




Conception and Analysis for New Social Networks in University Community

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Abstract: Social networks have dramatically changed the way people relate to each other. In the university context it has also been used as communication tools that intervene in the learning process. The objective of this study is to initiate a research process for the analysis, design and development of a new social network for the university community. Thus, a systematic mapping of literature was proposed with the research topic: social network analysis based on eye tracking. The method used establishes a research protocol that defines the guidelines for research, information extraction and analysis of the results of the mapping study. Among the results obtained, there is a growing trend in the use of eye tracking to obtain requirements prior to the design of a social network.


1 INTRODUCTION


Communication within a Higher Education Institution (HEI) is of vital importance, each member of the community must be aware of the different activities that the institution carries out; likewise, the different processes or procedures that each member can carry out and the places where these are carried out. This type of communication carried out within the HEIs is known as internal communication; (Vértice, 2007) defines it as "[...] that which is oriented to the internal public which is the group of people who make up an institution and who are directly linked to it". HEIs have several internal communication tools such as social networks, blogs, the official website of the HEI, bulletins, posters, etc. (De La Hoz, Acevedo, & Torres, 2015), social networks being the most used tools in internal communication (Almenara & Marín, 2013) due to the globalization of the same.


(Aguirre Naranjo, 2014) states that within the Pontificia Universidad Católica del Ecuador (PUCE) the most frequent activity among students is the use of Facebook, in the same way Aguirre confirms that students usually inform themselves about the

activities that take place through social networks (14%), email (24%) and conversations with colleagues (28%), demonstrating that digital communication channels are well received by the university community.

Ramakrishna claims that social networks have significantly changed the ways in which people interact (Kumar, Maheshwari, & Kumar, 2016). Due to the habituation of the use of social networks, the media was affected in two ways: positive, which encompasses different benefits such as: instantaneous communication, asynchronous communication, elimination of spatial barriers (long distances), etc., and a negative one, showing how the media has become more important in the usual way of communication in today's societies. (Djamasbi, Siegel, & Tullis, 2005) points out that "a large main image, celebrity images, short texts and a search system are design elements that appeal to a Generation Y audience" (Bodrunova, Yakunin, & Smolin, 2016). (Bodrunova & Yakunin, 2017) state that "a good user experience can be achieved by creating pages that generate confidence in users". They also differentiate two levels on which the evaluation is carried out: the macro level, general

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design structure, and the micro level, which is subdivided into syntagm and typography.

The communication work within the HEIs has been affected by the ineffectiveness of the different communication channels used in them, giving rise to misinformation of the members of the university community, causing total or partial ignorance of news of great importance related to events, campaigns or projects that are carried out within the community, in the same way this misinformation affects negatively the institutional image of the HEI (Andrade, 2019).

Some examples that show the ineffectiveness of the communication channels can be found in studies such as the one carried out by (Aguirre Naranjo, 2014) who shows that a large percentage of the PUCE university community qualifies the communication channels that exist within the same institution as ineffective, (Cabascango, 2018) states that most of the community of the Universidad San Francisco de Quito (USFQ) is moderately informed about the events that have taken place within the institution and (Andrade, 2019) states that a large percentage of the community of the Universidad Laica Vicente Rocafuerte considers both internal and external communication to be inefficient.

The objective of this paper is to present a systematic mapping to provide a vision that allows HEIs to know about the different tools for the conception and analysis of a social network, which allows to greatly improve the internal communication present within the community and its institutional image.

The rest of this paper is structured as follows. Section 2 explains the research method used. Section 3 presents the results of the systematic mapping. Section 4 presents the discussion. Finally, Section 5 shows the main findings of the investigation.

2 METHOD

This section describes the methodology used in the systematic mapping of social network and website analysis using eye tracking technologies. First, the methodology of the research is described, where the approach of a research protocol based on the determined search area stands out. We then present the collection of information based on the proposed protocol, the sources and search chains, and the selection of studies after applying the established inclusion and exclusion criteria.

2.1 Investigation Methodology

2.1.1 Research Interest

This study is designed to meet the purposes explained below. Words like “is”, “or”, “then”, etc. should not be capitalized unless they are the first word of the title. The general objective is to be an investigation as a starting point for the analysis, design and development of a new social network in the university context. Thus, it is expected that the results of the research will provide a guideline for the following phases in the creation of an internal communication tool for the university community, based on the use of eye tracking technology as a method to obtain specifications and features focused on the user experience.

The first objective of this systematic mapping study is to quantitatively identify scientific research based on the study of social networks, analysing their interface, the important or most used characteristics, or the techniques for their design using eye tracking methods. The second is to execute a broad temporal analysis of research related to the study of social networks and their specifications using eye tracking, with the intention of determining a trend (increasing or decreasing) in this area of research. The third objective is to extract the eye tracking tools used in the analysis of the social network interface or its design. The last objective is to identify the characteristics of the social networks studied with eye tracking and frame them in a specific research category, after an in-depth analysis of the literature.

To conduct this secondary study, the guidelines proposed by (Petersen, Vakkalanka, & Kuzniarz, 2015) were observed. In addition, the "Model Protocol for Systematic Mapping" (EBSE-RG., 2009) was used as a checklist to corroborate that a proper process has been followed. The process consists of three phases: (1) The Research Directive contains the protocol designed for the study, identifies the scenario in which it will be investigated, and then presents the research questions that will guide the rest of the work. (2) Information gathering indicates relevant studies according to the inclusion and exclusion criteria defined in the protocol previously. (3) The Results phase carries out the mapping of the literature based on the established criteria and its analysis to answer the research questions.

2.1.2 Research Directives

This section presents the research protocol as the first step in conducting systematic literature mapping.

Words like “is”, “or”, “then”, etc. should not be capitalized unless they are the first word of the subtitle. It was developed by the first author and then revised and applied by both authors. The protocol establishes a topic of study (social network analysis using eye tracking), and results in the setting of research questions; the search process includes keywords for the search strings, inclusion and exclusion criteria to select the studies and quality assessment, and the databases to be used. Finally, the method of information extraction is presented. To reduce the risk to validity across the study it was established within the protocol that each phase of the mapping study must be validated by both authors in scheduled sessions.

The research questions (RQ) for this study are (RQ1) Are there any published studies related to the analysis of interfaces, features or design of social networks using eye tracking technology? How many studies have been published? (RQ2) Is there a time trend in research based on analysis of social networks using eye tracking? (RQ3) RQ3. What tools or platforms are considered in eye tracking-based social network analysis? (RQ4) According to the data analysis, what are the characteristics of the social networks that have been studied using eye tracking? Within which research category are they framed?

2.2 Information Gathering

The study search strategy should lead to the inclusion and exclusion of documents. The search strategy of this study involves database queries using customized search strings, followed by manual filtering of the studies found through previously established inclusion and exclusion terms. Two investigators were in charge of executing the search strategy.

2.2.1 Sources and Search Chains

Three reference databases were consulted in the area: Scopus (Elsevier), IEEE Xplore (IEEE) and ACM DL (ACM). These ones were selected because of their relevance in the study topic. From the established research questions, the key words were identified, which make up the search chain. All the words forming the search string are connected by AND/OR to ensure that all the papers resulting from the search are relevant to the research topic. The final search string was: "click through rate" AND ("gaze tracking" OR "eye tracking") AND ("heat map" OR "heat system") AND "social network".

The first part of the search string consists of the click indicator using its English translation; the

second part consists of the terms for eye tracking and English synonym; the third part consists of the representation of the data analysis through maps. For each of the searches in the different databases, the search was filtered so that the words within the string are found within the title, summary or keywords of the different results obtained.

2.2.2 Inclusion and Exclusion Criteria

The terms of inclusion and exclusion established to perform the relevance filtering of the resulting studies are as follows:

Terms of inclusion:

- I1. Studies using tools for eye-tracking/gaze-tracking on social networks/websites
- I2. Studies using tools for click-through-rate on social networks/websites
- I3. Studies that have been published between January 1, 2014 and October 22, 2019
- I4. Studies that are research articles from journals and conference papers.

Terms of exclusion:

- E1. Studies that have no proven scientific basis.
- E2. Duplicate studies in several databases.
- E3. Studies not accessible in full text.
- E4. Studies published before January 1, 2014

2.2.3 Search Process

As shown in the search process described in Fig. 1, the search string was applied in the different databases listed above, a large number of studies were obtained.

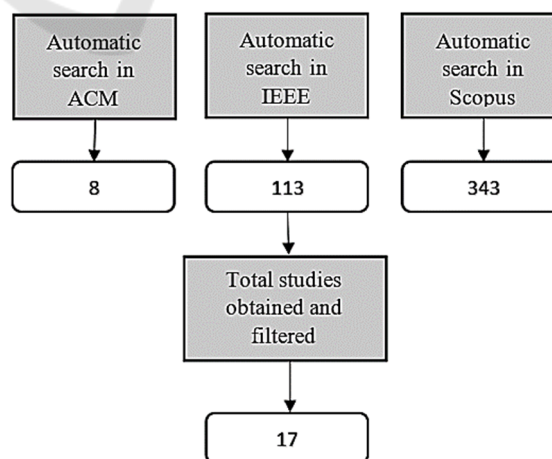


Figure 1: Search process. Automatic search and filtering of studies considering the inclusion criteria I1, I2, I3 and exclusion criteria E1, E2, E3 and E4 Total number of studies obtained.

Two researchers were responsible for the filtering of the 462 studies obtained independently. The first screening process involved reading titles and abstracts, thus 60 studies were identified. To complete the screening process, the researchers performed a complete reading of each study. In addition to taking into account the inclusion and exclusion criteria set out above, a total of 17 studies were obtained that were useful for the research; Fig. 2 shows the number of articles selected by each database. Searching for articles in a single database may result in the loss of important articles, justifying the need to use more than one.

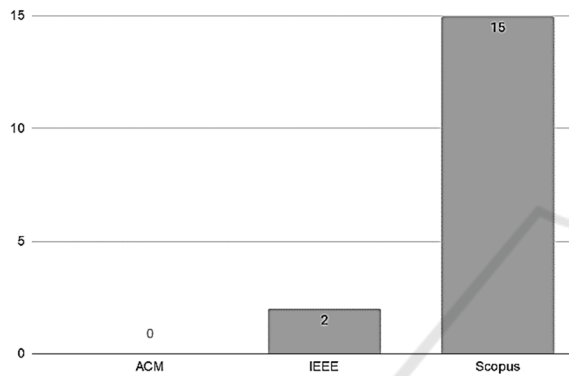


Figure 2: Number of studies selected according to each database.

3 RESULTS

Finally, 17 publications were selected according to the methodology described above. The relevant information to answer the research questions was extracted in a summary table where the following fields were detailed for each selected publication: eye tracking tools or platforms used in the study, web pages used for eye tracking analysis, the characteristics of the social networks studied with eye tracking. Then, descriptive statistics and frequency analysis were used to answer the questions posed in this study.

RQ1. Are there any published studies related to the analysis of interfaces, features or design of social networks using eye tracking technology? How many studies have been published?

Within the study period between January 1, 2014, and October 31, 2019, a total of 17 studies directly related to the analysis of the characteristics or design of social networks using eye tracking were published. These works were indexed in important databases such as IEEE Xplore and Scopus. The selected studies are listed and discussed in the Appendix.

RQ2. Is there a time trend in research based on social network analysis using eye tracking?

Based on the years of publication of the 17 selected studies, an increasing temporal trend has been observed. This increase in social network studies using eye tracking can be seen in Fig. 3. where, in addition, the trend line is increasing. In the year 2014 there were a maximum of 3 publications and then it is remarkable a decrease of 33.33% in the number of publications for the year 2015. In the following years, more studies in this specific area are observed, with a 50% increase until 2018. For the last year analysed, 2019, research on social networks based on eye tracking increased by 100% with respect to the years with fewer publications in this area.

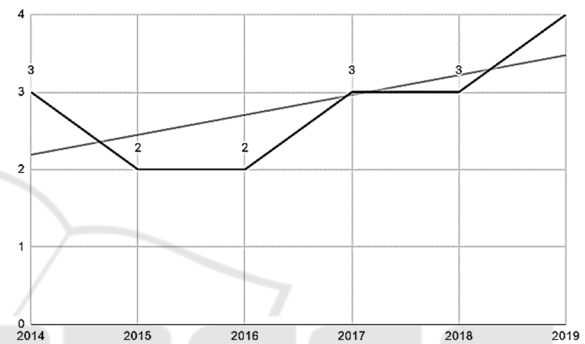


Figure 3: Time trend based on the number of studies published over the years.

RQ3. What tools or platforms are considered in the analysis of social networks based on eye tracking?

From the studies compiled in this research it has been observed that Tobii eye tracking systems are the most used, being mentioned in 35.3% of the analysed research (Chynał, Falkowska, & Sobiecki, 2018), (Güner & İnal, 2015) (Li, Che, Yuan, & Li, 2018), (Mabila & Ssemugabi, 2014), (Shahimin, Saad, Sivaji, Tzuaan, & Khean, 2014) and (Wong, Bartels, & Chrobot, 2014). Another tool that is preferred in eye tracking studies is Eye-tribe being used on 11.8% occasions (Divya, Amudha, & Jyotsna, 2016), and (Pavani, Prakash, Koushik, Amudha, & Jyotsna, 2019). These visual tracking systems have in common that they feature fast calibration environments, and parameterizable configuration options. On the other hand, among the rest of the alternative tools that have been used are: Mangold Vision Eye Tracking System (Eger, 2018), SMI RED eye tracking (Kumar, Maheshwari, & Kumar, 2016), EyeNTNU (Wang & Hung, 2019), Gaze Visual (Kar & Corcoran, 2019) and UXmood (Franco, et al., 2019); each tool has been used in at least 5.9% of the

research on social networks based on eye tracking. As shown in Figure 4, Tobii stands out as the most used tool in eye tracking studies.

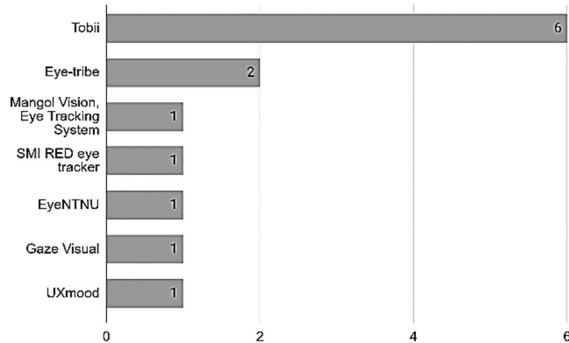


Figure 4: Outstanding tools in social network studies using eye tracking.

RQ4. According to the data analysis, what are the characteristics of the social networks that have been studied using eye tracking? Within which research category are they framed?

In order to make the best use of the analysis capacity with eye tracking some researches raise the analysis of the characteristics of the social network websites at macro and micro level. Thus, some of the aspects analysed were: at macro level the composition, colour, zoning and spacing at page level, combination of content and visual relevance of design elements; at micro level individual block parameters, typography, line spacing and readability (Bodrunova, Yakunin, & Smolin, Comparing efficacy of web design of university websites: Mixed methodology and first results for Russia and the USA, 2016), (Bodrunova, Yakunin, & Smolin, 2016), (Li, Che, Yuan, & Li, 2018) and (Divya, Amudha, & Jyotsna, 2016). Another viewpoint adopted for social network analysis using eye tracking defines the search for a user-generated pattern when browsing through web pages, for example: examining user viewing patterns and attention to banners (Güner & İnal, 2015) understanding viewing patterns on Facebook pages (Kumar, Maheshwari, & Kumar, 2016) analysing users' visual behaviour while browsing a website (Wong, Bartels, & Chrobot, 2014); studying the distribution of visual attention when browsing through Facebook pages (Wang & Hung, 2019).

Social networks currently are also analyzed by using eye tracking when looking to establish a relationship between the user's visual attention in addition to the time it takes to perform a specific task. The studies that followed this line of research raised the following approaches: what elements the user

focuses on while searching for information on a web page, and how long it takes to find the desired elements (Chynał, Falkowska, & Sobiecki, 2018); determine the time and frequency of visual fixation to infer the elements of interest of the student in an educational portal and show exactly in what order and for how long the students look at a set of web objects (Eger, 2018); what elements the user focuses on while performing a task and how long it takes to complete it (Mabila & Ssemugabi, 2014); determine the accuracy, efficiency and satisfaction of users with the interface when performing a specific task (Olmsted-Hawala, Holland, & Quach, 2014); establish the relationship between the time of the first fixation and the duration of the fixation recorded to the elements of a web page using an eye tracking tool and then create a heat map (Shahimin, Saad, Sivaji, Tzuaan, & Khean, 2014). Finally, other research used eye tracking to study the features that a website should have for its implementation (Hudák, Kianičková, & Madleňák, 2017), highlighting those that could help navigability (Pavani, Prakash, Koushik, Amudha, & Jyotsna, 2019) and improve user satisfaction regarding the layout of the elements that are presented such as: video, audio and text (Franco, et al., 2019).

From the results obtained for the last research question (RQ4), four dimensions have been determined through which social networks are analyzed using eye tracking: evaluation of website characteristics, identification of visual patterns, visual fixation/ task completion time relationship and analysis of website requirements. Then, these four dimensions were framed within a research area (Computer Science) and category (Theory & Methods and Software Engineering) according to Web of Science (WoS). Fig. 5. shows the number of studies of each dimension crossed with the categories proposed by WoS.

4 DISCUSSION

First, when analysing the time trend in research based on social network analysis using eye tracking, there is an augmentation present not only in the number of studies carried out, but also in the fields where this technology was applied.

The predominance of studies with a high content of scientific evidence is of great importance to establish the aspects and evaluation tools that are used in most studies, which allows to point to a high degree of maturity of the state of the art. Regarding to the evolution over time of the number of publications in recent years, it has been noted that the number of

studies has maintained a slight increase, showing that interest in this area has not shown any decrease, on the contrary, it maintains its importance as an area of avant-garde research.

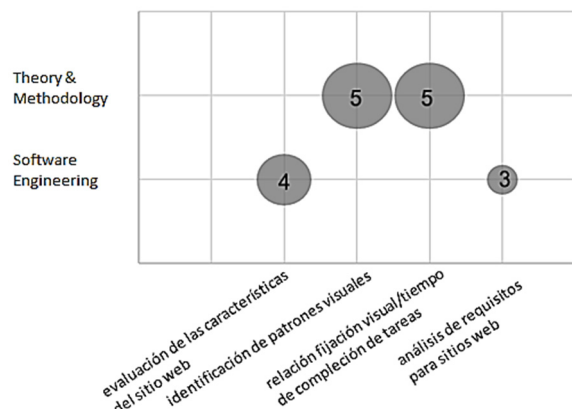


Figure 5: Number of studies of each dimension according to the categories proposed by WoS.

The results obtained in the present systematic mapping show that most of the studies make use of Tobii equipment for research, related to eye tracking within different web systems, showing this tool as the preferred one for this kind of evaluations; in the same way, it can be observed that open source software within the eye tracking area is very scarce, but those existing ones are available through GitHub so that users can make improvements and modifications that are useful for their development.

There are two specific categories (according to WoS) where the eye tracking technologies are being used: a) theory & methodology, and b) software engineering. The first category includes the recognition of visual patterns when the user is performing a particular task, hence the eye tracking tools are used to create and analyse these patterns. The second category involves the eye tracking technologies in the development process of websites at two points: at the beginning, for getting the initial requirements; and at the end, to evaluate the features developed in the web design through the user experience and heat maps.

5 CONCLUSIONS

This systematic mapping study shows a remarkable increase in the interest of using eye tracking tools for social network analysis, thus leading to a continuous improvement in the field of web systems development. Proof of this is the increase of studies

related to this research topic due to more studies were carried out within the last five years, and a high percentage of scientific evidence is reflected in researching of a similar nature.

In addition to eye tracking tools, it was observed that a large number of studies were conducted using Tobii eye tracking equipment, thus demonstrating the quality, confidence and adequate performance of this specific device. On the other hand, the mapping showed that the areas of greatest interest in the use of eye tracking technology were: the identification of visual patterns and visual fixation/time relationship in the performance of tasks. However, it is needed to point the boost of eye tracking in software engineering tasks in the last three years, such as: website’s features evaluation and web site requirements analysis. Finally, it should be noted that two groups of features were identified that are evaluated when using eye tracking tools, which are: a) those that are related to evaluations of website design at macro level (composition, colour, zoning and spacing at page level, combination of content and visual relevance of design elements) and micro level (individual block parameters, typography, line spacing and readability); and b) those that relate to the user experience (efficiency, navigability, satisfaction) when performing certain tasks within the website, which besides leads to the generation of visual patterns and heat maps.

The eye tracking technology has been involved in the whole process of websites development: to establish the start point; to evaluate the user experience when interacting with the website and get patterns; and when an improvement in the web design is needed. According to these results, the use of eye tracking in development of new social networks is expected to maintain the interest of HEIs.

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