architecture design is a set of specialized skills that allows one to interpret information and express distinctions between signs and systems of signs. More concretely, it involves the categorization of information into a coherent structure, preferably one that the intended audience can understand quickly, if not inherently, so that they can then easily locate the information for which they are searching [2].

Card sorting methods

There are two card sorting method (Fig.1), open and closed, and they produce different types of data regarding the organization of content.

In an open card sort, participants create their own names for the categories and have the freedom to classify information according to their domain knowledge and experience, without external influences.

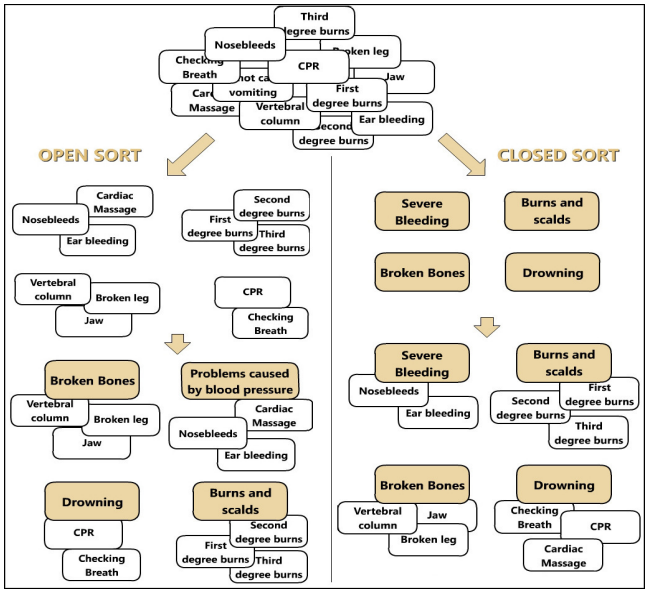


Fig. 1 Open and closed card sorting

This helps reveal both how they mentally classify the cards and what terms they use for the categories.

Open sorting is generative. It is typically used to reveal patterns in how participants classify, which in turn helps generate ideas for organizing information.

In a closed card sort, participants are provided with a predetermined set of category names. They then assign the index cards to these fixed categories. This helps reveal the degree to which the participants agree on which cards belong to each category.

III. Research Methodology

To examine how novice users conceptualize a mobile tablet application, we decided to create a card sorting session. (Fig. 2) This study used the open card sorting in

order to assess the participants' initial categorical structure. Since we are interested in categorization by non-experts, we chose to use paper cards to implement our card sorting method. Before the study the subjects were required to perform, by way of practice, a pilot test involving fourteen cards which they were required to classify in four categories (animals, birds, names of individuals, names of towns), the aim of this being to familiarize the participant with the process.

Fig. 2 During the card sort session.

A. Participants

The optimum number of participants to be employed in such a card sorting experiment is unclear. According to Robertson, four to six participants are enough [22]. Mower suggests 10 to14 participants [23]. Tullis and Wood propose a number of 20-30 participants [24]. Kaufman recommends "at least ten participants" for a card sort exercise, but cites no data for this recommendation and even goes so far as to state that "you can achieve reasonable results with fewer" [25]. There is thus no agreement on the appropriate number of participants in such an experiment. However, as Nielsen points out, the value of card sorting experiments lies in listening to the subjects comment as they sort the cards, which offers an deeper insight into the mental model that they employ than does examination of the mere fact that they sorted certain cards into the same pile [26]. Ross adds that "Having several people sort the cards together allows you to hear their discussions and the reasoning around how they group the cards"[27]. Our session was designed specifically to include a representative pool of the potential users of the mobile application that was being tested. Twelve participants (N=12) aged between 18 -76 (mean age = 41.6, SD = 20.9, years), seven of whom were males and five females, participated in the card sorting session. All participants were novices in computing. They did not suffer from any visual or cognitive impairment and were educated to at least high school level. Participants were told that the study was being done to help organize the information for a mobile tablet application dealing with the topic of "first aid".

B. Material

Thirty six cards were used in the open card sorting session and their subjects were drawn from information pertaining to "first aid ". Items were carefully selected to be of interest to our participant population. The titles were framed so as to be of a uniform level of complexity. An information sheet with detailed definitions of 36 terms was given to the participants. An example of such index cards is depicted in Fig. 3(a). In our study we used self adhesive cards for better user performance.

C. Procedure

Each participant was given a set of thirty six (36) randomly ordered paper cards (see appendix A). Group observation was used to test the participants, who were asked to sort the cards into logically ordered groupings. The participants were requested:

- To sort the cards by placing similar cards on the same pile.
- To create as many or as few piles as they like.

They were told to bear in mind:

- That the piles did not need to contain the same number of cards and that it was permissible for some piles to be very large and others to contain only one or two cards, if, in the view of the participants, the subjects of such cards were not sufficiently similar to others.

The subjects were also permitted to change their mind as much as they wanted, to move cards around and to split piles as much as they saw fit. They were also allowed to place a post-it note on top of each of their piles, with the name of the name of category that they had created.

(a) (b)

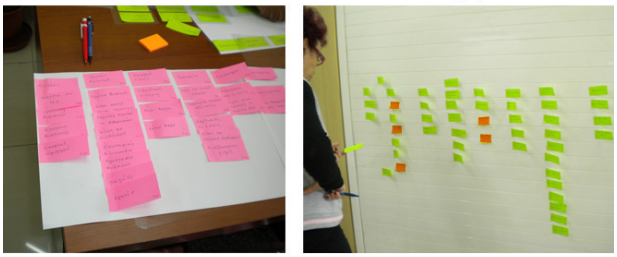


Fig. 3. (a) The cards , (b) Participant during the card sort session.

In addition, the participants were requested to:

- Use blank index cards to create new cards for anything the participant felt was missing or to create duplicate cards where the participant felt that a card belonged in multiple categories,
- To set aside cards that they considered to have no meaning or to place them in a pile of discards and
- To use a category called "other" or "general" for cards that seemed not to fit into any category but which they felt should still be retained (an idea we drew from the MIT study [28]). The subjects were encouraged to ask questions or to request further clarification whenever they desired of the concepts employed. Subjects were free to assemble as many groups of items as they wanted and to put as many items into one group as they saw fit. Each card was unique to the whole set. During the session participant, P4 requested more information about the card "cardiac massage" as he was unable to find anything on the information sheet of detailed definitions that the participants were provided with. Another

participant, P9, asked if she could create a new pile containing all "symptoms" together. She was told that she could group the topics as she saw fit.

When the participants were satisfied with their final classification, they were asked to record their card groupings on paper . They were then requested to fix the self-adhesive card to the final position .

Participants were given 45 minutes to complete the card sorting procedure. Only two of the 12 participants failed to finish in the set time, with most participants completing the sort in 30-40 minutes. When the classification was over, the participants were asked a set of open–ended questions to throw light on the process and describe their experience during the sorting process. To aid our understanding of the concepts that the participants employed in grouping the information, they were also asked to write down group names and descriptions of why they had grouped the items in this way.

IV. Results Analysis

All participants gave their permission for the test to be recorded on video. Although it was useful to look at the various cards to discover how users organized the information Fig. 3(a), it proved to be more convenient to assign a score to each of the cards, so that a statistical analysis could be run. On the basis of our review of the literature, we can choose a number of approaches, namely visual analysis, simply looking at the grouping categories, cluster analysis and a spreadsheet template. We did not, however, employ cluster analysis, since, in the view of Hudson, dendrograms (the graphic result of cluster analysis) are of use only when there is a single location for each card and a few of our participants used two locations for one card. We employed the spreadsheet template created by Spencer [29]. Card numbers were entered on the spreadsheet to be analyzed and determine which cards were placed in each category.

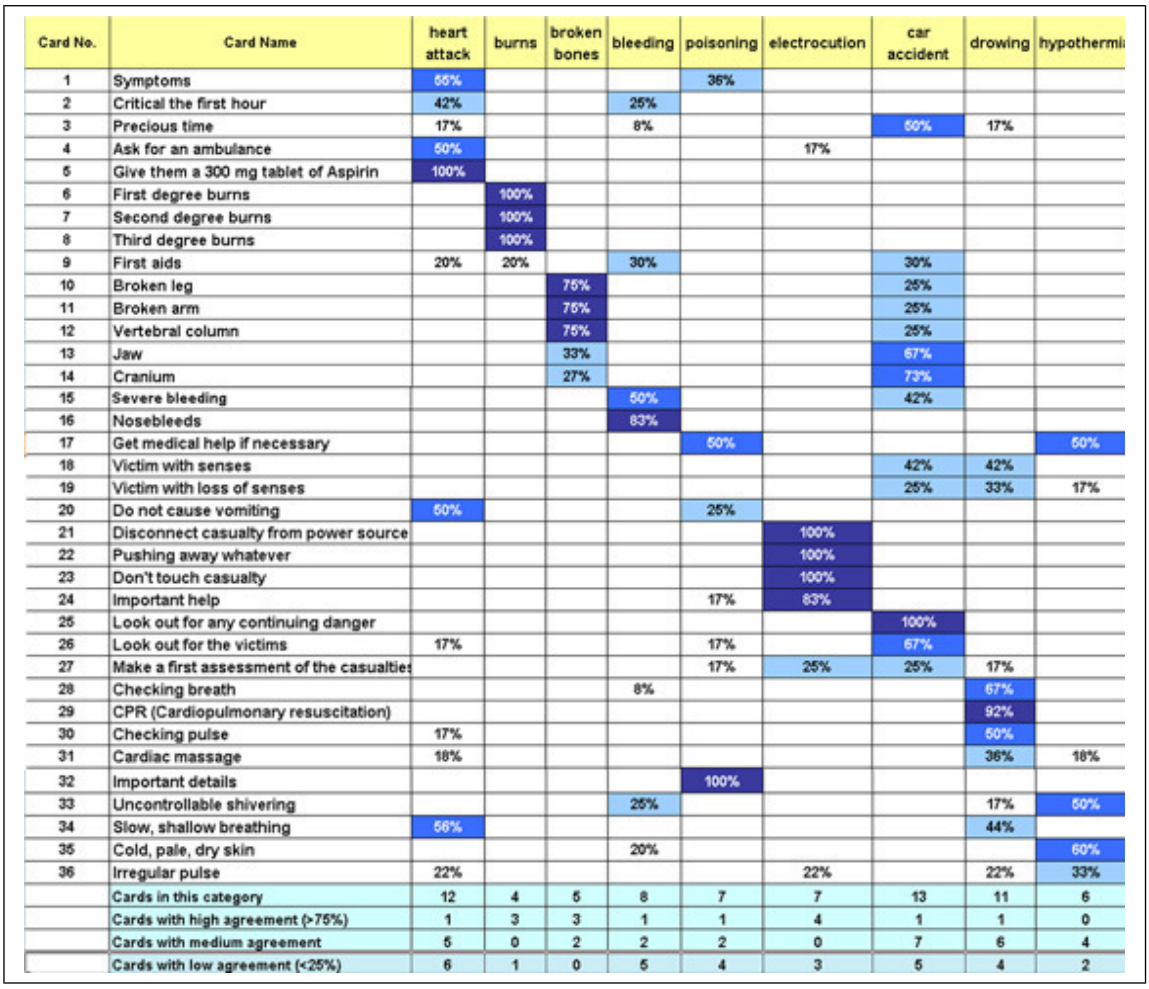
Fig.4 shows the relationship between cards, categories and participants. Each percentage shows how often a card was placed into a category by the participants. At the bottom of each column there are statistics regarding to:

- cards in this category , a count of how many participants cards were placed in this category
- cards with high agreement, a count of cards with a correlation of 75% of participants or more used this category for the card.
- cards with medium agreement, a count of cards with a correlation of 25%-50%
- cards with low agreement, a count of cards with a correlation of 25%or less.

Agreement: is a measure of how much agreement there was between participant results for that category [29].

The essential criterion for the formulation of categories was the presence of a "similarity of meaning" in the semantics of the language. This does not imply that the "same" meaning is to be sought, which would "reduce the semantic task to finding synonyms" [7]. No significant differences have been found between manual and electronic card sorts in terms of accuracy, test-retest reliability, and number of categories generated by participants [30]. It is very easy to organize online sorts, even those involving hundreds of participants, with the aim of discovering how far large numbers of individuals have understood the meaning of categories and concepts [31]. Although results offered by a card sorting session are mainly qualitative, those derived from large-scale online studies are mostly quantitative. According to Fincher and Tenenberg, "Traditional analyses of card sort data use semantic methods, those methods that rely upon interpretative judgments by individual researchers on the meanings of the respondents' utterances". Thus it is obvious that, in order to construct workable information architecture for the project, it is important to listen, as it were, to the users, to feel their experience and to observe their difficulties over the meaning of the labels. Analysis of the card sorting task revealed that one of the older participants did not arrange the cards in a hierarchical structure. Instead, she arranged the cards in groups of four, in such a way that there was no interconnection among the groups. One other participant displayed no clear organizing principle at all in their arrangement of the cards. The younger novice participants adopted a hierarchical menu structure. The subjects created a total of 16 categories, but, because some employed different names for the same category, we identified nine categories in all. These nine are: heart attack, poisoning, burns and scalds, severe bleeding, car accident, broken bones, drowning, electrocution and hypothermia. In Appendix B we present the category structure of the application we were intending to proceed before the session and in Appendix C the specified categories by participants.

As illustrated in Fig. 4 every participant created a group called "*burns*" and included the cards *"first degree burns", "second degree burns"* and *"third degree burns"*. In this case participants may group similar names together. But in other cases superficial similarities in the names used can produce unhelpful results [1]. Furthermore every participant created a group called *"electrocution"* and used the cards *"disconnect casualty from power source " "don't touch casualty", "pushing away whatever"*. The *"car accident"* group was diverse. The cards were put in that group least frequently were all ones that didn't fit strongly to one group. The card sort results were not used directly to create the information architecture. Instead, they were combined with results derived from other activities and an understanding of the users' behavior. According to Fling (2009) *"The secret is that mobile information architecture isn't all that different from how you might architect software or website; it just has a few added challenges"*. Appendix D portrays a low functional - prototype consisted of four level master screens of menu selection *"Drowning"* based on participants cooperation.



Card No.	Card Name	heart attack	burns	broken bones	bleeding	poisoning	electrocution	car accident	drowing	hypothermi
1	Symptoms	56%				36%				
2	Critical the first hour	42%			25%					
3	Precious time	17%			8%			50%	17%	
4	Ask for an ambulance	50%					17%			
5	Give them a 300 mg tablet of Aspirin	100%								
6	First degree burns		100%							
7	Second degree burns		100%							
8	Third degree burns		100%							
9	First aids	20%	20%		30%			30%		
10	Broken leg			75%				25%		
11	Broken arm			75%				25%		
12	Vertebral column			75%				25%		
13	Jaw			33%				67%		
14	Cranium			27%				73%		
15	Severe bleeding				50%			42%		
16	Nosebleeds				83%					
17	Get medical help if necessary					50%				50%
18	Victim with senses							42%	42%	
19	Victim with loss of senses							25%	33%	17%
20	Do not cause vomiting	50%				25%				
21	Disconnect casualty from power source						100%			
22	Pushing away whatever						100%			
23	Don't touch casualty						100%			
24	Important help					17%	83%			
25	Look out for any continuing danger							100%		
26	Look out for the victims	17%				17%		67%		
27	Make a first assessment of the casualties					17%	25%	25%	17%	
28	Checking breath				8%				67%	
29	CPR (Cardiopulmonary resuscitation)								92%	
30	Checking pulse	17%							50%	
31	Cardiac massage	18%							36%	18%
32	Important details					100%				
33	Uncontrollable shivering				25%				17%	50%
34	Slow, shallow breathing	56%							44%	
35	Cold, pale, dry skin				20%					60%
36	Irregular pulse	22%					22%		22%	33%
	Cards in this category	12	4	5	8	7	7	13	11	6
	Cards with high agreement (>75%)	1	3	3	1	1	4	1	1	0
	Cards with medium agreement	5	0	2	2	2	0	7	6	4
	Cards with low agreement (<25%)	6	1	0	5	4	3	5	4	2

Fig. 4 Participants agreement on classification.

V. Discussion-conclusion

This paper reports our initial exploration of the difference between the mental models of novice users regarding the information architecture of a mobile tablet application.

We derived nine categories (Fig.4) from the 16 that participants had created, but, as we have mentioned, participants used various words to describe the same category. A small percentage of cards weren't labeled well which indicates either that the participants did not understand the meaning intended to be conveyed by these cards or that there is simply no need for these cards.

The differences we observed in the way the participants classified these cards suggests that one of the reasons for differences in grouping lies in the use of different mental representations. Novices tend to create groups on one level alone (appendix C), without any sub-groupings (appendix B) or with at most only one sub-grouping. Furthermore, our observations suggest that novice users interpret the concepts they are dealing with on the basis of their personal experience and are unable to create a hierarchical structure.

As stated above, we held a discussion with our participants after the test, the aim of the conversation being to discover any organizational principles that they may have employed [33]. This helped us to decide on the final structure of the interface design of the prototype.

One way of minimizing misunderstanding and delay in the conduct of the test is to provide a definition on the rear face of the card. We feel that this is more convenient for the participants than having to search for the relevant definition in a list of 36 definitions. We employed the procedure involving adhesive cards, whose aim was to allow changes to be made easily, as some of the participants used the wall to sort the cards, Fig. 2(b).

The results of our study, which applies a user-centered design process to the construction of novice-oriented information architecture for a mobile tablet application centered around the topic of 'first aid', make clear the benefits of involving novice users in the process. Involving prospective users in the design can capture their underlying perception of the different components of the information architecture, thus leading to the design of, among other things, a hierarchy and navigation structure that reflects the mental model employed by the user, to the naming of

groups that likewise reflects this structure that efficiently categorize content.

We found card sorting to be a useful technique for task specification and for verifying task credibility. Moreover, the simple satisfaction of incorporating the user's point of view had a tremendous impact on the generation of ideas during the design of the prototype.

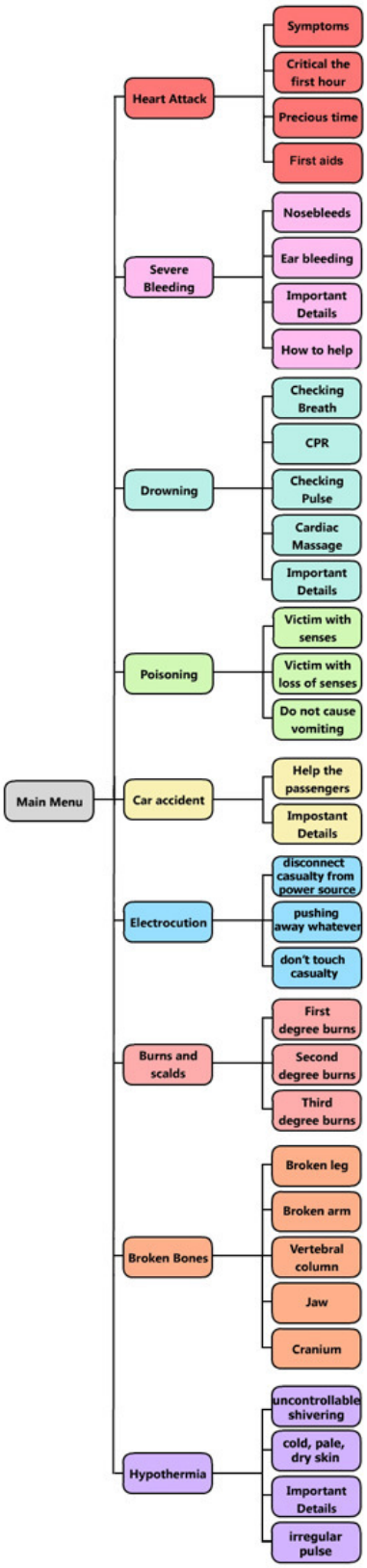
APPENDIX

Appendix **A** *Card Labels*

1	Symptoms
2	Critical the first hour
3	Precious time
4	Ask for an ambulance and say you suspect a heart attack
5	Give them a 300 mg tablet of Aspirin to chew
6	First degree burns
7	Second degree burns
8	Third degree burns
9	First aids
10	Broken leg
11	Broken arm
12	Vertebral column
13	Jaw
14	Cranium
15	Severe bleeding
16	Nosebleeds
17	Get medical help if necessary
18	Victim with senses
19	Victim with loss of senses
20	Do not cause vomiting
21	Disconnect casualty from power source
22	Pushing away whatever is conducting the current using an insulating material
23	Don't touch casualty because they may be 'live'
24	Important help
25	Look out for any continuing danger, to yourself and others
26	Look out for the victims
27	Make a first assessment of the casualties - is anybody in immediate danger?
28	Checking breath
29	CPR (Cardiopulmonary resuscitation)
30	Checking pulse
31	Cardiac massage
32	Important details
33	Uncontrollable shivering
34	Slow, shallow breathing
35	Cold, pale, dry skin
36	Irregular pulse

Appendix **B** *The intended structure before the session*

Appendix **C** *The specified structure by the participants*



Appendix **D** *A prototype (low functional) based on participants cooperation, who took part in the study.*

ACKNOWLEDGMENT

This research has been co-financed by the European Union (European Social Fund – ESF) and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) - Research Funding Program: Heracleitus II. Investing in knowledge society through the European Social Fund. We would also like to thank Aristovoulos Pavlakis and the participants in our study.

REFERENCES

[1] W. Hudson. Playing your cards right: Getting the most from card sorting for navigation design. HCI & Higher Education Column: *People: HCI & the web*, vol 12, no5, pp.56–58, Sep 2005

[2] P. Morville and L.Rosenfeld, *Information Architecture for the World Wide Web* O'Reilly Media, 2006.

[3] C. Gatsou, A. Politis, D, Zevgolis, From icons perception to mobile interaction. In proceedings of the Computer Science and Information Systems (FedCSIS), (2011) 705-710

[4] C. Gatsou, A. Politis, D, Zevgolis, "Text vs visual metaphor in mobile interfaces for novice user interaction" Proceedings of the 16th International Conference on Electronic Publishing, ElPub 2012 pp.125-135.

[5] C. Courage and K. Baxter, *Understanding Your Users: A practical guide to user requirements: Methods, Tools, & Techniques,* Morgan Kaufmann ,2005.

[6] D. Spencer, *Card Sorting: Designing usable categories,* Rosenfield Media, Brooklyn, NY, USA,2009.

[7] A. Coxon, *Sorting data: Collection and analysis. Series: Qualitative Applications in the Social Sciences.* Thousand Oaks, CA: Sage Publications,1999.

[8] J. N.Cooke, Varieties of knowledge elicitation techniques. *International Journal of Human-Computer Studies* Vol 41 pp 801-849, 1994.

[9] W. Craik, *Nature of explanation.* Cambridge University Press, Cambridge, (1943, Reprinted in 1952).

[10] B. Leiser "The presence phenomenon and other problems of applying mental models to user interface design and evaluation". In Y. Rodgers, A. Rutherford et al. 1992. Models in the mind - Theory, perspective, and application. London, Academic Press.

[11] P. Johnson-Laird, *Mental Models.* Cambridge, UK. Cambridge University Press ,1983.

[12] N. Staggers and A. Norcio "Mental models: concepts for human-computer interaction research," *International Journal of Man-machine Studies* vol.38,pp. 587-605, 1993.
[13] J. Nielsen, and D. Sano, "SunWeb: User Interface Design for Sun Microsystem's Internal Web" In Proc. 2nd World Wide Web Conf. '94: Mosaic and the Web. Chicago, IL, pp. 547.557.
[14] D. Norman. *Some observations on mental models. In Mental Models*, pages 7–14. Lawrence Earlbaum Associates, 1983.
[15] M. J. Davidson, L. Dove, J. Weltz, "Mental Models and Usability" Depaul University, Cognitive Psychology, 1999, [Online]. Available: www.lauradove.info/reports/mental%20models.htm
[16] J. Nielsen, UseIt.com [Online].Available: http://www.useit.com/ /alertbox/20030818.html
[17] M. Bernard, "Constructing user-centered websites: The early design phases of Small to medium Sites," *Usability News 2.1* [Online] ../usabilitynews/21/webdesign.asp
[18] W. Lidwell, K. Holden, & J ,Butler, *Universal principles of design.* Massachusetts: Rockport, 2003.
[19] 'What is IA?' Information Architecture Institute. IAinstitute.org
[20] R. S. Wurman, *Information Anxiety.* New York: Doubleday, 1989.
[21] W. Ding, X. Lin. *Information Architecture: The Design and Integration of Information Spaces*. Morgan & Claypool Publishers,2009.
[22] J, Robertson,. "Information Design Using Card Sorting" 2001 Retrieved on November 22, 2011 from the Step Two Designs website, http://www.steptwo.com.au/papers/cardsorting/ index.html
[23] D. Maurer, and T. Warfel, "Card sorting: A definitive guide." Boxes and Arrows. April, 2004. [Online]. Available: http://www.boxesandarrows.com/view/ card_sorting_a_definitive_guide [Accessed 10 December 2011].
[24] T. Tullis, T. and L.Wood, "How many users are enough for a card-sorting study?" *Proceedings of the Usability Professionals Association Conference,* Minneapolis, MN, 2004.
[25] J.Kaufman, "Card sorting: An inexpensive and practical usability technique", *Intercom,* 17-19, Nov-2006
[26] J. Nielsen, "Card sorting: How many users to test"2004. http://www.useit.com/alertbox/20040719.html
[27] J. Ross 2011 "Comparing User Research Methods for Information Architecture". UX matters [Online] http://www.uxmatters.com/mt/archives/2011/06/comparing-user-research-methods-for-information-architecture.php
[28] N. Hennig, "Card Sorting Usability Tests of the MIT Libraries' Web Site: Categories from the User's Point of View",pp. 88-99
[29] D. Spencer, "Card Sorting Designing Usable Categories" Spreadsheet Template 2009 [Assessed 14 November 2011]; Available from: http://www.rosenfeldmedia.com/books/cardsorting/content/resources/
[30] M. Harper, & L.R.Van Duyne, "Computer-based card sort training tool: is it comparable to manual card sorting?" *Proceedings of the Human Factors and Ergonomic Society 46th Annual Meeting* (pp. 2049-2053), 2002.
[31] S. Fincher and J. Tenenberg, "Making sense of card-sortingdata", Expert Systems, Vol.22,no3 2005.
[32] B. Fling *Mobile Design and Development*, Beijing: O'Reilly, USA, 2009.
[33] A. Cooper, *About Face: The Essentials of Interaction Design,* Wiley Indianapolis, 2007.