Biometric Tools in Information Science. The Example of an Information Literacy Study – A Holiday Planning Experiment

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Abstract. Effective studies within interdisciplinary research fields, such as information literacy, require complex research methodologies. The purpose of the paper is to present the possibilities of biometric tools in the field of information science in triangulation with other methods and techniques. In addition to a literature review, the paper presents the project concerning information skills of young respondents in everyday life tasks. The study was conducted with the triangulation of a behavioral experiment, biometric measurements, and individual interviews. Results proved that young people are not as fluent in social media usage as it may seem. College students have limited communication and content creation skills. University students, however, present more advanced information skills. That might implicate the positive influence of university education and socialization on information literacy. During the project the biometric measures proved to be effective tools in exploring psychophysiological reactions while executing information tasks.

Keywords: Information literacy · Digital skills · Biometric tools · Experiment · Methodology design

1 Introduction

Nowadays numerous daily activities are being realized in the digital environment including shopping, travelling, cooking, and paying bills. Therefore, the importance of information literacy in everyday life activities is obvious. While the amount of actions that are realized on-line is growing it is important to know how young people, often perceived as technologically and informationally skilled, deal with Internet services. At the same time, new research possibilities, emerging from technological development, enhance chances to understand how young people are using digital technologies in everyday life. Biometric measurements enrich information literacy research, both in methodological and essential ways. In this paper potential usage of biometric methods in information science will be explored. Its' purpose is the presentation of the possibilities of biometric tools and their potential use in the field of information science in

triangulation with social sciences' methods and techniques. Besides the literature review, the paper presents the project concerning information skills of young respondents in everyday life tasks, such as planning a holiday trip.

2 Literature Review

2.1 Jan van Dijk's Access to New Media Model

van Dijk's [1] model of access to new media, being a conceptual framework of the discussed project, clearly defines types and levels of competencies required for being an effective member of an information society. It specifies four levels of access to information communication technologies (ICT): motivational, material, skills, and usage. The skills level, which is next to last, includes six levels/areas of skills:

- operational – the ability to operate software, use of various input options, operate files in various formats;
- formal – the ability to navigate the Web with the ability to 'find yourself';
- information – the ability to find needed information;
- communication – the ability to choose and participate in online contacts, online image management, online experimenting, and negotiating in order to obtain optimal results of actions taken;
- content creation – the ability to create quality messages and publish them online;
- strategic – the ability to choose and direct actions towards a goal, make decisions, and to take advantage of achieving goals [1, 2].

The above model draws attention to the motivation and to the benefits of contact with digital media. This approach redefines the assumptions of digital activation and education, focusing on individual determinants in the use of digital technologies. Thanks to the van Dijk model, the axes of interest are motivation, competences, and applications of digital technologies. Digital competences are perceived as a condition for the extensive use of digital media in various contexts. In connection with the above, this model allows to regard digital competences not as a rigid register of skills that should be possessed, but as a multidimensional issue that determines the effective use of the opportunities given by digital media.

2.2 Biometric Projects in Library and Information Science

Although biometrics offers wide range of solutions and might be a valuable supplement to the research methods used widely in the library and information science (LIS field), such as interviews or observations [3], it is used rather frequently. Popular applications of biometric tools in LIS research include reading patterns [4, 5] and information retrieval, in particular evaluation of relevance criteria [5–9], and evaluation of search results in individual documents [10]. Biometrics is sometimes also used in evaluation of online services provided by the libraries [11, 12]. Lopatovska and Arapakis [13] offered a review of theories and studies of emotions in LIS, information retrieval, and human-computer interaction. They also mentioned neuro-physiological signal processing methods, i.e. biometric studies on emotions in information processing.

Projects focusing on reading patterns include for example the one concerning reading effectiveness – its influence on the process of metacognitive skills and development of specialist knowledge. Eye tracking was used also in a research aimed to examine online reading patterns of first language and second language readers. It was recognized that both groups of respondents performed equally well and similar behaviours were observed when it comes to navigating through the text, but second language readers needed twice the time as first language readers to find needed information [14]. Problem of text relevance assessment with an eye tracking has been analysed by Gwizdka and Zhang [15], as well as eye tracking and EEG by Gwizdka et al. [16]. They found out that reading relevant texts differed from reading irrelevant ones in larger pupil dilations, longer fixations, and higher propensity. Buscher et al. [4] have found strong relationship between reading patterns and relevance (reading behaviours are very focused on relevant part of documents), as well as relevance and gaze-based measures. Their results can be useful in improving and personalizing information retrieval methods (in both printed and Web documents) and in developing so-called attentive documents.

The other category of biometric projects consider information behaviours of the users of library websites and services (OPACs). Kules et al. [12, 17] examined library users' gaze behaviours while searching a web-based, faceted library catalogue, and depending on the training, familiarity with this tool, and/or the stage of searching process. They applied both eye tracking and interviews to gather data. The study confirmed the proportion of facets in library interface use, its changes during the searching process, as well as in the result of video training. Examination of effectiveness of academic libraries' Internet usage to meet the needs of the users was undertaken by Mierzecka and Suminas in 2016. As the outcome of eye tracking research of student behaviour it was stated that although academic libraries see websites as important gateway of communication with their users (based on an observation of amount of information available there), they do not meet users' needs. It was observed that users seemed to be lost while performing everyday activities, such as using an online catalogue, checking opening hours, and logging to their account [11].

Studies on online information retrieval concern evaluation of relevance, of the searching process, and its results. In their position paper, Mostafa and Gwizdka [18] defined potentials of applying neuro-physiological measurements (like eye tracking, EEG, fMRI) in research of information retrieval behaviours and formulated recommendations and cautions concerning highly desirable development of this approach. Cole et al. [13–19] presented and confirmed a potential of eye tracking measurement for exploring user's domain knowledge, without considering content of documents or websites, but referring only to eye movements patterns, that can be further analysed in studies on user-centered, personalised information systems.

Knaeusl and Ludwig made an attempt to develop a theoretical model for planning searching paths [20]. They referred to changes in motivations and contexts of searching, using the Wikipedia example. They considered use of Wikipedia not only in searching for learning purposes, but also for leisure, on mobile devices, any time – any place. Eye tracking, electromyography, and browser logs were used to record the respondents' activities: looking up, learning, and browsing. Actual differences were found in information searching behaviours depending on the task. Arapakis, Konstas

and Jose [21] aimed at exploring information processing psycho-physiological symptoms, trying to develop a model describing affective features of information searching. They used an automated facial expression recognition system, heart rate monitoring, galvanic skin response, and skin temperature. As a result, a classification of user affective responses from biometric data was developed. The authors confirmed that these responses "vary across the relevance of perused information items" [21, p. 468]. Lopatovska [22], referring to the facial-expression theory of emotions, recorded respondents' face expressions with computer camera, and analysed them with a specific software their emotions during and after online information search. She did not found any direct influence of search tasks, performance variables, or quality of search results on the respondents' mood. The only relation was between a positive mood accompanying fewer search activities and a negative mood resulting from an increased number of search activities [22, p. 1790].

Although the use of biometrics in information science is somehow limited, Gwizdka and Zhang [15] offered a new "neuro-information science" term as encompassing research trends using neuropsychological tools and methods of measuring reading or information searching behaviours.

3   Holiday Planning Experiment

Due to the need of exploring potential use of biometrics in the field of information science, research based on the ground of methodological triangulation was conducted. In addition to a behavioral experiment, observation, and individual interviews were carried out. Although the research aim was to study behavior on the internet and social media in a task based setting and explore wide range of digital skills of the youth, outcomes concerning information skills will be presented here.

3.1   Research Questions

The following research questions were formulated to explore information skills of the youth:

1. Do the respondents pay attention to the collective knowledge elements (opinions, ratings, "likes")?
2. Which opinions attract attention of the respondents most (shorter, longer, newer, older)?
3. Do the respondents pay attention to factors that prove the reliability of information (date, source)?

3.2   Research Settings and Methods

Qualitative methods (semi-structured individual in-depth interviews) were used along with ethnographical (non-participating observation) and biometric ones (eye-tracking and face-tracking). Additionally the Polish adaptation of the Positive and Negative Affect Schedule (PANAS) by the Psychological Test Laboratory of the Polish

Psychological Association was used [23]. The research was carried out by researchers at the Media Analysis Centre at the University of Warsaw.

Task. The respondents were asked to complete a task of everyday use of ICT and information available online. It was expected that this kind of task will minimalize the risk of outcomes misstatement caused by the unnatural laboratory situation. Therefore the respondents were instructed to prepare a post in any social network they used, inviting their friends to a holiday trip to Masuria, a well-known holiday destination in Poland. Respondents were allowed to use any functionality of a social network. Additionally they were asked to check the opinions about the destination, travel options, and local attractions. They were supposed to insert a picture in a post and clear the search history of the search engine after completing the task. The level of difficulty was similar for all the respondents, especially due to the location of the destination in Masuria region that is situated apart from the main attractions of the region, with the limited possibility of traveling by public transportation. Therefore previous visits to the region would not affect the research task itself.

Operationalisation of Jan van Dijk's Model of New Media Access. Regarding research aims and questions, operationalisation of a competence level of Jan van Dijk's model of new media access was of key importance. Therefore, first we offered a potentially completed list of activities for each area of competence. Then the activities that were not expected to appear in the task to be realised were removed. Indicators were added to the rest. Final version of the observation sheet included eleven subject sections with particular activities and two additional sections for biometric measurements only.

Pilot Test. Before the research, two pilot tests were realised: the first was to verify the observation sheet; the second – all the measurements. The pilot test of the observation sheet was realised on November 9, 2017, with two respondents (adults, 1 woman and 1 man). During the test it was noticed that completion of the task took a dozen or so minutes, and its first part (before writing a post) – less than 10 min. This observation enabled shortening the anticipated time of task realisation; minor changes in the observation sheet were also introduced.

A pilot test of the whole research (including all types of measurements) took place on November 23, 2017. We confirmed amendments and changes in the observation sheet, as well as previous observation concerning time for task realisation. We discarded previous assumption concerning 2 researchers to observe a respondent (one in a cabin, the other at the measurement equipment), as it was noticed, that this would be too stressful for the respondents. Another changes were made in the observation sheet: abbreviations and coloured sections were added to facilitate its navigation; order of behaviour components was changed; an indicator concerning usage of keyboard shortcuts (e.g. alt + tab, crtl + c – in the section "efficiency in hardware and software usage") was added, and minor language changes were introduced in a description of behaviours.

Research. The research was conducted during December 2017 and January 2018 with all selected methodologies. Biometric measurements were collected form 19 respondents: 13 high school students (2 women and 3 men measured on December 15, 2017;

4 women and 4 men measured on January 12, 2018), and 6 university students (5 women and 1 man measured on January 8, 2017). Due to poor quality of some data, 16 persons were selected for further analyses: 10 high school and 6 university students. All the respondents participating in biometric measurements were also observed; 14 of them were interviewed.

The measurement data were integrated in the iMotions platform, monitoring, and analysing reception of audiovisual media. This system enables biometric measurements (physiological reactions to a stimulus) taken with specific equipment. In this research the following devices were used:

- eyetracker TOBII X2-60 (60 Hz) for measuring eye movements during reception of different media content;
- Affectiva (Facial Expression Analysis Engine) for monitoring so-called mimic expression, in other words, measuring and coding movements of face muscles; this measurement enables reading and interpretation of basic emotions, being expressed during reception of specific parts of stimuluses (e.g. advertising spots, films, and texts).

Next, the results were recoded to integrate them with the operationalised van Dijk's model. The recoding procedure were based on the Likert scale, modified according to the project's specific. A general scale and three detailed scales were applied to particular activities, shown in Table 1.

Table 1. Recoding scales for the actions taken during realisation of the task.

General scale	1 – done
	0 – not observed
	−1 – done, but mistaken
Media differentiation scale	1 – applied ≥ 5 media
	0 – 1–4 media applied
	−1 – 0 media applied
Writing efficiency (number of fingers being used while writing on a keyboard)	1 – > 6 fingers used
	0 – 3–5 fingers used
	−1 – 1–3 fingers used
Time needed to prepare to writing a post	1 – ≥ 3 min
	0 – 1–2 min
	−1 – 0 min

Due to the complexed research methodology, empirical material is very extensive. It is worth to mention that interviews outcomes, even though they are not presented here, were recorded and analysed. Because of the obvious limitations, in this paper only chosen results of the eye-tracking and face-tracking measurements will be presented, while the latter were used in exploratory scope here. Deeper analysis of the empirical material will be presented in other articles.

3.3   Results

Before the results concerning the information skills will be presented, some general observation are required. First, all the respondents completed the task and prepared the post, even though three of them (college students) did not paid attention to any opinions at all. Secondly, the respondents used different ways to meet the task criteria, but still some common sources were used: Facebook as a social media where the invitation was prepared, and Google as a first-choice search engine. Most of the respondents additionally used Booking.com, Google Maps and Google Images. While collecting information about the holiday trip destination, a few of them also used the Polish equivalent of Booking.com – noclegowo.pl. Thirdly, respondents from both groups did not need much time to locate information needed to prepare the post: university students spent on that 5 min in average, while the college students – only 2 to 3 min, but a few them needed 7 or 16 min on that. Within that time span they were able to find a guesthouse's website (via Google) and open a couple of other websites, as potentially useful in task realisation. Writing the post took more time: 6 to 20 min for college students, and 13 to 34 min for university students. While doing this, they either browsed through the websites opened before, or developed the post. The task was more time-consuming for the latter. This can be explained by their greater awareness of the task complexity, more careful selection and usage of information sources, and more precise construction of the post. These differences come from information more than operational competences, however potential explanations require further studies.

None of the subjects applied an option of advanced searching nor the Boolean operators while formulating the information retrieval phrase. It can be discussed in regard of information competencies, but effectiveness of Internet searching tools seems to be sufficient to complete a task of this complexity.

Nevertheless there were clear differences between university and college students observed. While the former run (limited) search and collected information about the destination of the holiday trip, the latter immediately started to work on the Facebook post and searched for the needed information in the meanwhile.

Results show that most of respondents pay attention to the opinions – 12 of them read short (or numeric) opinions (see Fig. 1). One did it carefully. It is worth mentioning that 3 respondents did not read opinions at all. When it comes to the numeric reviews there is bigger discrepancy between the respondents – only 7 of them paid attention to them; 9 did not. Therefore we can cautiously suggest, that it is not a routine activity, taken as an obvious or indispensable element of most (if not any) information searching.

There are recognizable patterns while reading the opinions. The respondents did not favour longer opinions, even though they seem to contain more information. They were read by older respondents recruited from among the university students, while college students tend to skip longer opinions and read shorter ones.
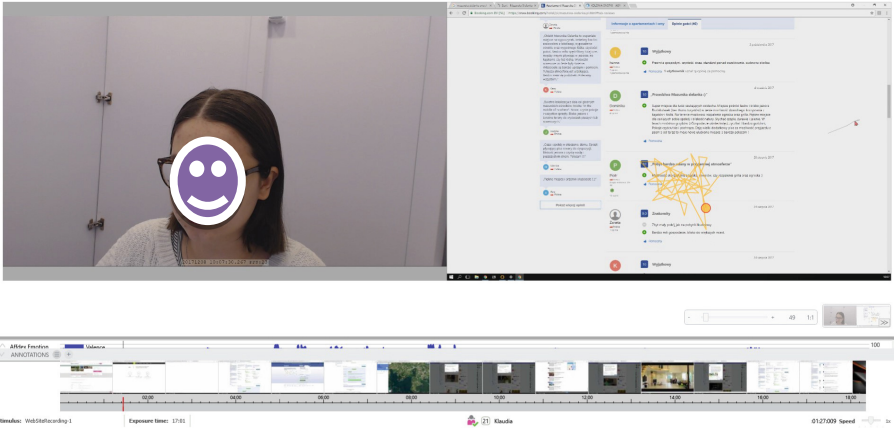
Fig. 1. Fixations on a short opinion at booking.com.

Analysis of websites selected as information sources does not empower us to make any conclusions concerning respondents' decisions in relation to websites' reliability. We cannot verify if the trust in booking.com is characteristic as all the sites being visited were selected from among first 3 to 5 search results on Google. This can be considered as a kind of respondents' "laziness" and routine. No other recognizable patterns of verifying information were noticed. Respondents did not check the date nor the institutions/persons/other authorities responsible for information.

If the respondents were not able to achieve what they had planned, a sense of being lost and/or helpless was observed. They were neither able to find a mistake nor to correct it while conducting the task.

3.4   Limitations

Limitations of this project are twofold. The first one is the number of the respondents in this study. The other was related to the laboratory conditions of the experiment and potential influence of a "being observed and recorded" status on the respondents' behaviours and/or emotions. This might have slightly reduced the authenticity of performed activities. However, it should be noted that it was the sphere of social media that was researched, where it is obvious to be exposed to the assessment and judgment of other Internet users. Due to the exploratory character of this study, verification of the results in further studies are strongly required.

4   Conclusion

Information competencies belong to a set of capabilities crucial for effective and successful usage of Internet resources. As discussed in the literature review section, they have not been so far a subject of biometric research within the LIS discipline.

The project discussed above seems to be the first attempt to operationalize information competencies to measurable skills and/or behaviours expected from information literate people.

Youth as a research group was selected due to social perceptions of their proficiency in information and communication behaviours, and in a virtual network in particular. However, as the project revealed, they are not so advanced in Internet navigating and searching information. They use simple searching tools and the most popular engines, visit websites from the top of the results list, and do not verify their date or authority. Even instructed, they read opinions selectively, according to "the least possible effort" rule. They feel quite uncomfortable and lost when mistaken (for example, when visiting a website of another guesthouse of the same name as the proper one), with no precise reflection of what is actually wrong and how to correct themselves. The positive symptom is that they work on 2 to 3 websites while searching for specific type of information (destination; travel options; images), as comparison is the simplest and most popular way of verifying information among the youth.

These results stand in line with research showing that a stereotype of a "digital native" generation, fully capable to use the Internet in competent and reasonable way, is invalid. They rather confirm the general tendency to seek and apply the simplest solutions. They are also a reason for discussion concerning the range and effectiveness of information literacy education, in either formal (website structure, in other words, where to find specific elements, also those revealing reliability of a source) or content (why one should read opinions and how to interpret them) aspects. Therefore, the results show deficiencies in information literacy of the youth.

Finally, biometric tools proved to be applicable in studies concerning information and digital literacy. They reveal in detail gaze movements, directly related to information behaviours in general, while in the information searching process. Emotional reactions revealed during this process are also measurable. As it was said, biometric research was not used before while researching information literacy, but rather reading patterns and evaluation of on-line services and in limited scope in information behaviour. Therefore it is not possible to link the research with previous methodological solutions or research outcomes. However, as it is often mentioned in literature, biometric data should be confronted and/or completed with other qualitative or quantitative ones, to get an objective set of information.

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