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A comparison of heuristics applied for studying the usability of websites

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Abstract

The study of the usability of interfaces of all types of applications, including websites, is still a very topical research area. The heuristic method is among the methods applied to evaluate the usability of interfaces. Many researchers use Nielsen's heuristics developed in 1996, while others propose their own heuristic sets. This article aims to present the results of a study which consisted in a comparison of original heuristic sets with Nielsen's heuristics. The original heuristic proposals selected for the analysis concern different interface types, but they have in common is the possibility of using them to study the usability of websites. On the basis of the literature research conducted, 9 sets of heuristics were distinguished, each of which was compared with Nielsen's heuristics. The contribution of this article consists in a tabular comparison between 9 original proposals and 10 Nielsen's heuristics.

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1. Introduction

Computers and mobile devices intended for a wide group of users, not necessarily IT experts, could not function today without appropriate graphical interfaces. The ways and techniques of their development, depending on the hardware platform, software, subject matter, or even their artistic quality, are extremely varied. Regardless of

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designers' and ordering entities' approach, the main purpose of a given interface is to communicate with the user in order to effectively present specific content (usability) to the widest possible group of users (accessibility). This means that both healthy and disabled people should be able to effectively familiarize themselves with and use the information contained in a given application or website, as well as being able to take advantage of their functionalities. Among the many features of an interface, the already mentioned usability and accessibility are particularly important as they determine the possibility of using a given application or website. In the literature, accessibility is often considered as a component of usability [1-3]. This interpretation was also adopted for the purpose of this article.

Creating useful and accessible interfaces requires research and testing. There are many ways to evaluate these features, one of the most popular of which is the heuristic method. Due to the ever-growing diversity of interfaces, there is an increasing number of original proposals of heuristics [4] to be used to assess the usefulness of an interface. Authors who apply heuristics for interface usability studies often refer to Nielsen's 10 heuristics [5]. The article aims to present the results of a study consisting in a comparison between original sets of heuristics and Nielsen's heuristics in the context of website usability studies. The original proposals of heuristics chosen for the analysis concern different interface types but they are linked by the possibility of using them for examining the usability and accessibility of websites.

The structure of the article is as follows. The next section describes the theoretical aspect of the issues in question, focusing primarily on the usability of interfaces and the heuristic method used to study them. The third section discusses the details of the study. First, the formulated research questions and the applied research procedure are presented. The following part of the article focuses on discussing the conducted literature review, as a result of which 9 original proposals of a set of heuristics for the study of interface usability were identified. Next, the results of the comparison between these selected groups of heuristics and Nielsen's heuristics were discussed and conclusions were formulated. The article ends with a summary.

2. Theoretical Background

The concept of usability is extremely broadly described in the literature. ISO 9241-210:2019 [6] standard defines it as "the extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use". The ISO/IEC 25010:2011 [7] standard on software engineering and product quality describes usability as a feature of software that must be understandable, convenient to use, and attractive to the user. It is also the device's "capacity to be used" [4], depending on what the user wants to do and achieve [8]. Jakob Nielsen describes usability as a qualitative attribute that affects the difficulty of operating a given interface [5]. It includes the following [5]:

- learnability, ease of use on the first attempt,
- efficiency, the speed of performing tasks using the already known system,
- memorability, ease of use after a break from using the interface,
- errors, error handling and minimizing the chance of error occurrence,
- satisfaction and pleasure in using the interface.

A website is an example of a graphical interface. Research shows that web usability is a key quality parameter for its evaluation [9]. It determines the level of legibility, intuitiveness, and convenience [10]. It is also related to the second concept, i.e. web accessibility, which is important from the standpoint of human-computer interaction. It is a feature of a website that enables all people to use its content, regardless of their health condition, hardware, software, or the quality of their Internet connection. Accessibility problems are most often related to disabled users, as well as the elderly. This may concern reduced motor skills, poor eyesight, or cognitive impairment [11].

Usability and accessibility can be considered as separate components of User Experience, which together create value for the user and ensure that their needs related to a given product are met [12]. According to many authors, usability is a broader concept, and accessibility is its subset including problems pertaining to interface operation by, for example, people with disabilities [1-3].

There are several ways to study the usability of websites [4, 13-17]. The heuristic method is one of the most widespread. It is an expert and inspection-based procedure for identifying usability problems. It indicates the extent to which an interface, e.g. of a website, meets given standards and guidelines. These relate to the human-computer interaction and are referred to as usability heuristics [4]. In this method, the main role is played by an expert deciding on the compatibility of the interface with the design assumptions and/or standards [18].

Performing a heuristic analysis is a relatively simple task. It is an advantage of this method, as is the universality of the method itself, which can be adapted to any type of interface. This method also makes it possible to perform a comprehensive analysis of the website, as well as individual pages constituting its components. The lack of necessity to engage a large number of users reduces the costs of usability testing. An optimal team of experts comprises three to eight people [19]. Each expert's independent approach impacts the objectivity of results. The heuristic method enables detecting any problems related to the operation of a website and identifying elements that negatively influence its usability. However, the procedure of preparing guidelines related to the use of the heuristic method for a specific purpose may cause some difficulties because it requires experience and thorough research.

When creating new rules and guidelines on usability, the starting point is usually Jakob Nielsen's heuristics. These are [5]:

H01. Visibility of system status The interface should clearly communicate the current status of individual actions and determine the user's current location in the system.

H02. Correspondence between the system and the real world. The messages should be clear and understandable to the user. Technical terms and excess information should be avoided and logically structured.

H03. User control and freedom The user should be given the flexibility to influence actions taken in the system, their reversibility, the ability to record the current status, as well as the option to pause and return after a break.

H04. Consistency and standards The system should be characterised by visual and operational consistency as well as transparency of the processes taking place in it. This means standardisation of the appearance of individual parts of the interface, orderly operation of all its elements, and predictable reactions to user actions.

H05. Prevention of errors At the stage of system design, situations conducive to user errors should be predicted. Those which cannot be corrected should be accompanied by an appropriate warning or informative message.

H06. Recognition and not remembering The user should have full access to all the information they need at any given time, without the need to memorise instructions appearing at earlier stages of the dialogue with the system.

H07. Flexibility and efficiency of use The system should adapt flexibly to the user's needs. It should instruct new users in detail, and enable more experienced users to take shortcuts or even offer options to automate frequently performed and repetitive actions.

H08. Aesthetic and minimalist design The form should serve the content. An aesthetic and clear interface with an orderly layout facilitates system readability and intuitive operation. Excessive visual effects distract attention unnecessarily, hinder orientation, and are sometimes cumbersome for the user focusing on a particular task.

H09. Help users recognise, diagnose, and recover from errors Error messages should be understandable and comprehensive, as well as clearly indicating how to solve the problem.

H10. Help and documentation Regardless of the form and manner of error handling, each system should be accompanied by documentation, a help desk, or a user's manual. This element should not be too extensive, enabling quick searching for information and containing instructions on how to deal with failures.

The above heuristics, also called traditional ones, became the basis for many people to design new rules and guidelines related to usability. A review of the literature indicates that individual authors develop them for their analyses and adapt them to specific interface types [4]. Preceding this article, the empirical studies consisting in the evaluation of usability and accessibility of public administration units' websites confirmed the validity of extending the set of heuristics proposed by Nielsen [20].

The subject discussed in the article is very topical. The number of new publications in the field of interface usability studies is growing exponentially every year. Table 1 presents the results obtained from the literature review conducted using the Google Scholar search engine. Figure 1 illustrates the quantitative trends with respect to publications.

As it transpires from the data presented in the table and figure, a continuous increase in interest in the topic can be observed. A slight decrease appears only in the first part of the graph, which results from the construction of Table 1, meaning that in the years 2002-2003 fewer publications appeared than in all publications up until 2001. At

the same time, it is worth pointing out that this number is higher already in the period 2004-2005 and constantly growing in subsequent years.

Table 1. Google Scholar search results with respect to usability-related issues that have appeared over the past 19 years.

| Google Scholar | Do 2001 | 2002 -2003 | 2004 -2005 | 2006 -2007 | 2008 -2009 | 2010 -2011 | 2012 -2013 | 2014 -2015 | 2016 -2017 | 2018 -2019 |
|-----------------|--|------------|------------|------------|------------|------------|------------|------------|------------|------------|
| Search 1 | 1 410 | 1 990 | 3 710 | 5 260 | 7 160 | 9 710 | 12 500 | 15 500 | 18 000 | 19 900 |
| Search 2 | 1 330 | 1 620 | 2 960 | 4 070 | 5 450 | 6 920 | 9 130 | 11 000 | 13 100 | 16 500 |
| Search 3 | 1 170 | 1 440 | 2 690 | 3 730 | 5 060 | 6 400 | 8 260 | 10 100 | 12 100 | 15 800 |
| Search 4 | 3 590 | 2 970 | 4 600 | 5 700 | 7 230 | 8 380 | 9 660 | 11 100 | 12 200 | 13 600 |
| Search 5 | 4 360 | 2 940 | 4 550 | 5 670 | 7 030 | 8 080 | 9 730 | 11 000 | 12 500 | 13 900 |
| Search 6 | 1 150 | 706 | 1 200 | 1 510 | 1 860 | 2 320 | 2 810 | 3 090 | 3 780 | 4 250 |
| Search keywords | | | | | | | | | | |
| Search 1 | (website) AND (accessibility) AND (usability) | | | | | | | | | |
| Search 2 | (website) AND (heuristics) AND (usability) | | | | | | | | | |
| Search 3 | (website) AND (heuristic evaluation) AND (usability) | | | | | | | | | |
| Search 4 | (heuristic evaluation web usability) | | | | | | | | | |
| Search 5 | (heuristic evaluation) and (web usability) and (literature review) | | | | | | | | | |
| Search 6 | (heuristic evaluation) and (web usability) and (literature review) and (public administration unit publications) | | | | | | | | | |

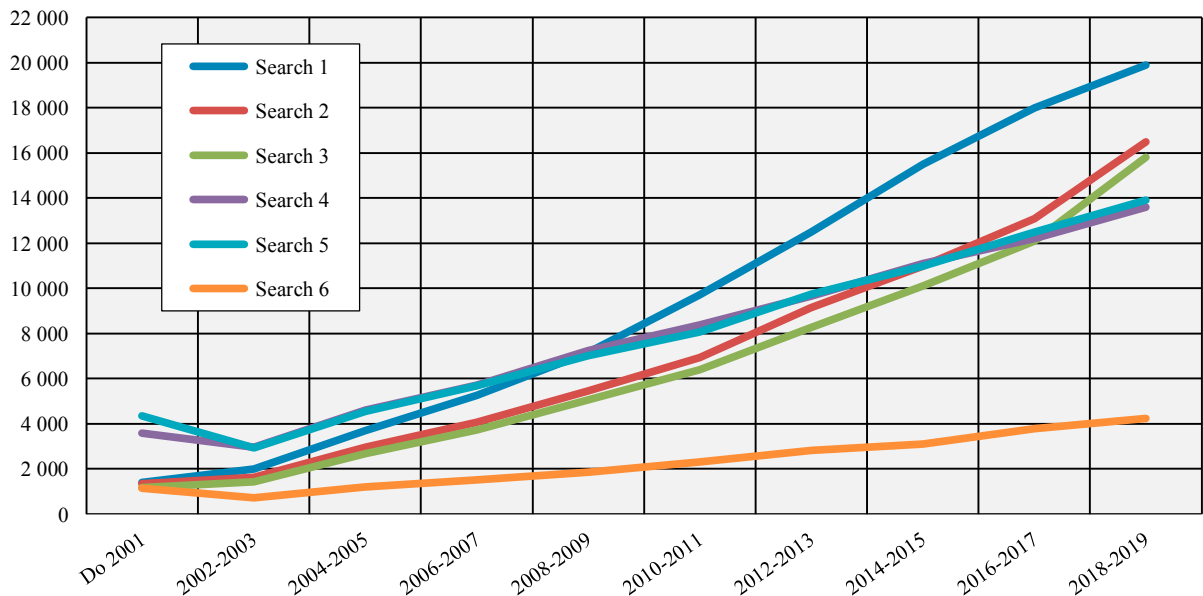


Fig. 1. The trend in the number of publications and materials related to usability studies which have appeared in the Google Scholar search engine over the past 19 years.

3. Research Methodology and Findings

3.1. Research Questions and Procedure

The analysis of the literature made it possible to identify – apart from Nielsen's heuristics – other original proposals for a set of heuristics applied to examine website or interface usability. This led to the following research questions:

(RQ1) Have the guidelines proposed by Nielsen become out of date? Are they still the foundation of the heuristic method applied in usability testing?

(RQ2) Are there heuristics in Nielsen's set that are not reflected in subsequent proposals (partial obsolescence)?

(RQ3) How do new heuristic sets go beyond the traditional Nielsen's heuristics?

The study was performed according to the following procedure:

- Literature research to identify publications describing original proposals for a heuristic set to study the usability of interfaces, including websites.
- Analysis of the identified heuristics.
- Comparison of identified heuristics to Nielsen's 10 heuristics.
- Formulation of conclusions from the conducted research.

In the next section, we will discuss the literature research, as a result of which original proposals for a set of heuristics to examine interface usefulness were identified.

3.2. Literature research

The literature research was conducted by means of searching for publications in various databases based on the following keywords: usability, accessibility, website, web usability, heuristics, heuristic evaluation, literature review, and public administration unit publications. Searched automatically, the publications were then analysed manually. The snowballing technique was also used. To conduct a comparative analysis of the heuristic sets applied, publications meeting the following criteria were isolated:

- based on empirical research, they proposed a set of heuristics to study the usability of interfaces, including websites;
- they proposed an original approach to the usability of websites, referring to traditional Nielsen's heuristics none the less;
- they were written in English.

The literature research made it possible to identify, apart from 10 Nielsen's heuristics, nine original groups of heuristics used to evaluate the usability of interfaces and websites (Table 2). As shown in Table 2, the proposed sets contain 8 to 20 usability heuristics. The next section sets out to discuss their comparison.

3.3. Summary of identified usability heuristic sets

Table 3 presents an overview of the identified applied heuristic groups. Nielsen's heuristics, to which heuristics proposed by various authors were assigned, were taken as the basic set. Therefore, 10 Nielsen heuristics were placed in the first column. In the following columns, there are 9 sets of heuristics, placed in the order resulting from the year of publication.

In each set, each heuristic was compared to Nielsen's heuristics. The comparison included the context and interpretation of the heuristics concerning specific aspects of usability testing, rather than focusing on their names only. Therefore, the following cases concerning the analysed heuristic were created:

- it is identical to a specific Nielsen heuristic – it is placed in the line of Nielsen's heuristic, to which it fully corresponds;
- it includes elements belonging to more than one Nielsen heuristic – it is placed in those lines of Nielsen heuristics which it concerns;
- it is not reflected with any Nielsen heuristic – it is placed in an additional line.

Then the heuristics which were not assigned to Nielsen's heuristics were compared with each other in order to identify if they do not have the same interface usability study context. If they were found to cover the same area, they were placed in the same line.

Table 2. List of identified original proposals for sets of heuristics

| # | Author | Year of publication | Set of usability heuristics | Number of heuristics | Contains subcategories |
|-----|--|---------------------|--|----------------------|------------------------|
| 1. | Jakob Nielsen | 1994 | 10 Usability Heuristics for User Interface Design [5] | 10 | NO |
| 2. | Jill Gerhardt-Powals | 1996 | Cognitive Engineering Principles for Enhancing Human-Computer Performance [21] | 10 | NO |
| 3. | Susan Weinschenk, Dean T. Barker | 2000 | Weinschenk and Barker classification [22] | 20 | NO |
| 4. | Ashok Sivaji, Azween Abdullah, Alan Giffin Downe | 2011 | Heuristic Evaluation in E-Government Website Development [23] | 12 | NO |
| 5. | Bruce Tognazzini | 2014 | First Principles of Interaction Design [24] | 19 | YES |
| 6. | Hana Al-Nuiam, Lulwah Al-Harigy | 2015 | Guidelines for designing mobile apps [25] | 14 | YES |
| 7. | Ben Shneiderman | 2016 | The Eight Golden Rules of Interface Design [26] | 8 | NO |
| 8. | Rodolfo Inostroza, Cristian Rusu, Silvana Roncagliolo, Virginica Rusu, Cesar A. Collazos | 2016 | SMASH: A set of SMARTphone's uSability Heuristics [8] | 12 | NO |
| 9. | Marcos A. D. Dourado, Edna D. Canedo | 2018 | Usability Heuristics for Mobile Applications [27] | 13 | NO |
| 10. | Łukasz Krawiec, Helena Dudycz | 2020 | Heuristics for Assessing the Usability of the Public Information Bulletins in Poland [3] | 14 | NO |

3.4. Conclusions from the study

The conducted comparison of the different original heuristic sets shows that some of the usability rules are repeated, even though sometimes there are differences in naming. Other ones are completely new proposals developed by the authors. There are also situations where several guidelines from a given set can be assigned to one of Nielsen's heuristics. Table 3 presents these links and differences in lines. Nevertheless, due to the diversity of the discussed proposals, such records cannot be completely precise and accurate. This is also due to the nature of the heuristics themselves, which to some extent constitute a general description rather than a specific action pattern.

Nielsen's traditional heuristics remain the absolute foundation of the heuristic method. Thanks to their universality, despite the passage of years, they are still valid (RQ1). Most researchers make minor corrections to them, complement and modify them in terms of a specific type of interface or specific purpose, which often means breaking down individual Nielsen heuristics into more precise guidelines. An increased level of detail is beneficial when the researcher focuses on a particular application. Due to the context, heuristics such as privacy and accessibility cannot be attributed to Nielsen's traditional heuristics (RQ3). Examples thereof include mobile applications or websites of public administration units. In such a situation, however, we are dealing with specialisation and thus a decrease in the universality of a given research method. The strength of Nielsen's heuristics is their versatility, thanks to which they provide a specific platform for modification, a basis for new proposals for standards as well as usability guidelines. It is also important to note the complexity of the ten traditional heuristics. None of them was omitted in other authors' works (RQ2). There were additions and clarifications, but it would be difficult to omit any of Nielsen's principles, as they touch on every important aspect of interface operation.

Table 3. List of usability heuristics

| 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. |
|--|--|--|---|---|---|--|--|--|--|
| Nielsen (1994) | Gerhardt-Powals (1996) | Weinschenk & Barker (2000) | Srivaji et al. (2011) | Tognazzini (2014) | Al-Niam & Al-Harigi (2015) | Smiedeman (2016) | Inostroza et al. (2016) | Dourado & Canedo (2018) | Krawiec & Dudycz (2020) |
| 1. Visibility of system status | --- | 2. Human Limitations 20. Responsiveness | 7. Informative Feedback | 9. Explorable Interfaces 19. Visible Interfaces | 13. Feedback Guidelines | 3. Offer informative feedback | 1. Visibility of system status | 1. Visibility of System Status | 5. Navigation, menu, and page grouping 6. Navigation between web pages |
| 2. Match between system and the real world | 3. Fuse data with meaningful aids to interpretation 4. Present new information with meaningful aids to interpretation 8. Include in the displays only that information needed by the user at a given time 10. Practice judicious redundancy | 2. Human Limitations 4. Accommodation 5. Linguistic Clarity 14. Cultural Propriety | 8. Language & Content | 14. Metaphors | 6. Content Selection Guidelines | --- | 2. Match between system and the real world | 2. Correspondence between the Application and the Real World | 3. Content and the form of content presentation 4. Content and the substantive matter |
| 3. User control and freedom | --- | 1. User Control 19. Forgiveness | 3. Error Prevention & Control 5. Flexibility & Control | 3. Autonomy 6. Defaults 9. Explorable Interfaces 15. Protect Users' Work | 10. Site Navigation Design Guidelines 11. Guidelines for Managing Hyperlinks | 4. Design dialogs to yield closure 6. Permit easy reversal of actions | 3. User control and freedom | 3. User Control and Freedom | 5. Navigation, menu, and page grouping 6. Navigation between web pages 7. Navigation - website search engine 8. Navigation - links |
| 4. Consistency and standards | 6. Group data in consistently meaningful ways to decrease search time | 6. Aesthetic Integrity 8. Predictability 11. Technical Clarity 16. Consistency 18. Precision | 2. Consistency | 5. Consistency 10. Fitts' Law 11. Human-Interface Objects 13. Learnability | 2. Page Layout Guidelines 5. Consistency Guidelines | 1. Strive for consistency 7. Keep users in control | 4. Consistency and standards | 4. Consistency and Standards | 1. Website ergonomics 2. Consistency across the website 3. Content and the form of content presentation 4. Content and the substantive matter 5. Navigation, menu, and page grouping |
| 5. Error prevention | 2. Reduce uncertainty | 2. Human Limitations 10. Accuracy 11. Technical Clarity | 3. Error Prevention & Correction | 3. Autonomy | 1. Analysis Guidelines 9. Guidelines for Using Tables | 5. Prevent errors | 5. Error prevention | 5. Error Prevention | 3. Content and the form of content presentation 14. Other error and hindrances |
| 6. Recognition rather than recall | 1. Automate unwanted workload 3. Use data 5. Use names that are conceptually related to function 10. Practice judicious redundancy | 2. Human Limitations | 12. Visual Clarity | 2. Anticipation | 1. Analysis Guidelines 2. Page Layout Guidelines | 8. Reduce short-term memory load | 6. Minimize the user's memory load | 6. Minimize User Memory | --- |

4. Conclusions and Future Works

This article set out to compare heuristics used to test the usability of interfaces, such as websites. Since many of the approaches are based on the heuristics proposed by Jakob Nielsen in 1994, this set of guidelines was adopted as the basic one. The literature research conducted made it possible to identify 9 original proposals, which were compared with Nielsen's traditional heuristics.

The study shows that despite the passage of years, Nielsen's classic heuristics are still relevant and willingly used by those dealing with the quality of interfaces. Their universality and holistic approach to the subject has been proven. Despite its unquestionable advantages, the traditional set of heuristics is still worth developing and adapting to specific types of interfaces.

All the analysed sets of standards and usability rules can also be applied to analyse websites, which is their undoubted advantage, as the quality of these types of interfaces is extremely important today. This is due to their universality connected with the constantly progressing development of the information society – particularly now, at the time of the COVID-19 pandemic when websites have become the basic channel of communication.

It is planned to continue the research, a key part of which will be a further development of an original heuristic method aimed at analysing the websites of public administration units. The quality of such websites, in terms of usability and accessibility, despite the guidelines and legal requirements, is often unsatisfactory. Future research is aimed at further improving the heuristic method and validating the proposed detailed heuristics concerning the accessibility of public administration websites. The purpose is to help identify errors and usability problems as effectively as possible and thus contribute to improving the quality of the websites whose content should be accessible to every citizen of a given country.

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