Beyond the Dichotomy: A Systematic Review of ELM in Health Information Elaboration

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Abstract: The Elaboration Likelihood Model (ELM) is a foundational framework for understanding information processing and attitude change, yet its application within the complex domain of health information remains fragmented. This paper provides a comprehensive review to synthesize the extant literature on users' health information elaboration. Through a systematic review of literature from major academic databases (including Web of Science, Scopus, EBSCO, and CNKI), this paper aims to (1) systematically map the conceptualization and operationalization of central and peripheral pathways, (2) integrate multidisciplinary research on information processing modes, and (3) identify critical gaps. The analysis reveals three primary findings: First, while ELM is widely adopted in health research to study outcomes like information adoption, the operationalization of central and peripheral routes is highly inconsistent. Second, research on information processing modes is siloed across psychology, information behavior, and computer science, lacking an integrated framework. Third, a critical gap exists wherein most studies treat the two processing routes as dichotomous extremes, neglecting their potential mixed use. This review synthesizes a fragmented field and highlights the need to move beyond a static, binary view of elaboration. The study proposes a research agenda focused on modeling the dynamic and mixed-use of pathways, examining the influence of user context (e.g., active search vs. passive browsing) on pathway selection, and employing more objective, real-world behavioral data to analyze users' attention allocation and processing patterns.

Keywords: Elaboration Likelihood Model (ELM); Health information; Information processing; Health communication; Dual-process theories; Literature review

1. Introduction

The Elaboration Likelihood Model (ELM) is a psychological theoretical model used to explain and predict the ways in which people process information and form attitudes during information handling and attitude formation processes. Proposed by Petty and Cacioppo (1986), the Elaboration Likelihood Model (ELM) is a foundational theory of persuasion in social psychology.

The core idea of the ELM model is the processing pathway, which refers to the manner in which people process information. This model explains the dual-pathway framework for how users' cognition is influenced and changed from the perspective of the effort level in individual information processing, with the model structure as shown in **Figure 1**. According to the ELM model, when people receive information, they can process it through two different processing pathways: the central route and the peripheral route. The degree of information elaboration is determined by the individual's motivation and ability, where motivation refers to the relevance of the accessible information to the individual, and ability refers to the user's professional knowledge and personal experiences. When the recipient has stronger motivation, more knowledge, or greater cognitive ability to process and analyze information, they are more likely to adopt the central route. When users lack sufficient ability or motivation to deeply analyze information, they will more often use the peripheral route.
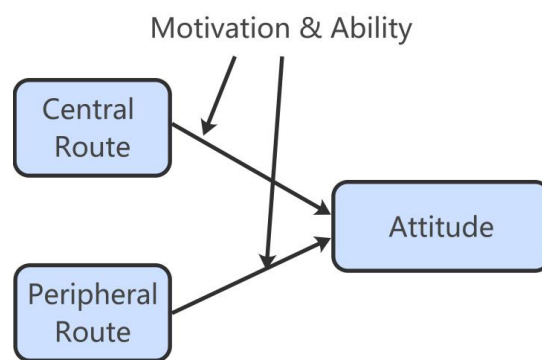

Figure 1. ELM model

2. Theoretical foundations and development of ELM

The theoretical foundations of the ELM model can be traced back to cognitive psychology, social cognitive theory, and dual-process theories, among others. It connects people's cognitive processing processes with attitude formation and emphasizes the influence of the depth and breadth of individual information processing on attitude changes. The ELM model posits that people select different processing pathways based on their personal motivation and cognitive ability when processing information, and different processing pathways will produce different effects on attitude formation.

In the development history of the ELM model, researchers have continuously expanded and improved it to meet the research needs of different fields and contexts. For example, some scholars have applied the ELM model to areas such as advertising, marketing, community participation, and information systems, exploring the mechanisms by which different information processing pathways influence audience attitudes and behaviors. At the same time, the ELM model has also been inspired and influenced by other theoretical models, such as cognitive resource theory and social cognitive theory. Through continuous empirical research and theoretical exploration, the importance and application background of the ELM model in psychology and communication research have received widespread recognition.

Existing research has examined various user information behaviors based on ELM theory in environments such as innovation communities, social media, and online tourism, including adoption behavior, participation behavior, purchasing behavior, and so on. Despite its broad application, ELM's use within the health information

domain remains fragmented and inconsistent. This article addresses this critical gap by conducting a systematic review of users' health information elaboration pathways and processing modes.

3. Overview of research on users' health information elaboration pathways

The ELM model points out that people can be persuaded through two pathways: the central route is a deep processing pathway based on the audience's thinking and reasoning. When people receive information with high personal importance and relevance, they tend to process it through the central route. Central route processing requires cognitive resources and effort, involving careful thinking, evaluation, and rational analysis of the information. Under the central route, people are more likely to form lasting and stable attitudes. The peripheral route is a surface processing pathway that relies on external surface features and simplified cognitive strategies. When people receive information with lower relevance or lower relation to their personal interests, they tend to process it through the peripheral route. Peripheral route processing does not require much cognitive resources and effort, but instead relies on heuristics and simplified judgments. Under the peripheral route, people are more easily influenced by non-rational factors such as emotions, social conformity, and authority. These persuasion pathways are not inherent to the information itself, but are still related to the objective environment in which users process information, and the information recipient's thinking about the descriptive features of the information plays a secondary role in the persuasion outcomes [1].

Chinese literature was selected from China National Knowledge Infrastructure (CNKI), Wanfang, and VIP databases, while English literature was selected from Web of Science (WoS), Scopus, and EBSCO databases, using keywords such as "health information", "health community", "medical", "elaboration", "elaboration likelihood", "ELM", and "user behavior" for literature retrieval and analysis. Taking the CNKI database as an example, the search formula was TKA%=('health information'+'health community'+'medical'+'health') ('elaboration'+'elaboration likelihood'+'ELM')('user behavior'+'user'+'behavior').

3.1. Research on user behavior from the perspective of information elaboration

The Elaboration Likelihood Model (ELM) constructs a dual-pathway model of central route and peripheral route from a social psychology perspective, explaining the mechanism of personal behavior change in the process of information processing, and analyzing the influence of factors such as individual involvement, source diversity, cognitive needs, and ability on the degree of information elaboration [1–2]. The ELM model, as a persuasion mechanism, has been widely applied in research on decision-making processes related to information [3]. In recent years, the application of this model in health contexts has gradually enriched. In terms of health digital product usage, Chen Y found that doctor service quality and information quality, as central route factors, positively moderate continuous usage intention, while reputation and institutional guarantees influence user usage intention positively from the peripheral route [4]. Kim found that interactivity peripheral route factors, such as the number of comments, reply counts, discussion shares, and topic click times in online health communities, as well as the authority peripheral route of health information publishers, will affect users' usage methods and utilization levels in online health communities [5].

3.2. Research objectives

Attitude is the outcome variable of the ELM model, referring to an individual's overall evaluation of various issues, objects, and people [6]. From the perspective of research objectives, the ELM model is usually used as a

theoretical foundation in the field of health information behavior to explore the influence of the usage degree of different information processing pathways on users' willingness to use health information consultation services, information adoption willingness, and so on in network environments such as virtual communities. For example, Angst et al. used the dual-pathway model to study user adoption behavior, with results showing that information privacy concerns and argument quality, respectively negatively and positively affect users' adoption likelihood of EHR, and the interaction of the two will influence users' attitudes toward electronic health records [7]. In addition, the phenomenon of using the ELM model to explain users' health information search behavior has also become increasingly common, such as Guo et al. relying on the ELM model, combined with information needs theory, using online health communities as the research carrier to build a research model of influencing factors on users' health information search behavior in the community [8].

3.3. Research methods

From the perspective of research methods, research on dual pathways mainly adopts qualitative approaches such as questionnaires and interviews, while quantitative research mainly focuses on crawling interactivity data from websites. For example, Zhu and Wu, based on ELM, used questionnaire data for empirical research, exploring the influencing factors affecting the willingness to disclose health information and the pathways produced by different factor combinations [9]. Wang et al. used a large-scale online scenario questionnaire survey method to collect data and conduct empirical testing [10]. In addition to the most common questionnaire data, Sun et al., with the grounded theory method as the foundation, took users of online health tools as research objects, constructed and analyzed the formation mechanism of users' health information attitudes [11].

3.4. Pathway division

The ELM model has been widely applied in fields such as information dissemination, commercial advertising, and e-commerce, and according to different research themes, the classification standards for central and peripheral pathways are not consistent (**Table 1**). The division of central route and peripheral route under information elaboration is usually measured from aspects such as the information content processed by the two pathways, the influence effects on user attitude changes, and the degree of investment by information recipients in processing the information. Cao et al. defined textual content that requires careful reading and understanding, such as doctors' medical diagnostic content and patients' inquiry descriptions on the Haodafu website, as the central route, while doctors' certification information (department, title, reputation, etc.) and patients' evaluation information (fan count, patient votes, comprehensive recommendation heat, likes received), advertisements, pictures, system recommendations, and other information that assists users in perceiving the credibility and authority of website sources are usually considered as peripheral routes [12–14]. However, most studies believe that the central route includes information quality (such as comprehensiveness, completeness, and timeliness of information), and the peripheral route includes source credibility, information expression quality, and other information that plays a supplementary reference role.

Table 1. Research on classification methods for central and peripheral routes in the ELM model

Reference	Research Theme	Central Route	Peripheral Route
Cheung C et al. [15]	Examining Misinformation in Online Health Communities	Topic Features	Language Features, Emotional Features, and User Behavior Features
Crlab C et al. [16]	Factors Influencing Users' Online Doctor Selection	Doctor Service Quality: Technical Quality (accurate medical application, measured by monthly patient growth); Interpersonal Quality (communication, via ratings)	Electronic Word-of-Mouth (eWOM): Comments, votes, gifts
Chen Y [17]	Influences on Mobile Health App Continuation	Service Quality (communication, competence) and Information Quality (relevance, accuracy, sufficiency, timeliness; via consultations, health info, qualifications)	Reputation (cognitive/ competence, emotional) and Institutional Assurances (monitoring, certification)
Si Y et al. [18]	Doctors' Participation in Medical Sites	First Responder Ability (ratings for online, title for clinical); High-level responses attract peers	Patient Rewards (remuneration)
Yi M Y et al. [19]	Initial Trust in Online Health Information	Argument Quality (timeliness, relevancy, completeness, accuracy)	Source Credibility (expertise: trustworthy, truthful, knowledgeable)

4. Overview of research on users' health information elaboration modes

Information processing is an important content in information science and cognitive psychology research, describing the process by which people, during information consumption, change their internal knowledge structures with the obtained information, perform systematic processing, and ultimately form a certain knowledge system. This chapter mainly examines information processing behavior from the perspectives of cognitive methods and the utilization of information pathways, where information processing modes refer to the selection and allocation by users of central routes and peripheral routes during the information processing process. Cognitive psychology emphasizes that past experiences and real stimuli are both essential factors for generating intuition and cognition, and Simon and Kaplan divided information processing into bottom-up processing and top-down processing from the perceptual process of information handling, and pointed out that the combination of the two can form a complete and unified perceptual process [20–21]. In addition, the way of utilizing information pathways is also an important perspective for studying user information processing modes, and cue utilization theory points out that users will evaluate product quality based on product-intrinsic cues or non-product cues closely related to the product [22]. The essence of health information in health communities also belongs to internet information products, and users' evaluation of the quality of health information is an important link in determining their behavior.

Currently, psychology, information behavior studies, and computer science fields have all conducted rich research on information processing modes, but different research perspectives determine differences in their research focuses. Research in the psychology field mainly studies modes of interaction among cognition-related concepts, such as brain thinking processes and psychological emotional changes, during people's information analysis and behavioral decision-making from a cognitive perspective. Research in information behavior studies and computer science fields mainly takes information browsing as the entry point to study users' information processing behavior; research based on the information behavior perspective mostly starts from a qualitative angle, adopting research methods such as grounded theory, coding, observation, and interviews, focusing on users' behavioral changes and the psychological processes behind the behaviors; research in the computer field mostly uses technical means such as web mining and artificial intelligence to improve and enhance algorithms for mining,

clustering, and recommending user browsing patterns, and the following sections respectively review the research methods and achievements in information processing modes in the three disciplinary fields.

4.1. Research on information processing modes in the psychology field

Research on information processing modes in the psychology field mainly concentrates on the construction of theoretical models, with representative achievements including Cognitive Information Processing Theory, Dual-System Theory, and others.

In the early 1990s, Peterson, Sampson, and Reardon proposed the Cognitive Information Processing (CIP) theory with the information processing pyramid model as the core (**Figure 2**), exploring users' decision-making processes for career issues from the perspectives of cognitive science and cognitive psychology. This theory views the processes of career development and counseling as processes of learning information processing abilities, which include the ways people use information in various links related to information processing, such as analyzing problems, solving problems, and making decisions. The knowledge domain is located at the base of the pyramid, including prior knowledge accumulations such as self-knowledge and occupational knowledge, constituting the foundation of career decision-making; the decision domain located in the middle layer describes the thinking processes that appear in alternating cycles in decision-making, such as communication—analysis—synthesis—evaluation—execution; the executive domain at the top describes the metacognitive processes that respond to and regulate cognitive activities, embodied through forms such as self-talk, self-awareness, control, and monitoring, reflecting individuals' preset programs and information usage methods in making decisions.
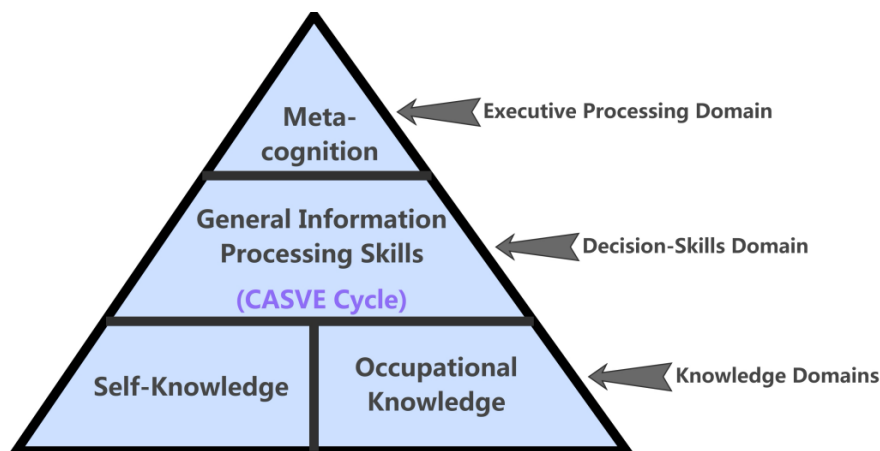

Figure 2. Information processing pyramid model

Dual-System Theory is an important theory for studying people's reasoning and decision-making processes from a cognitive angle, and this theory believes that human behavioral decision-making and information processing involve the use of two information processing systems [23]. One is the intuitive heuristic system, in which information processing is fast and automatic, consuming few psychological resources, and easily influenced by objective factors such as information environment, information theme, and information layout; the other is the rational analytic system, with a rational and slow processing process, consuming more cognitive resources and not easily influenced by objective factors such as information background. It is generally believed that in cognitive activities, users first use the heuristic system to process familiar information backgrounds and problems they need to solve precisely and quickly, and then decide whether to use the analytic system according to cognitive

needs. When facing new problems with certain difficulty, the heuristic system provides solutions according to experience, while the analytic system plays a role in supervision and correction. Goel et al. discovered through functional magnetic resonance imaging that the degree of accumulation of prior knowledge and experience related to target information influences people's selection methods for the dual processing systems, where those with rich knowledge and experience related to the information context will adopt the intuitive heuristic system, and those lacking experience will activate the rational analytic cognitive system [24].

4.2. Research on information processing modes in the information behavior field

From the perspective of research content, research on user information processing behavior in the information behavior field mainly focuses on the definition, classification, and influencing factors of user browsing behavior, with relatively less exploration of browsing behavior regularities. For example, Dervin adopted definitions of key user behaviors in network information browsing behavior, summarizing three browsing modes for university library users: linear type, circuit type, and hybrid type, resulting in the Sense-Making model [25]. C. Kuhlthau divided the information search process into 6 stages: initiation, selection, exploration, formulation, collection, and presentation [26]. In addition, there are M. J. Bates's Berrypicking model, Ellis et al.'s six-factor model [27–28].

In terms of research methods, most adopt qualitative research methods such as interviews and coding, or adopt quantitative research methods to crawl and analyze users' network interaction data. Dumais et al. performed cluster analysis based on users' fixation times on different elements in SERP pages, summarizing three browsing modes: exhaustive type, result-economical type, and ad-economical type [29].

From the perspective of research objectives, most existing research results analyze information browsing as an important stage of information searching, focusing on the identification and feature extraction of users' specific browsing behavior patterns, exploring the behavioral and psychological characteristics of user browsing behavior at different stages. For example, Leiva et al. explored web browsing behavior in targeted and aimless situations, and concluded that when the search target is in different areas of the page, the subjects' search efficiency has significant differences [30].

4.3. Research on information processing modes in the computer field

In the field of Web usage mining, analyzing users' browsing behavior and browsing patterns has become an increasingly important research area. Web data mining techniques are often used to analyze various data sources, such as Web logs, user registration information, and page content on the Internet, to find various implicit knowledge patterns between data on the network and obtain some predictive information. The main research contents include browsing pattern discovery, browsing pattern clustering, browsing pattern mining, etc.

In terms of research methods, methods for data mining include association analysis, cluster analysis, neural networks, collaborative filtering, etc. Anwar and Uma adopted the analysis method of association technology to find the association between user-selected items and recommend the best browsing web pages to users [31]. Mladenic proposed a collaborative filtering recommendation algorithm, which filters information by comparing the similarity between resources and user interests, and recommends web pages to users [32]. Research results usually serve commercial needs, mining customers' purchase decision behaviors, and users' potential consumption needs, and are widely applied in behavior prediction, personalized services, etc.

5. Conclusion

In recent years, the application of the Elaboration Likelihood Model in health contexts has gradually been enriched. The article expounds the central idea of the Elaboration Likelihood Model and summarizes the research overview of information elaboration pathways in health contexts. From the perspective of research objectives, the ELM model is usually used as a theoretical foundation in the field of health information behavior to explore the influence of the usage degree of different information processing pathways on users' willingness to use health information consultation services, information adoption willingness, etc., in network environments such as virtual communities. From the perspective of research methods, research on dual pathways mainly adopts qualitative angles, such as questionnaires and interviews, while quantitative research mainly focuses on crawling interactivity data from websites. In addition, the article reviews the research methods and achievements in information processing modes in different disciplinary fields, finding that existing research results mostly analyze information browsing as an important stage of information searching, focusing on the identification and feature extraction of users' specific browsing behavior patterns, exploring the behavioral characteristics and psychological characteristics of user browsing behavior at different stages. In terms of future development directions, currently most articles, when using the ELM model to explain how information processing influences users' information decision-making processes, consider the central route and peripheral route as singular basic elaborated extremes; however, the information processing process may involve the mixed use of these two information pathways, and attitude or perceptual changes occurring through processing the central route are often more stable and lasting than attitude changes occurring through the peripheral route. In future research, more focus can be placed on the research of specific users' information browsing behavior in specific contexts, as well as the influence of specific information search contexts on users' selection of information elaboration pathways. In terms of data acquisition, more objective data can also be collected from real scenarios of information searching and browsing to analyze users' selection of information elaboration pathways and attention allocation issues.

Disclosure statement

The author declares no conflict of interest.

References

[1]   Yi M, Yoon JJ, Davis JM, et al., 2013, Untangling the Antecedents of Initial Trust in Web-based Health Information. Decision Support Systems, 55(1): 284–295.

[2]   Cacioppo JT, Petty RE, 1984, The Elaboration Likelihood Model of Persuasion. Advances in Consumer Research, 19(4): 123–205.

[3]   Petty RE, Cacioppo JT, 1984, The Elaboration Likelihood Model of Persuasion. Advances in Consumer Research, 1984(11): 673–675.

[4]   Li CY, 2013, Persuasive Messages on Information System Acceptance: A Theoretical Extension of Elaboration Likelihood Model and Social Influence Theory. Computers in Human Behavior, 29(1): 264–275.

[5]   Chen Y, Yang L, Zhang M, et al., 2018, Central or Peripheral? Cognition Elaboration Cues' Effect on Users' Continuance Intention of Mobile Health Applications in the Developing Markets. International Journal of Medical Informatics, 2018(116): 33–45.

[6]   Kim HS, Sundar SS, 2014, Can Online Buddies and Bandwagon Cues Enhance User Participation in Online Health

Communities? Computers in Human Behavior, 2014(37): 319–333.

[7] Chen Y, Yang L, Zhang M, et al., 2018, Central or Peripheral? Cognition Elaboration Cues' Effect on Users' Continuance Intention of Mobile Health Applications in the Developing Markets. International Journal of Medical Informatics, 2018(116): 33–45.

[8] Angst CM, Agarwal R, 2009, Adoption of Electronic Health Records in the Presence of Privacy Concerns: The Elaboration Likelihood Model and Individual Persuasion. MIS Quarterly, 33(2): 339–370.

[9] Guo X, Chen S, Zhang X, et al., 2020, Exploring Patients' Intentions for Continuous Usage of mHealth Services: Elaboration-likelihood Perspective Study. JMIR mHealth and uHealth, 8(4): e17258.

[10] Zhu M, Wu C, Huang S, et al., 2021, Privacy Paradox in mHealth Applications: An Integrated Elaboration Likelihood Model Incorporating Privacy Calculus and Privacy Fatigue. Telematics and Informatics, 2021(61): 101601.

[11] Yu CW, Ying Z, Liao Z, 2021, Health Privacy Information Self-disclosure in Online Health Community. Frontiers in Public Health, 2021(8): 602792.

[12] Sun H, Li J, Cheng Y, et al., 2022, Developing a Framework for Understanding Health Information Behavior Change from Avoidance to Acquisition: A Grounded Theory Exploration. BMC Public Health, 22(1): 1115.

[13] Cao X, Liu Y, Zhu Z, et al., 2017, Online Selection of a Physician by Patients: Empirical Study from Elaboration Likelihood Perspective. Computers in Human Behavior, 2017(73): 403–412.

[14] Cheung C, Lee M, Rabjohn N, 2008, The Impact of Electronic Word-of-mouth — The Adoption of Online Opinions in Online Customer Communities. Internet Research, 18(3): 229–247.

[15] Sanford BC, 2006, Influence Processes for Information Technology Acceptance: An Elaboration Likelihood Model. MIS Quarterly, 30(4): 805–825.

[16] Crlab C, Eza D, Jthab C, 2020, Adoption of Online Follow-up Service by Patients: An Empirical Study Based on the Elaboration Likelihood Model. Computers in Human Behavior, 2020(114): 106581.

[17] Chen Y, Yang L, Zhang M, et al., 2018, Central or Peripheral? Cognition Elaboration Cues' Effect on Users' Continuance Intention of Mobile Health Applications in the Developing Markets. International Journal of Medical Informatics, 2018(116): 33–45.

[18] Si Y, 2020, Factors Influencing Doctors' Participation in the Provision of Medical Services Through Crowdsourced Health Care Information Websites: Elaboration-Likelihood Perspective Study. JMIR Medical Informatics, 8(6): e16704.

[19] Yi MY, Yoon JJ, Davis JM, et al., 2013, Untangling the Antecedents of Initial Trust in Web-based Health Information: The Roles of Argument Quality, Source Expertise, and User Perceptions of Information Quality and Risk. Decision Support Systems, 55(1): 284–295.

[20] Posner MI, 1989, Foundations of Cognitive Science. MIT Press, Cambridge.

[21] Solsowrited R, 1991, Cognitive Psychology. 3rd ed. Allyn and Bacon, Boston.

[22] Carroll RBJS, 1982, Foundations of Information Integration Theory by Norman H. Anderson. The American Journal of Psychology, 95(4): 708–711.

[23] Kahneman D, Frederick S, 2002, Representativeness Revisited: Attribute Substitution in Intuitive Judgment, in Heuristics and Biases: The Psychology of Intuitive Judgment. Cambridge University Press, Cambridge.

[24] Goel V, 2003, Evidence for Dual Neural Pathways for Syllogistic Reasoning. Psychologica, 2003(32): 301–309.

[25] Sense DB, 1998, Making Theory and Practice: An Overview of User Interests in Knowledge Seeking and Use. Journal of Knowledge Management, 2(2): 36–46.

[26] Kuhlthau CC, 1991, Inside the Search Process: Information Seeking from the User's Perspective. Journal of the

American Society for Information Science, 42(5): 361–371.

[27] Bates MJ, 1989, The Design of Browsing and Berrypicking Techniques for the Online Search Interface. Online Review, 13(5): 407–424.

[28] Ellis D, 1987, The Derivation of a Behavioural Model for Information Retrieval System Design, thesis, University of Sheffield.

[29] Dumais ST, Buscher G, Cutrell E, 2010, Individual Differences in Gaze Patterns for Web Search. Proceedings of the Third Symposium on Information Interaction in Context, 185–194.

[30] Milisavljevic A, Abate F, Le Bras T, et al., 2021, Similarities and Differences Between Eye and Mouse Dynamics during Web Pages Exploration. Frontiers in Psychology, 2021(12): 554595.

[31] Geetharamani R, Revathy P, Jacob SG, 2015, Prediction of Users Webpage Access Behaviour Using Association Rule Mining. Sadhana, 40(8): 2353–2365.

[32] Mladenić D, 2002, Web Browsing using Machine Learning on Text Data, in Intelligent Exploration of the Web. Physica-Verlag HD, Heidelberg, 288–303.