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Usability in Scientific Databases

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Abstract

Usability, most often defined as the ease of use and acceptability of a system, affects the users' performance and their job satisfaction when working with a machine. Therefore, usability is a very important aspect which must be considered in the process of a system development. The paper presents several numerical data related to the history of the scientific research of the usability of information systems, as it is viewed in the information provided by three important scientific databases, Science Direct, ACM Digital Library and IEEE Xplore Digital Library, at different queries related to this field.

Keywords and phrases: usability, information systems, scientific databases

1 Introduction

Bragge et al. [1] show how the computer-supported research can facilitate the literature review and critical evaluation. Suduc et al. [2] noticed that many international scientific databases offer, on queries, a wide range of information (authors, publications, subjects, etc.), based on results of the query performed. These information are, usually, quite comprehensive to gain a "big picture" perspective on the research activity of that field. Suduc et al. [2] also noticed that this method of computer-aided research profiling substantially minimizes the data processing time comparing to the method used by [1] [3] [4] [5].

This paper aims at presenting and evaluating the information provided by three scientific databases, namely ACM Digital Library, IEEE

Xplore Digital Library, and Science Direct, to various queries concerning the usability of information systems with a view to identifying the trends in the evolution in time of the interest for this research field.

2 Usability concept

According to ISO 9241-11 (1988) and ISO 9241-171 (2008), for a product to be usable and accessible users should be able to use it to achieve their goals in an acceptable amount of time, and be satisfied with the results [6]. The new draft standard ISO/IEC CD 25010.2 (2008) proposes a more comprehensive breakdown of quality in use into usability in use, flexibility in use, and safety.

Usability in use corresponds to the ISO 9241-11 definition of usability as effectiveness, efficiency, and satisfaction. The *effectiveness* is provided if the user can successfully and correctly fulfil his objectives. The assistance quality within the interface can have a great impact on the effectiveness. The interface should be as informative as possible [7]. *Efficiency* can be described as the speed (with accuracy) in which users can complete the tasks for which they use the product [8]. *Satisfaction* is composed of comfort (overall physiological or emotional responses to use of the system) and acceptability of use (overall attitude towards the system, or the user's perception of specific aspects) [9].

Flexibility in use is a measure of the extent to which the product is usable in all potential contexts of use, including accessibility. Safety is concerned with minimising undesirable consequences [6].

During the process of designing and implementing information systems, sequences of decisions should be made with respect to the choice of the most adequate alternatives concerning several critical aspects, such as system orientation, composition of the team, method to be adopted, IT&C tools to be utilized, resources to be allocated and so on [10]. During this process there should be made the design decision that determines the usability of the system [11]. Therefore, usability expertise and knowledge is crucial in the projects. In any software project, there should be considered five essential usability characteristics [12]: (1) *learnability* – rapidly begin working with the system; (2) *efficiency*

– user high level of productivity; (3) *memorability* – no necessity to relearn everything after a period of not using the system; (4) *low error rate* – fewer and easily rectifiable errors while using the system, and no catastrophic errors occur; and (5) *satisfaction* – a system pleasant to use.

Systems that are difficult to use lead to business costs and losses. As shown in [13] if the system is difficult to use, people either won't use it at all or if they will eventually use it they will do so to the less extent possible, or they will waste unnecessary time. In addition more technical support and/or more technical changes and adaptations would be necessary.

There are good reasons to evaluate the usability in the design process of a product such as (a) a deeper understanding of the user needs and (b) to set the stage for product improvement in order to provide a better user experience.

3 Usability evolution

Usability concern is part of human being, but "the field of usability research really came into being when the tools we used started to run up against our cognitive and physical limitations" [14]. The term usability started to be used around 1980s in order to replace the term "user friendly" which "had acquired a host of undesirably vague and subjective connotations" [15].

Usability has evolved from "representing a relatively simple utilitarian concern for task performance into a highly complex notion of a contextualised human experience, also including emotional and social aspects" [16].

According to [14], it was the aviation engineers who started to think about usability seriously in order to reduce human errors of aviators. M. Soegaard [17] identifies the origins of the concept of usability in the falling prices of computers in the 1980s, when for the first time in the human history, it was feasible for many employees to have their own personal computer and, therefore, usability became a key goal for the design of any interactive software that would not have been used by

trained technical computer specialists. According to [18], the usability profession can be associated with the work of John Whiteside at DEC (Digital Equipment Corporation) and John Bennett at IBM. During the late 1980s, they published a number of chapters and papers on the topic of "usability engineering". With their work they stressed a quantitative but practical engineering approach to product design. They stressed the importance of the work context in creating usable and functional products to improve productivity. They stressed also that it is useful to integrate usability specialists in the design and implementation team who aims at obtaining the best solution for the allocated resources [10]. At present, the terms "usable" and "usability engineering" are used to describe well-designed products and the process by which they should be designed [18].

The current understanding of usability evolved from its meaning of the starting days of the "usability movement" in the 1980s and the researches have ever more focused on usage contexts. "Usage quality no longer appeared to be a simple issue of how inherently usable an interactive system was, but how well it fitted its context of use" [17].

4 Method and Results

In order to identify a trend of the evolution, in time, of the interest for the usability research field, a study has been conducted in May, 2012. The study consisted in several queries, related to the usability research filed, on three major scientific databases, ACM Digital Library, IEEE Xplore Digital Library and Science Direct. Therefore, first, there have been searched all the scientific materials which contained the "usability" term in title, then in abstract and at the end in keywords. Second, there have been searched all the scientific materials which contained the "usability" word and also one of the following terms: "information system" or "information systems" or software.

Table 1 presents the number of the scientific materials contained by the three analysed scientific databases at 25^{th} of June 2010 [19] and at 9^{th} of May 2012. Comparing the numbers of materials at almost two years distance, it can be noticed that the databases increased in

content with good percentages: ACM Digital Library with almost 24% (365,331 items), IEEE Xplore Digital Library with 20% (527,853 items) and Science Direct with 12% (1,183,521 items).

Table 1. The numbers of scientific materials contained by ACM Digital Library, IEEE Xplore Digital Library and Science Direct

Database	**Scientific materials (25^{th} of June 2010)**	**Scientific materials (9^{th} of May 2012)**
ACM Digital Library	1,529,482	1,894,813
IEEE Xplore Digital Library	2,651,920	3,179,773
Science Direct	10,236,351	11,419,872

Table 2 shows the results of the queries performed: the number of scientific materials, contained by each of the three databases, which has (a) "usability" or (b) "usability" and "information system" or "information systems" or "software", in title, abstract and keywords. The results show that there are not too many scientific materials which contain "usability" and "information system" or "information systems" or "software" in title or abstract but there are much more which contain "usability" in abstract, title or keywords fields.

Table 2. The numbers of scientific materials which contains the specified terms in title, abstract or keywords, indexed by ACM Digital Library, IEEE Xplore Digital Library and Science Direct

	Title		**Abstract**		**Keywords**
Searched term Database	**Usability**	**Usability AND (“information system” OR “information systems” OR “software”)**	**Usability**	**Usability AND (“information system” OR “information systems” OR “software”)**	**Usability**
ACM Digital Library	2810	203	9700	2118	3309
IEEE Xplore Digital Library	940	134	5367	3771	679
Science Direct	582	43	2471	430	553

Comparing to the total number of the items in the scientific databases, the materials which contain the searched terms represents only a small part. For example in ACM Digital Library 0.511% of the scientific materials contains usability in abstract, in IEEE Xplore Digital Library 0.168% and in Science Direct 0.021%.

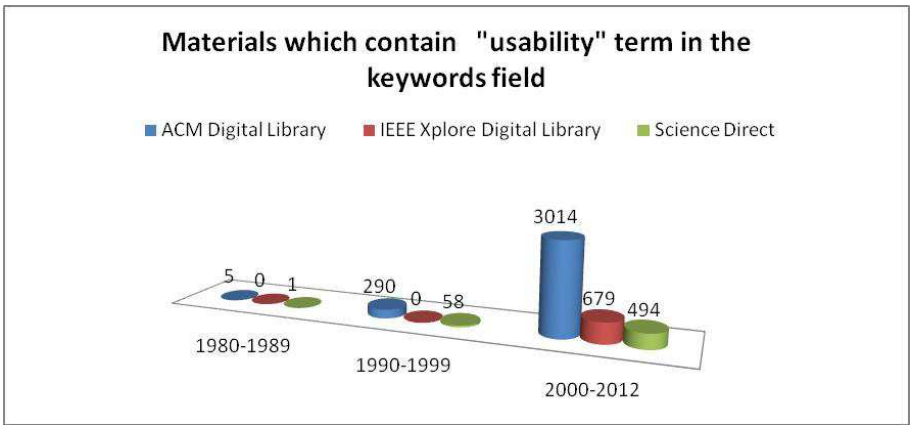

Figure 1. The number of scientific materials, per decades, included in ACM Digital Library, IEEE Xplore Digital Library and Science Direct, which contains "usability" term in the keywords field (on 9^{th} *of May 2012)*

Because the keywords of a paper capture the main topics of the scientific material, there have been analysed the materials which contain usability as keyword. Therefore, Figure 1 presents the number of scientific materials in the usability research field in three periods of time: 1980-1989, 1990-1999 and 2000-2012. The results show clearly that this research area started in 80's, continued in 90's and increased a lot in the last twelve years.

Figures 2, 3 and 4 present the evolution in the last 12 years of the numbers of scientific materials, with "usability" as keyword, which are included in the three analysed scientific databases. The figures show an increasing interest for the usability research field.

Because the study was made in May 2012, it is obvious that the

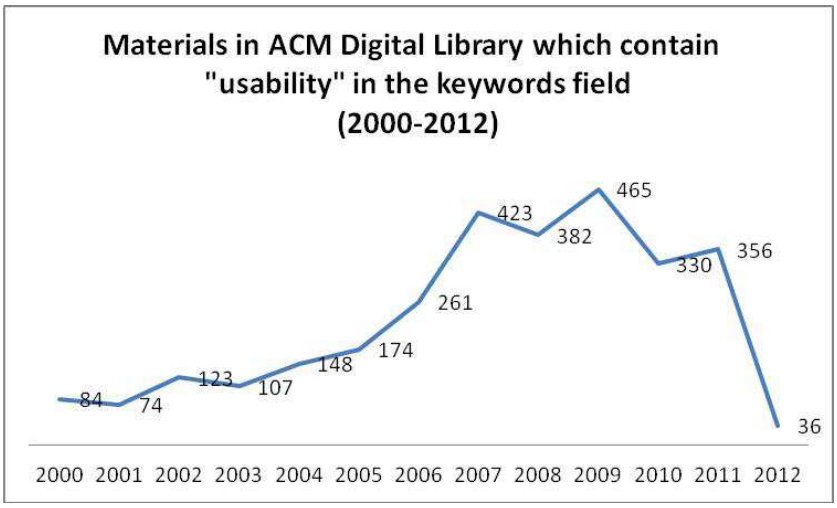

Figure 2. The number of scientific materials, published in the last 12 years and included in ACM Digital Library, which contains "usability" term in the keywords field (on 9^{th} *of May 2012)*

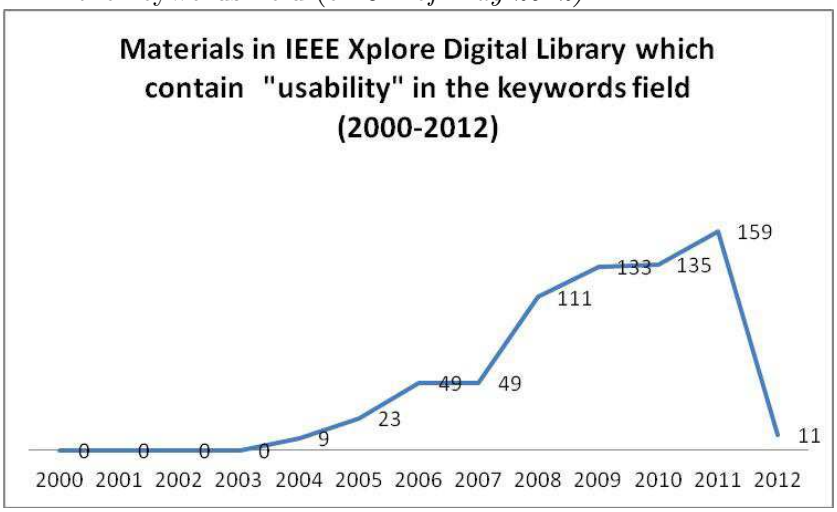

Figure 3. The number of scientific materials, published in the last 12 years and included in IEEE Xplore Digital Library, which contains "usability" term in the keywords field (on 9^{th} *of May 2012)*

values for 2012 are only partially relevant. Also for 2011, the values might be influenced by the databases updating process for that year, which might be still ongoing.

ACM Digital Library and IEEE Xplore Digital Library, at any search, give the list of the authors of the scientific materials returned as results of the search. Science Direct does not offer such a list. Table 3 presents the top ten authors with the highest number of scientific materials in the usability research field included in ACM Digital Library and IEEE Xplore Digital Library.

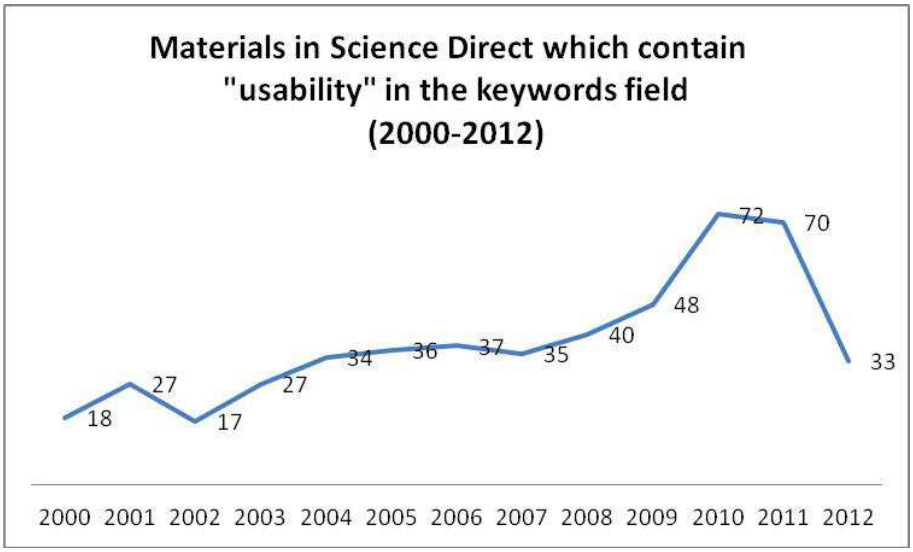

Figure 4. The number of scientific materials, published in the last 12 years and included in Science Direct, which contains "usability" term in the keywords field (on 9^{th} *of May 2012)*

Table 3. The list of the first ten authors with the highest number of scientific materials published and included in ACM Digital Library and IEEE Xplore Digital Library, scientific materials which has "usability" term as keyword

ACM Digital Library		**IEEE Xplore Digital Library**	
Author	**Number of scientific materials**	**Author**	**Number of scientific materials**
Andreas Holzinger	29	Azizah Jaafar	8
Kasper Hornbaek	25	Suziah Sulaiman	7
Barbara Leporini	23	Cristian Rusu	6
Stephanie Rosenbaum	23	Silvana Roncagliolo	6
Marina Buzzi	21	John M. Carroll	5
Ann Blandford	17	Liang Lu	5
Bonnie E. John	17	Dimitrios Rigas	5
Jakob Nielsen	15	Bekim Fetaji	5
Jonathan Lazar	15	Majlinda Fetaji	5
Rolf Molich	14	Deng Xiaoling	5

All of these authors are researchers with wide experience and large number of scientific papers in human computer interaction area. For example Andreas Holzinger, the author with the highest number of scientific articles with "usability" as keyword in ACM Digital Library, in his online CV[1], presents himself as the author of more than 300 publications and as a researcher very involved in the HCI research area (e.g. he is chair of the Workgroup Human–Computer Interaction and Usability Engineering (HCI&UE) of the Austrian Computer Society (OCG) and founder and leader of the Special Interest Groups HCI4MED and HCI4EDU).

Therefore, a top of authors with the highest number of scientific articles which contain specific terms might be very useful for any researcher in order to identify people with similar research interests.

Table 4 presents the first ten publications (journals/proceedings) which contains articles in the usability research field. The publication with the highest number of papers in the usability field is *Interacting with Computers* (101 papers in Science Direct and 42 in ACM Digital Library), followed by *International Journal of Human-Computer Studies* (53 papers in Science Direct and 50 in ACM Digital Library) and *Proceedings of the SIGCHI conference on Human factors in computing systems* (52 papers in ACM Digital Library). Thus, a top of the publications with scientific articles which contain specific terms is also useful in order to identify the representative publications for a specific research filed.

[1] http://user.meduni-graz.at/andreas.holzinger/holzinger/

Table 4. The list of the publication names with the highest number of scientific materials published and included in ACM Digital Library, IEEE Xplore Digital Library and Science Direct, scientific materials which has "usability" term as keyword

ACM Digital Library		**IEEE Xplore Digital Library**		**Science Direct**	
Publication name	**Number of scientific materials**	**Publication name**	**Number of scientific materials**	**Publication name**	**Number of scientific materials**
Proceedings of the SIGCHI conference on Human factors in computing systems	52	IEEE Transactions on Professional Communication	20	Interacting with Computers	101
International Journal of Human-Computer Studies	50	IEEE Security & Privacy	15	International Journal of Human-Computer Studies	53
CHI '04 extended abstracts on Human factors in computing systems	42	IEEE Software	10	International Journal of Medical Informatics	27
Interacting with Computers	42	Second International Conferences on Advances in Computer-Human Interactions, 2009. ACHI '09	10	Applied Ergonomics	26
CHI '06 extended abstracts on Human factors in computing systems	40	International Conference on User Science and Engineering (i-USEr), 2011	9	Computers in Human Behaviour	21

Continuation of Table 4

ACM Digital Library		**IEEE Xplore Digital Library**		**Science Direct**	
Publication name	**N.of sc. mat.**	**Publication name**	**N.of sc. mat.**	**Publication name**	**N.of sc. mat.**
Proceedings of the 2nd international conference on Usability and internationalization	40	IEEE Pervasive Computing	8	Journal of Biomedical Informatics	17
CHI '08 extended abstracts on Human factors in computing systems	35	9th International Conference on Computer-Aided Industrial Design and Conceptual Design, 2008. CAID/CD 2008	8	Journal of Systems and Software	17
Proceedings of the 12th international conference on Human-computer interaction: interaction design and usability	35	IEEE International Professional Communication Conference, 2009. IPCC 2009	8	Journal of Visual Languages & Computing	14
Universal Access in the Information Society	33	IEEE International Professional Communication Conference, 2006	7	Computers & Security	12
CHI '97 extended abstracts on Human factors in computing systems: looking to the future	32	IEEE 10th International Conference on Computer-Aided Industrial Design and Conceptual Design, 2009. CAID/CD 2009	7	Displays	11

5 Conclusions

The scientific databases, like Science Direct, ACM Digital Library and IEEE Xplore Digital Library, provide, on each search, besides the list of scientific papers which responds to the search criteria, useful information (e.g. representative publications and authors, etc.), which enable the researchers to better understand the research field and the deep meaning of what they can find in the database related to that field.

Although, research on usability has, since the late 2000s, been superseded by research on *user experience*, according to many authors, it has been and remains human computer interaction core concept. The results presented in this paper shows that the usability research area started in 80's, continued in 90's and increased a lot in the last twelve years. Also the results present the *Interacting with Computers* and *International Journal of Human-Computer Studies* as the most representative journals in the usability research area and authors such as Andreas Holzinger, Kasper Hornbaek and Barbara Leporini, the most prolific authors in this area, that are included in the analysed scientific databases.

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