

Promoting prevention to fake news through an educational software

Valmir V. de Almeida Santos   [State University of Feira de Santana | vvalmeida96@gmail.com]

Claudia Pinto Pereira   [State University of Feira de Santana | claudiap@uefs.br]

 State University of Feira de Santana, Av. Transnordestina, s/n, Novo Horizonte Feira de Santana, BA, 44036-900, Brazil.

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Abstract: This paper discusses the development of an educational system that aims to train individuals to recognize false information. The application includes a news analysis module, which highlights information that can help the user read a news story. To do this, the users simply need to enter the link to the news they wish to analyze. In addition, the system also contains a training module, in which real examples of news stories to be analyzed by users are shown. For each news example, the user must state whether they believe the information to be true or false. The design of the product is theoretically anchored in lateral reading and inoculation theory. The tool was validated in two phases. The first involved 26 participants from different age groups and showed positive acceptance of the software, especially in terms of efficiency and attractiveness. The second phase of validation was aimed specifically at the elderly and had 16 responses, which indicated a deterioration in the user experience for this type of audience, prompting the need to enhance the application with more instructional and accessibility elements.

Keywords: Fake News, Education, Literacies, Lateral Reading, Inoculation Theory, Application

1 Introduction

Since its popularization, digital media have played a fundamental role in educational, cultural and economic exchanges between different regions of the world. The clearest consequence of this process is increased access to information. At the same time, the new reality has imposed - and continues to impose - new issues, especially with regard to its adverse effects, such as mass disinformation through fake news [Allcott and Gentzkow, 2017].

In particular, social networks are a favorable environment for the large-scale production and dissemination of untrue information. Some probable explanations for this are the speed with which content circulates and the creation of niches of thought [Shu *et al.*, 2017; Cinelli *et al.*, 2021]. The negative impacts of this scenario have been seen in discussions about climate change, the effectiveness of vaccines and even electoral decisions [Montagni *et al.*, 2021; Van der Linden *et al.*, 2017].

In opposition to these movements, areas of knowledge have been proposing ways to mitigate the damaging effects of fake news. In journalism, fact-checking initiatives are an example of this effort, as they check the veracity of news that is in circulation at the time [Spinelli and de Almeida Santos, 2018]. On the other hand, technology is adopting artificial intelligence methods (natural language processing and machine learning, for example) to automate the detection of potentially disinformative publications [Villela *et al.*, 2023; Medeiros and Braga, 2020; Oliveira *et al.*, 2019].

Although significant, these alternatives are not directly educational and therefore do not empower citizens to determine the quality/veracity of the content they absorb. Some of the possible educational responses to fake news are media literacy, news literacy and information literacy. Broadly speak-

ing, these literacies aim to improve the individual's relationship with the media, providing knowledge capable of promoting healthy consumption of these media [Rosenbaum *et al.*, 2008].

Media literacy is about building an autonomous attitude towards the different media, moving from the passive position of mere spectator to a critical eye, recognizing that any media is produced within a context and can be influenced by monetary, political and other factors [Siqueira and Cerigatto, 2012]. The specialization of media literacy for journalistic media is known as news literacy [Fleming, 2015]. Finally, information literacy emerges to emphasize that any piece of information can be viewed from different angles, resulting in different analyses and conclusions [Lee and So, 2014].

The skills that literacies seek to build are closely related to capacities expressed in the Common National Curriculum Base - a document that regulates the curricula of public and private schools in Brazil - especially with regard to the development of thinking primarily based on facts and the importance of students being able to interpret data and information from multiple media - a necessary ability in the context of digital media, especially the internet [Brasil, 2018].

One of the ways of practicing literacy is lateral reading, which consists of not restricting the reading process to just the information presented in a single source, on a single site [Walsh-Moorman *et al.*, 2020; Wineburg and McGrew, 2017]. Through this technique, the user can identify important metadata from the news, such as the name of the person responsible for the publication and the editorial preferences typically adopted there, as well as checking what other media outlets are saying about the same subject [Wineburg and McGrew, 2019]. Lateral reading is opposed to vertical reading, which focuses only on the original text and generally takes into account visual aspects and other manipulable features

[Wineburg and McGrew, 2017].

In addition to the primordially of counterpoint with concrete facts, another front in the fight against fake news is the development of barriers against persuasion - a characteristic that is strongly present in false content. The consolidation of resistance against convincing arguments, but with no basis in reality, is what the inoculation theory discusses [McGuire, 1961]. Using a biological metaphor, the theory argues that, just as vaccines confer immunological resistance through a weakened version of a certain virus, it is also possible to immunize oneself against misleading arguments through weakened and subsequently contested versions of these arguments [McGuire, 1964].

In its first applications, inoculation served to demonstrate that cultural truisms (the denomination of widely accepted perceptions that are rarely questioned by a social group; e.g. the habit of brushing one's teeth is healthy) are easily discredited in the face of incisive counter-arguments. Thus, it has been found that one way of reinforcing these perceptions is to encourage refutation - through shortened versions of counter-arguments quickly followed by their rebuttal [McGuire, 1964].

More recently, the theory has expanded and its validity has also been perceived in the field of arguments stemming from disinformation. Some examples are the confrontation with conspiracy theories in the field of health, more specifically with regard to movements that encourage non-vaccination - which is particularly dangerous in epidemic and pandemic contexts [van der Linden *et al.*, 2021; Islam *et al.*, 2021; Wong, 2016]. Nevertheless, conspiracy theories related to global warming denial have also been tackled through the inoculation theory [Van der Linden *et al.*, 2017].

Given this scenario, a systematic mapping procedure was carried out in order to identify educational initiatives that seek to promote guidance on *fake news*. The process revealed that although initiatives do exist, they are scarce, mainly in Portuguese and aimed at Brazil. It was also observed that a considerable number of publications do not validate their propositions or have problems with the protocol adopted for this validation. In addition, no studies were found that sought to implement Lateral Reading and Inoculation Theory techniques in digital tools.

Based on the context presented, this work proposes an online system for guidance on fake news, whose main objective is to encourage the development of skills that enhance the identification of fake news. The main module of the application will work in such a way that, from a news link provided by the user, information will be displayed that can help answer three questions: "Who is behind the news?", "What is the evidence for the claim?" and "What do other sources say about subject?". The questions are part of the Online Civic Reasoning curriculum, proposed by the history education group at Stanford University, whose aim is to enable students to evaluate information about politics and society accessed online [McGrew *et al.*, 2018; Breakstone *et al.*, 2021].

A second module of the system will present different stories to the user, who in turn will have to analyze each one and answer whether or not they believe it to be false. In the event of an error, arguments and data will be provided to prove that the news is untrue. The design of this module -

which will include game elements such as scoring and sound effects - is based on the principles of inoculation theory, as it shows a false statement immediately followed by arguments that challenge it.

In Section 2, there will be an in-depth analysis of the components and theoretical discussions that underpin the project described. In addition, an overview of the general methodological steps of this paper is presented on Section 3. Sections 4 and 5 details the Systematic Mapping and Tool Development, respectively. Section 6 presents the operational flow of the developed product. The validation process methodology and results are described on Section 7. Final considerations and future perspectives for the study are listed in Section 8.

2 Theoretical Framework

2.1 Fake News

Since the 2016 United States (US) presidential election, fake news has become one of the most important contemporary issues in various social spheres, including politics [Bovet and Makse, 2019; Jardelino *et al.*, 2020] and even in the field of health [O'Connor and Murphy, 2020; Carrieri *et al.*, 2019]. Allcott and Gentzkow [2017] define fake news as articles that are intentionally and verifiably false, capable of misleading readers. They are therefore considered fabricated news with the explicit purpose of promoting lies, as well as humorous satire. When decontextualized, these humorous pieces can contribute to the spread of untruths [Allcott and Gentzkow, 2017].

In this discussion, it is important to introduce and distinguish between two concepts: misinformation and disinformation. Wardle and Derakhshan [2018] present that misinformation refers to the inadvertent sharing of false information. On the other hand, *disinformation* consists of the deliberate creation and sharing of information that is known to be false. Therefore, intentionality is what differentiates these two concepts. In this paper, fake news is understood in the context of disinformation.

The spread of this kind of news, whether through the media or rumors, is nothing new. In Brazil, for example, a notorious case is the vaccine revolt, which took place in the 20th century, when people revolted over the compulsory vaccination against smallpox [Sevcenko, 2018]. However, the emergence and massification of social networks have brought a new dimension to this problem. In general, the functioning of these networks is strongly based on the creation of niches, made up of individuals who share similar world views [Shu *et al.*, 2017].

The main consequence of this phenomenon is the formation of echo chambers. By limiting the user's exposure to different points of view, this phenomenon enhances predominant narratives, shared and reinforced to exhaustion [Cinelli *et al.*, 2021]. In this context, a basis in concrete facts becomes, in a way, dispensable. The group's perception of credibility is one of the factors capable of attesting to the validity of a source, for example in Shu *et al.* [2017].

Another result of this scenario is the lack of awareness

that many news stories are motivated by political and monetary purposes, for example. In politics, disinformation has been adopted as a convincing and persuasive mechanism. By distorting opponents' speeches, misrepresenting events and masking reality, candidates are able to garner votes and win over new supporters [Zhang and Ghorbani, 2020]. In addition to the 2016 US presidential election [Bovet and Makse, 2019; Jardelino *et al.*, 2020], studies point to the influence of *fake news* on voter decision-making in the 2018 Brazilian elections [Abdin, 2019; Jardelino *et al.*, 2020] and in the UK's BREXIT referendum [Marshall and Drieschova, 2018], which resulted in the country leaving the European Union.

However, fake news is also a lucrative business for its creators. One of the main drivers of disinformation is the individuals who write/publish articles with misleading content and sensationalist headlines - therefore with a high potential for generating clicks [Figueira and Oliveira, 2017]. This content is formatted primarily with a view to mass sharing on social networks, where it is immediately reproduced by a number of users who are impressed only by the eye-catching titles [Bondielli and Marcelloni, 2019]. Information from *National Public Radio*, a US non-profit media organization, shows that promoters of this type of content can earn between 10 and 30 thousand dollars a month [Sydell, 2016].

The consequences of the scenario consolidated by this escalation of disinformation can be seen in various spheres. McKay and Tenove [2021] and Benkler *et al.* [2018] are some of the authors who point out the harmfulness of *fake news* for deliberative democracy, while they corroborate the extreme polarization and radicalization of political debate. In the field of public health, the dissemination of untrue information - mostly based on conspiracy theories - about the effectiveness and probable risks of vaccines contributes to an increase in the rate of people who do not adhere to vaccination campaigns; a situation that is especially damaging in epidemic or pandemic contexts [Carrieri *et al.*, 2019; Montagni *et al.*, 2021; Hansen and Schmidtblaicher, 2021]. Moreover, Van der Linden *et al.* [2017] discuss the impact of fake news - usually sponsored by groups with strong financial interests - on the corrosion of discussions on climate change, including with regard to scientific consensus.

In opposition to these movements, scholars and professionals from different fields have been proposing ways to combat the spread of fake news. Fact-checking is an initiative in the field of journalism that has emerged in recent years [Spinelli and de Almeida Santos, 2018]. The technique consists of assessing the veracity of news or statements made by public figures that are circulating on the web. In general, this study is carried out by high-profile newspapers. However, agencies specialized in *fact-checking* are increasingly common [Zhang and Ghorbani, 2020].

In the field of technology, there has been a rise in the adoption of methods based on the artificial intelligence paradigm, mainly machine learning and natural language processing techniques, for the automatic detection of articles, posts and other disinformative content [Villela *et al.*, 2023; Oliveira *et al.*, 2019]. One of the possible applications for these algorithms is the identification of suspicious *posts* on social networks [Medeiros and Braga, 2020].

Despite the promising results, these alternatives do not en-

able users to autonomously recognize fake news or consult reliable sources to determine the quality of the information they consume in the media [Rosenbaum *et al.*, 2008]. Good user interaction with these channels depends on education, more specifically through media, information and news literacy, which will be presented and discussed in the next section.

2.2 Media, News and Information Literacy

The consolidation of *fake news* as a phenomenon with a significant impact on modern life has also created a major challenge in the field of education. From this perspective, the possibility of adopting media, news and information literacies is emerging. *Media Literacy* is "an interdisciplinary area of knowledge that is concerned with developing ways of teaching and learning relevant aspects of the insertion of the media in society" [Siqueira and Cerigatto, 2012, p. 239]. Thus, an individual who has access to and is familiar with media literacy should be able to build an autonomous relationship with the different media, consuming each of them critically and aware that the content is produced in a certain context [Aufderheide, 1993; Mcdougall, 2019].

Aufderheide [1993] presents some conceptions about media that are considered fundamental to media literacy: the media build and are built by reality; media have commercial, political and ideological implications; form and content are related in each medium, with each medium having unique aesthetics, codes and conventions; and finally, each viewer interacts in a unique way with the media.

A particular case of media literacy is news literacy. News literacy consists of developing the skills and motivations needed to make the individual capable of evaluating, analyzing and understanding content presented in the news media [Fleming, 2015]. In addition, this literacy aims to instigate the decoding of contextual information, based on the understanding that news is produced in the context of the journalistic industry, so monetary aspects, governance and other interests should not be disregarded when analyzing a piece of journalism [Maksl *et al.*, 2015; Ireland, 2018].

In this context, another elementary skill is *information literacy*. In line with media literacy in terms of cultivating skills for accessing, understanding, using and creating media messages, information literacy emphasizes information itself [Lee and So, 2014]. More specifically, this literacy refers to a set of practices that include encouraging reflection in the process of searching for, analyzing and understanding information, highlighting that the same information can be seen through different prisms - which culminates in different analyses and conclusions [ACRL (Association of College and Research Libraries), 2015].

The skills developed by the literacies presented above are also supported by the BNCC (National Common Curricular Base), a document that regulates the curricula of public and private schools in Brazil [Brasil, 2018]. Although it does not specifically mention the concepts discussed here, by explaining the General Competences of Basic Education in its first pages, the text points to the importance of students being able to "argue on the basis of facts, data and reliable information, in order to formulate, negotiate and defend ideas, points of

view and common decisions that respect and promote human rights, socio-environmental awareness and responsible consumption at local, regional and global levels” [Brasil, 2018, p. 9]. In particular, the material emphasizes the need for pedagogical action that provides, in addition to literacy, the student’s involvement in various literacy practices from the first two years of elementary school [Brasil, 2018].

Furthermore, when addressing the Portuguese language component, the BNCC once again deals with related themes of media literacy, news literacy and information literacy. In this sense, it highlights the need for this subject to “provide students with experiences that contribute to the expansion of literacy, in order to enable meaningful and critical participation in the various social practices permeated/constituted by orality, writing and other languages” [Brasil, 2018, pp. 67]. The text also reminds us that contemporary language practices involve new genres, with multisemiotic texts (full of elements such as images and drawings) and multimedia, and updated ways of producing, configuring, making available, replicating and interacting [Brasil, 2018].

In addition to its interconnection with the BNCC, the academic literature presents examples of papers that study the applicability of the literacies discussed here to the specific case of promoting guidance on *fake news*. Buselic [2019] and Auberry [2018] are some of the authors who propose and discuss the results of courses on information literacy, with a focus on sharpening critical analysis and identifying fake news. Grace and Hone [2019] detail the development and results of a game to combat disinformation by enhancing news literacy. Wineburg and McGrew [2017] evaluated the adoption of media literacy, mainly through the technique of lateral reading, to make individuals more capable of critically analyzing information found on the internet. Lateral reading and its possible applications will be discussed in depth in the next section.

2.3 Lateral Reading

The expansion in the use of the internet as a means of disseminating and monitoring news has brought and continues to bring the need to develop new strategies in order to make proper use of these new channels. Ratifying the conceptions of literacy presented in the previous section, the ability to ask questions and consult reliable sources is fundamental; exceptionally in contexts where fake news faithfully simulates real stories produced by serious professionals [Walsh-Moorman *et al.*, 2020].

One way of promoting responsible news consumption in virtual media is the technique of lateral reading, which consists of evaluating information from the original website, carrying out research and comparing the original source with other sources - including assessing the credibility and possible biases of the primary publication [Wineburg and McGrew, 2017]. With this technique, it is possible to answer questions such as: “Is the information available on professional sites presented without spelling mistakes or spam?” and “Does the publication use reliable sources?” [Wineburg and McGrew, 2019]. This way of consuming content is opposed to vertical reading, which is based only in the information presented in the original source [Wineburg and McGrew,

2019].

When researching lateral reading, Wineburg and McGrew [2017] carried out a study with three different groups of individuals: history PhDs, undergraduate students and journalists. The study consisted of observing their research process when evaluating websites on social and political issues. At the end of the study, it was possible to determine that historians and students ended up drawing conclusions through aesthetic attributes and other easily manipulated characteristics, such as domain names - in short, they adopted vertical reading. Journalists, however, immediately resorted to lateral reading, consulting external sources and comparing information. The conclusions of the study indicate that, in general, journalists obtained more positive results, reaching correct conclusions in less time.

In the field of education, the Digital Polarization Initiative, a project carried out by the Association of State Colleges and Universities at the national level in the United States, aims to teach university students how to check facts, using the lateral reading method [Caulfield, 2017]. The methodology proposed by the organization consists mainly of four steps: searching for credible sources; finding the original publication of the news/information in question; investigating the source from which the content is being consumed and starting the search again whenever the desired results are not found. The student is also encouraged to pay attention to their own emotions in this procedure, in order to mitigate the effect of subjective biases [Caulfield, 2017].

Another application of lateral reading in education is the Civic Online Reasoning curriculum, proposed by the history education group at Stanford University. Consisting of a series of short tasks, the intervention aims to make students more adept at searching for and evaluating information about politics and society in virtual media. In addition to evaluating evidence and research methods that are not restricted to the first results indexed by search engines, the curriculum also includes lateral reading as a procedure for reaching accurate conclusions [McGrew *et al.*, 2018]. When tested with the target audience (primary, secondary and higher education students), the guidelines proved to be effective, as they made students more capable of critically evaluating various publications, reinforcing the importance of this type of curriculum [McGrew, 2020].

2.4 Innoculation Theory

Fake news is a phenomenon that is necessarily based on convincing individuals. Therefore, an important stage in tackling this scenario is building active resistance, capable of protecting the individual against disinformation initiatives [Eagly and Chaiken, 1993]. Refusing to accept persuasive arguments based on previous knowledge and experience is one of the basic principles of the inoculation theory [McGuire, 1961].

Drawing on a metaphor with human biology, inoculation theory explains that, just as vaccines confer immunological resistance through a weakened variant of a certain pathogen, it is possible to make people capable of actively opposing fallacious arguments through weakened and previously contested forms of these claims [McGuire, 1964]. In short, the

theory argues that conceptions based on truthful facts can be solidified, becoming less susceptible to change caused by arguments without robust foundations [Lewandowsky and Van Der Linden, 2021].

Cook *et al.* [2017] demonstrate two significant elements for inoculation: 1) a prior warning of an imminent persuasive threat; 2) exposing the fallacy by presenting counter-arguments that reveal possible tactics - which the individual may encounter again in the future. More practically, a message of inoculation against climate change denial, for example, should warn of the rise of movements that aim to cast doubt on the scientific consensus on the subject and reveal that, in general, these groups use false experts to arrive at their assertions [Cook *et al.*, 2017].

Having initially been understood as a measure to be applied before the individual is exposed to a misleading argument, recent research has studied the theory of inoculation for post-contact cases, in order to mitigate the possible effects of misinformation. Although not as effective as prior inoculation, these studies argue that post-exposure can prevent future attempts at persuasion. Other studies also argue that both prevention and “therapeutic treatment” are important and should not be dissociated [Roozenbeek and Van Der Linden, 2019; Compton, 2020].

As a means of mitigating the profusion of conspiracy theories and other fake news in general, inoculation theory has been employed in different contexts. As discussed earlier, a classic example of the use of inoculation is in confronting the rejection of scientific consensus on the phenomenon and effects of global warming - one of the most pressing environmental issues of recent years [Van der Linden *et al.*, 2017; Maertens *et al.*, 2020].

In addition, countering movements that encourage speculation - usually based on decontextualized information or motivated by interests unrelated to the promotion of public health - about the efficacy and safety of vaccines, van der Linden *et al.* [2021], Islam *et al.* [2021] and Wong [2016] are some of the authors who show the causal relationship between inoculation messages and less vulnerability to vaccine denial discourses. Also in the field of health, Basol *et al.* [2021] present the positive results of adopting the theory to combat false information about the origins and treatments in the context of the COVID-19 pandemic through a *online* game.

The approach of using inoculation theory for particular themes (e.g. conspiracy theories about vaccines), however, is not the only one possible. Resistance to persuasive arguments can be developed in a general way, by elucidating the methods commonly used to generate persuasion. Again using the biological metaphor, this way of applying inoculation could be compared to a broad-spectrum vaccine, capable of preventing the human body from different pathogens that use the same mechanism to cause illness. In this sense, the individual can be “protected” against disinformation initiatives that use strategies to convince through information that has no basis in concrete reality.

3 Research Methodology

This section presents the general methodological steps taken to design the system. Each of these methodological steps will then be described in more detail in specific sections. These steps are represented on a flowchart in the Figure 1.

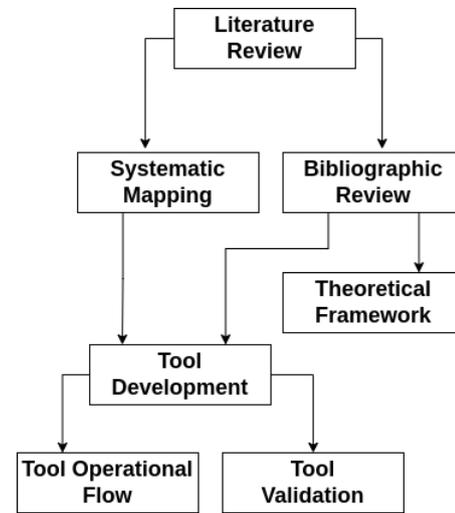


Figure 1. Research Methodology General Flowchart

In order to promote a theoretical approach to the literature that underpins the themes of this project, a literature review was the first methodological step adopted. More specifically, this process was divided into two stages: Bibliographic Review and Systematic Mapping.

The first stage was focused on delimiting the scope of the project, particularly with regard to the theoretical aspects of fake news, including its origins, motivations and the implications involved. In addition, educational initiatives/methodologies that offer a response to the phenomenon of disinformation were also delimited, including through the consolidation of skills that enable individuals to identify fake news. Lastly, this stage also involved finding technological mechanisms, such as programming languages and Application Programming Interfaces (APIs), capable of supporting the implementation of the proposed project. Despite not having been carried out systematically, these initial studies were fundamental in providing the basic theoretical framework for the work, as well as technical basics for the application development.

After this stage, the next methodological step consisted of carrying out Systematic Mapping. The aim of this process was to identify the state of the art on the topic of interest, its potential and possible research gaps. More specifically, to identify other recent initiatives that seek to promote education about fake news. The protocol adopted in this process and the results achieved are presented in detail in Section 4.

The Systematic Mapping findings served as the basis for designing the tool. These results highlighted the opportunity to develop a digital tool aimed at Brazilian users to promote education about fake news. The methodological description of this modeling process, including how the Theoretical Framework and the Bibliography Review impacted the final product, is presented in Section 5, which also de-

scribes the technical resources used on the software development process.

The tool developed in this context consists of a web system, aimed at desktop browsers and smartphones. The details on how the application works, including all the system screens, are explained in Section 6. The final part of the methodological cycle of this study consisted of testing the product with the target audience. This evaluation took place using the structured UEQ (User Experience Questionnaire) and also through observation of use by an observer. Both the evaluation protocol and the results and discussions obtained from this process are presented in Section 7.

4 Systematic Mapping

Systematic Mapping is a mechanism adopted as a way of synthesizing academic evidence, using previously delimited protocols with the aim of removing tendencies/preferences intrinsic to the researcher. This procedure identifies gaps in areas of knowledge, making it possible to correctly position new research, propose different approaches and guide new studies Kitchenham [2004].

The next subsections will present the Systematic Mapping protocol - which was based on the guidelines proposed by Kitchenham [2004] - and the results and discussions obtained in this process.

4.1 Mapping Protocol

4.1.1 Research Objective

The first stage of the process consisted of defining the research objective in order to set the direction for the study, as follows.

“Identify educational initiatives with the aim of promoting guidance on fake news.”

4.1.2 Research Questions

The formulation of research questions is one of the most important stages during the design of the Systematic Mapping protocol. These questions should reflect the interests of the study, raised earlier in the objectives. The defined research questions are presented below:

- **Q1:** What types of educational initiatives exist to provide guidance on *fake news*?
- **Q2:** How do these initiatives make the user more able to identify *fake news*?
- **Q3:** What are the limitations of these proposals?

4.1.3 Languages of Interest

Although the topic in question is quite wide-ranging and has relevance on a global scale, only papers published in English or Portuguese were considered in this study. The choice of English was based on the fact that academic papers from different countries are published in this language, opening up a wide range of research. In addition, as the product proposed

here is aimed specifically at the Brazilian public, studies in Portuguese were also researched.

4.1.4 Search strings

Another step was the formulation of words and logical connectors to be subsequently applied to the search bases. The process of designing these strings went through a number of iterations, and it was necessary to make continuous adjustments until we obtained a string that returned the results relating to the scope of the Systematic Mapping. In this sense, an important step was the addition of terms to disregard studies in the field of artificial intelligence and related subjects (machine learning and deep learning).

Below are the English and Portuguese versions of the strings reached at the end of the iterations.

English Strings:

(fake AND news) AND (education OR teaching OR learning OR (digital OR literacy)) -deep -machine

Portuguese Strings:

((fake AND news) OR (notícias AND falsas)) AND (ensino OR aprendizado OR (letramento AND digital) OR (literacia AND digital)) -artificial - máquina -profundo

4.1.5 Research Sources

To carry out the research effectively, the Academic Search Engines of interest were determined: *IEEE Xplore*, *ACM Digital Library*, *Science Direct*, *Brazilian Computer Society OpenLib (SOL)*. The choice of the first sources was based on their good position in the classification presented by Buchinger *et al.* [2014], which evaluated criteria such as search resources and refinement. Dybå *et al.* [2007] argue that *IEEE Xplore* is extremely important when it comes to studies in the field of computing and engineering.

On the other hand, the SOL database was adopted because it groups together papers from a wide range of events, journals and newspapers produced in Brazil. In addition, in order to broaden the scope of the results in Portuguese, we also used the results of *Google Academic*, a tool that compiles productions from various databases. In this case, only the results from the first ten pages were considered (each page returns 10 articles), as it was noted that the subsequent results did not match the search string.

4.1.6 Criteria for Inclusion and Exclusion

The directives that guide the inclusion of a given study in the scope of Systematic Mapping are called Inclusion Criteria. In addition, the Exclusion Criteria describe the characteristics that should contribute to the removal of papers from the final selection of the Systematic Mapping.

To this end, the following Inclusion Criteria were defined:

- **CI1:** Papers that present some kind of initiative (digital or not) aimed at offering guidance on *fake news*;

- **CI2:** Papers that present some kind of initiative (digital or not) aimed at enabling individuals to recognize *fake news*;
- **CI3:** Papers that are a review of the literature related to educational techniques aimed at providing guidance on *fake news*.

The Exclusion Criteria are as follows:

- **CE1:** Papers that do not meet any of the inclusion criteria;
- **CE2:** Papers that are not in the languages provided;
- **CE3:** Papers published more than 5 years ago (before 2016, since the research occurred in 2021) - the purpose of choosing this time frame was to select more recent articles;
- **CE4:** Papers that are duplicates or older versions of other papers;
- **CE5:** Papers without an abstract;
- **CE6:** Papers that are only available as an abstract or introduction;

4.2 Results and Discussions of the Systematic Mapping

After searching the databases, the results were catalogued and this raw data can be downloaded on Zenodo. In total, 42 papers that met some of the inclusion criteria were found. For these first results, the authors read the title and the abstract. After taking into account the exclusion criteria, a total of 32 papers were obtained. For the final set of selected articles, a complete reading was carried out. The details of the subsequent stages of this process, including the answer to the questions initially proposed and the categorization of these answers, can be seen in the flowchart in Figure 2.

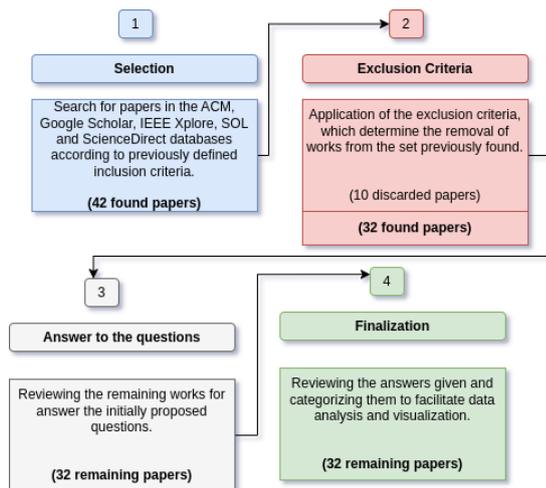


Figure 2. Systematic Mapping Results Cataloging Flowchart.

The next step was the analysis of the obtained data. Taking the year of publication as a criterion, the graph in Figure 3 shows the distribution of papers over the previously defined timeframe (2016 - 2021). There is a greater concentration of articles between the years 2019 and 2020. No papers published in 2016 were found.

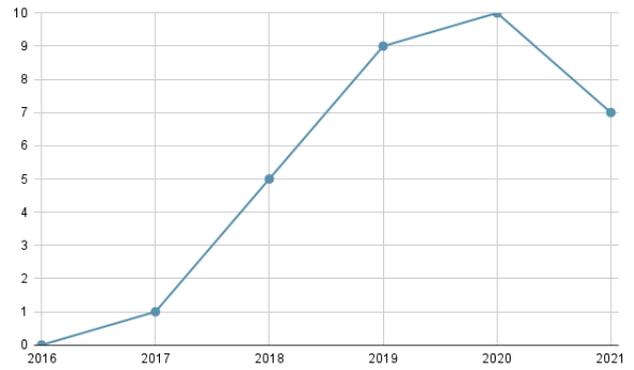


Figure 3. Graph relating Year and Number of Publications.

Furthermore, the country of origin of the found papers was also analyzed. The graph in Figure 4 shows the results. The highest percentage (31.3%) of papers found were published in the United States. There was also a considerable amount (21.9%) of work published in Brazil - which was important for understanding the state of the art in the country.

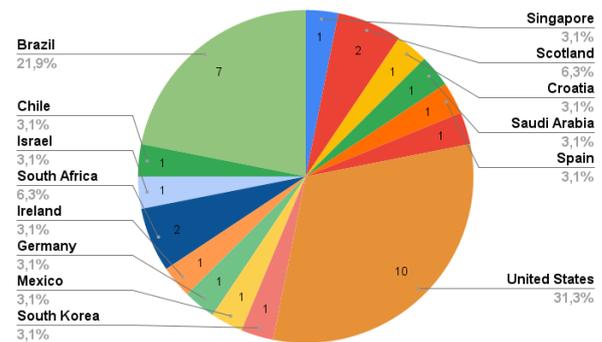


Figure 4. Graph relating Countries and Number of Publications.

The graph in Figure 5 shows the distribution of papers in relation to publication sources. The largest proportion of articles (37.5%) was found on Google Scholar.

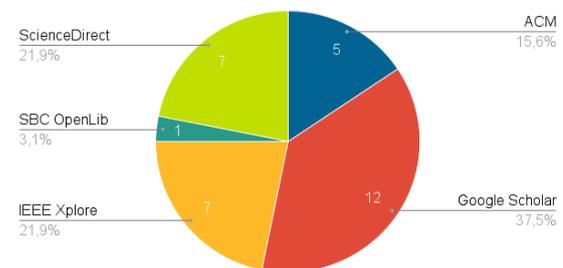


Figure 5. Graph relating Sources and Number of Publications.

After reading the selected articles, the answers to each of the questions initially proposed were obtained. In order to make these inputs easier to understand, the next step was to subdivide these answers into categories. For each question, the categorizations and the number of papers in each category are explained.

Q1: What kind of educational initiatives exist to promote guidance on fake news?

Table 1 shows the categories obtained from the answers to question Q1 and their descriptions.

Although there is a roughly even distribution between the number of papers in each of the categories, the largest share - represented by 25% of the results - features digital tools that aim to promote some kind of guidance on fake news (Figure 6).

One article, however, did not fit into the other categories and was classified under “Other”. This study deals with the state of the art in relation to assessing the quality of information published on social networks, making it possible to alert/warn users about potentially disinformative content.

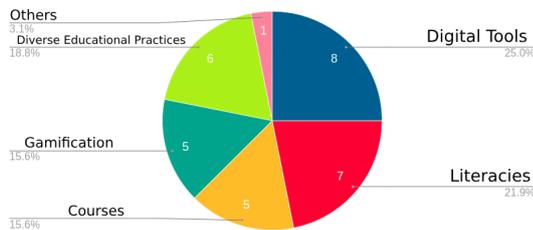


Figure 6. Graph relating questions and number of publications in each category for Question Q1.

Table 1. Categories and respective description of answers for Question Q1.

Category	Description
Digital tools	Technological tools developed with the aim of providing education about fake news, helping users to understand the problem and/or identify fake news
Literacies	Studies that describe/apply media, news and/or informational literacies as a way of educate individuals to help them understand what fake news is and/or how to identify it.
Gamification	Initiatives that use gaming to promote guidance on fake news in a playful way.
Diverse Educational Practices	Comprises diverse educational efforts that in some way counter the spread of fake news, making students more adept at recognizing this type of news, the possible consequences of mass disinformation and the importance of exercising critical analysis when consuming information.
Courses	Proposals for educational courses to provide guidance on fake news, focusing on students at different levels (high school and college, mainly)
Other	Studies that do not fit into the categories described above.

Q2: How do these initiatives make the user better able to identify fake news?

Table 2 lists the typifications for the answers to question Q2 and the respective descriptions of each category.

Table 2. Categories and respective description of answers for Question Q2.

Category	Description
Elucidating the motivations behind the phenomenon	Groups together papers that focus on informing individuals about the main mechanisms involved in the production/distribution of fake news. In this sense, economic, political and ideological interests are elucidated, as well as techniques usually employed in the dissemination of disinformation by digital media.
Highlighting common characteristics	Publications that describe initiatives based on highlighting some typical characteristics of fake news, such as sensationalism, unknown sources, high potential for virtual dissemination, etc.
Proposition of computational methods to evaluate the quality of information	Intervention proposals based on the adoption of computational methods to evaluate the quality/veracity of information and, based on this, alert users to sources of disinformation.
Other	Studies that do not fit into the categories described above.

According to the graph in Figure 7, there is a predominance (around 37%) of proposals that promote guidance on fake news by elucidating the tactics, strategies and interests that work as a background to the phenomenon of mass disinformation. In addition, a significant number of publications (approximately 34%) seek to educate individuals by detailing the characteristics commonly found in fake news. A smaller proportion of the results (12.5% of the total) propose the use of computational methods to alert/warn users about fake news.

Five articles, however, could not be fitted into any of the categories discussed above. These papers cover literature reviews and systematic mappings that catalog different educational methods that facilitate the identification of fake news. In addition, other scientific productions discuss skills that need to be developed, especially with regard to literacy, and are essential in recognizing material created with a focus on the dissemination of fake news in virtual media.

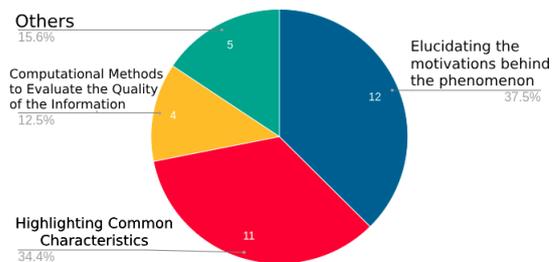


Figure 7. Graph relating questions and number of publications in each category for Question Q2.

Q3: What are the limitations of these proposals?

Table 3 shows the categories identified in the answers to question Q3.

When evaluating possible limitations in the proposals of the results analyzed during the Systematic Mapping process, a key finding is that most of the gaps observed are related to the evaluation of the study. More specifically, 43.75% did not assess the propositions presented and did not discuss the practical results of the ideas discussed. A considerable portion (approximately 35%), on the other hand, did not detail the evaluation protocol used or did not present the limitations, such as a low sampling rate, for example (Figure 8).

Among the papers classified under “Other”, we identified articles that, in general, did not go into the educational bias introduced in their initial sections, so they focused on determining the quality of the information, without providing information on ways of making the individual autonomous. In addition, gaps were observed with regard to the possibility of generalizing the methods, since some papers deal with particular spheres of the fake news problem (such as vaccine denial and climate change, for example).

Table 3. Categories and respective description of answers for Question Q3.

Category	Description
No evaluation of the proposal	Includes articles that, despite presenting intervention proposals, did not actually test these proposals with the target audience.
Problems with the evaluation protocol	Papers in which there are problems with the protocol adopted to evaluate the intervention proposal. These problems range from a lack of information about the protocol to flaws in the evaluation itself.
Other	Studies that do not fit into the categories described above.

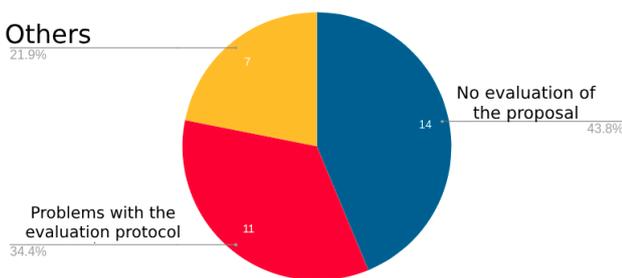


Figure 8. Graph relating questions and number of publications in each category for Question Q3.

The Systematic Mapping process served to highlight a gap in digital educational tools aimed at tackling the issue of fake news. In the field of technology, most of the initiatives are geared towards the field of Artificial Intelligence, mainly through machine learning. In contrast, there are not many initiatives aimed at making the human individual more adept at identifying disinformation. These initiatives are even rarer

when we look specifically at Brazil’s national scenario. In addition, some of the study identified is focused on fake news on a specific topic, while the system presented does not have this limitation, as it can be used to analyze any type of news published on journalistic websites or blogs.

5 Tool Development

This section discuss the application development process, both at a conceptual level and at a software development level. In this process, the conceptual aspects are based on both the information from the Theoretical Framework and the understanding of the state of the art, provided by the Systematic Mapping, in relation to digital educational initiatives that seek to promote awareness about fake news. In addition, the technical aspects related to software development are based on the studies carried out during the Bibliographical Review.

5.1 Modules

The application developed is a web system that can be used on both desktops and smartphones and consists of two modules. The first module (News Analysis Module) assists the user in the process of Lateral Reading. The second module, called the Training Module, adopts the Inoculation Theory and seeks to train the user by showing some examples of news stories and asking them to evaluate their veracity.

The **News Analysis Module** is responsible for highlighting the characteristics and metadata extracted from the link to a particular news item, which will be provided by the user. The intention is for the information highlighted via the link to serve as a starting point, enabling the user to begin an autonomous research process and therefore form their own opinion on the content in question.

The construction of this analysis was based on the Online Civic Reasoning curriculum [McGrew *et al.*, 2018; Breakstone *et al.*, 2021], in particular the three questions that underpin the method and whose answers help the individual to make assertive decisions.

Based on these questions, information was gathered (metadata, external data, etc.) which, when highlighted, helps users reach their own conclusion and also encourages them to carry out searches in order to read the article laterally. These questions and their respective information are presented below.

1. Who is behind the news?

- (a) Author/News Writer
 - By highlighting this information, the user will be encouraged to check whether the person responsible for the writing is a recognized professional in the journalistic field and, consequently, to learn about the professional’s possible personal tendencies.
- (b) Responsible for the domain on which the news is hosted

- When available, the information of the Individual or Legal Entity can also be used to verify the credibility and/or possible ideological biases of the medium in which the news is published.
- (c) Information available on Wikipedia about the site on which the news is published
- Although commonly considered an unreliable medium, especially for academic studies, Wikipedia can function as a starting point for fact-checking - especially when it comes to obtaining information about the source on which the news is published [Brodsky *et al.*, 2021; Head and Eisenberg, 2010].

2. What is the evidence for the statement?

- (a) Publications about the news analyzed in Fact-Checking Agencies
- Google offers the *Fact Check API*, which allows searches to be carried out at different Fact Check Agencies. In this way, it will be possible to highlight publications related to the news story being analyzed. The aim of this information is, once again, to reinforce the aspect of lateral reading - after all, the user will have access to publications that have carried out research on the subject of the news and that highlight evidence and arguments to demonstrate the truth or untruth of the news. Furthermore, this information will offer users the chance to get to know the fact-checking agencies.
- (b) Publication date
- It is common for old, out-of-context articles to re-circulate on social networks for the purpose of misinformation. What's more, inattentive users often don't pay enough attention to these dates. Therefore, in some cases, emphasizing the date of publication is enough to show that old news is being used for disinformation purposes.

3. What other sources say?

- (a) Related news in other media outlets
- Another tool provided by Google is Google News, which organizes news published in different media. In this sense, the system will display other news stories, related to the analyzed story, but published in other news sources. This way, the user can compare the news with what is being said in other media - again exercising lateral reading.

Another feature of the project is to provide the users with a module in which they can exercise their skills in recognizing fake news. This module, called **Training Module**, present some real examples of news, and it will be up to the user to analyze them and answer whether they believe each one to be true or false. The real news comes from professional, reliable

media outlets (G1 - Globo's news portal, CNN Brasil, UOL News Portal and Forbes), and to find the fake news, consultations will be made with Fact-Checking Agencies (Agência Lupa (Lupa Agency), Projeto Comprova (Comprova Project) and Boatos.org).

The design of the module is based on the Inoculation Theory, whereby the user is encouraged to analyze examples of real news stories and contrast them with the information presented during the lateral reading exercise. This action means that the arguments presented in the news are immediately countered - when the news is false - or reinforced - in situations where the news is true. In this way, there is a stimulus - which in the biological metaphor of Inoculation Theory can be seen as the "development of antibodies" - to passively reject information that is not based on solid, verifiable arguments.

5.2 Definition of Requirements

One of the main activities involved in designing software is defining the scope of the product you want to deliver as a result. In this scenario, Requirements Engineering emerges, which is the work of gathering, describing and prioritizing requirements. [Pressman and Bruce R. Maxim, 2014].

Requirements can be classified as functional or non-functional. Functional requirements correspond to the services that the software needs to provide, what responses should be generated from certain inputs and how the program should behave in specific scenarios. On the other hand, non-functional requirements are properties of the system as a whole, not related to a specific portion/module.[Sommerville, 2015].

Tables 4 and 5 show the functional requirements for the two application modules. Each requirement is represented by a code, description and its priority (essential, important or desirable) for the final product. On the other hand, the Table 6 shows the non-functional requirements.

Table 4. Functional Requirements - News Analysis Module

Code	Description	Priority
RFA-1	The system must be able to analyze news links that contain information such as: title, author and date of publication.	Essential
RFA-2	Only articles in Portuguese can be analyzed by the system.	Essential
RFA-3	Each piece of information presented must be accompanied by an explanation of how it can assist your analysis.	Essential
RFA-4	The explanation should be clear and easy to understand for anyone, even those who do not have advanced knowledge of virtual environments.	Important
RFA-5	The following criteria must be shown for a given news item, divided according to the key questions that help the user make a decision:	Essential

Table 4. Functional Requirements - News Analysis Module (continued)

Code	Description	Priority
RFA-5	<ul style="list-style-type: none"> • Who is behind the news? <ul style="list-style-type: none"> – Responsible for the domain of the record; – Author; – Information about the vehicle obtained from Wikipedia. • What is the evidence for the claim? <ul style="list-style-type: none"> – Publications related to the story in fact-checking agencies; – Date of publication. • What do other sources say? <ul style="list-style-type: none"> – Similar stories in other news sources. 	Essential
RFA-6	If any of the information is unavailable/cannot be accessed for some reason, the user should be presented with a message of encouragement, explaining that it was not possible to retrieve the information, but that they can find it through other means, such as search engines or news aggregators, for example.	Important

Table 5. Functional Requirements - Training Module

Code	Description	Priority
RFT-1	The user must be presented with 5 news items.	Essential
RFT-2	The news must be presented in layouts that simulate virtual contexts such as <i>posts</i> from social networks, news sites or messages from communication applications.	Important
RFT-3	The news presented must contain, in addition to the text, information such as: name of the publication vehicle, date of publication, author’s name, <i>link</i> in which the news was originally published .	Essential
RFT-4	If the analysis is correct, the system should present the user with a celebratory <i>feedback</i> .	Essential
RFT-5	In the event of an incorrect analysis, the system must be able to present the user with the information that should have been taken into account for a correct analysis.	Essential

Table 5. Functional Requirements - Training Module (continued)

Code	Description	Priority
RFT-6	At the end of the evaluation of all the news displayed, the system should display the user’s percentage of correct answers.	Essential
RFT-7	At the end, a feedback message should be displayed to the user. If achieved a score less than or equal to 50%, you should be shown an encouraging message, as well as tips on what to do to exercise your skills. If achieved a score higher than 50%, a congratulatory message should be displayed.	Essential

Table 6. Non-Functional Requirements

Code	Description	Priority
RNF-1	The system must be compatible with modern browsers and show no difference in behavior between these browsers.	Essential
RNF-2	The tool must also be compatible with browsers mobile. Thus, responsiveness is an aspect to be considered in the implementation process.	Important
RNF-3	The criteria for analysis must be laid out in a way that makes it easy for the user to read and, in addition, the guidelines associated with these criteria must be written in a simple way that makes them easy to understand.	Important
RNF-4	The system must contain recovery mechanisms in the event of failure, which includes: problems with the hosting service and failures in accessing external resources (APIs), for example.	Desirable
RNF-5	The application must consider accessibility features, not imposing operating conditions that hinder users who use screen-reading features and others.	Important

5.3 Technologies and Application Architecture

The proposed system was developed with a focus on operating in virtual environments. This decision was based on the fact that web systems can be accessed through a variety of media - mainly computers and smartphones. The responsive nature of the application is a particularly important aspect considering that cell phones are the most widely used digital devices in the country; currently, around 242 million are active in Brazil - corresponding to 53% of all digital inputs [Meirelles, 2021].

The architecture adopted for the tool was Client-Server. As far as the technologies used are concerned, tools

aimed at building *web* systems have been adopted: HTML [WHATWG, 2021], CSS [Mozilla, 2021a] and JavaScript [Mozilla, 2021b]. While the first two are used specifically to create the graphical interfaces on the client side, the JavaScript programming language is used throughout the software. In particular, the Vue.js framework [Vue.js, 2021] helps to create interfaces, making it easier to develop dynamic pages that also incorporate HTML and CSS.

As far as the Server side is concerned, Node.js [OpenJS, 2021] provides an execution environment for JavaScript on servers. One of the capabilities provided, in this sense, is access to external APIs, as well as the construction of new APIs - essential features for the development of this project.

Figure 9 shows a diagram of the architecture and external components used by the system. As well as being responsible for fully implementing the Training Module, the client side of the application will be responsible for displaying the data that makes up the News Analysis Module. To obtain this data, requests are made to the server side, which in turn uses libraries, APIs and other platforms to extract this data, performs the appropriate processing and provides access routes to this information via the HTTP protocol.

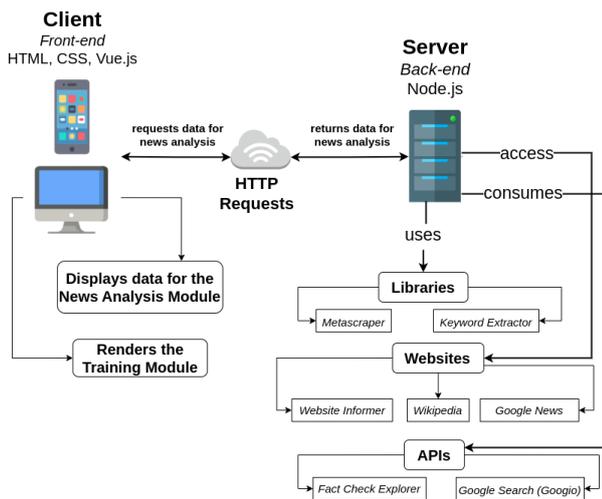


Figure 9. System Architecture.

An important point of discussion in this architecture is the instruments (Libraries, APIs and Sites) used to obtain the data used to help the user carry out lateral reading. This information, displayed in the News Analysis module, relates to the criteria outlined in the “News Analysis Module” section. These tools will be discussed below.

1. Libraries:

- **Metascraper:** this is a Node.js library that makes it possible to extract (*scrapping*) metadata from *on-line* articles (e.g. news, blog posts, etc.) [Metascraper, 2022]. As well as textual data, the tool can also retrieve images, videos and audio. The library does this by analyzing the HTML elements present on the page of the article of interest. For a piece of information, there is a set of selectors that can be used to extract it. For example, to obtain the Author’s name, it is possible to filter HTML elements whose “class”

attribute or “name” attribute contains the term “author”. When a non-empty value is found in one of these elements, the search is stopped and the data found is returned.

In the context of this study, the library was used to obtain the following data: Author, Title and News Publication Date.

- **Keyword Extractor:** this is a Node.js library that selects keywords from a *string* containing a phrase. This process is carried out by removing *stop words* [DeLorenzo, 2022]. *Stop words* are “noise words”, i.e. words that don’t have much relevance or meaning in a textual expression. Removing these words from a phrase is commonly used to improve the accuracy of the results returned when searching on online search engines, such as Google [Feldman *et al.*, 2007]. Some examples of *stop words* in Portuguese are: “a”, “de”, “para” and “aquela”.

In this study, keyword extraction was necessary to implement fact-checking related to the news analyzed and to news similar to the news analyzed, but published in other sources. Both processes are explained below.

2. APIs:

- **Google Search API (Googio):** this API, developed by the Googio company, makes it possible to carry out unlimited searches on Google’s engines. The results provided include links, descriptions and websites. Using the API is very simple and straightforward, but it also makes it possible to customize parameters such as Language, Nationality and Geographic Location of the results [Google, 2022d].

In addition to the conventional Google search engine, the API also provides access to searches using Google Images (image search service), Google News (news aggregator, that indexes news from different sources) and Google Scholar (search engine for academic articles) [Google, 2022d].

For this paper, the tool was used to access Wikipedia and to obtain related news.

- **Fact Check Explorer:** this Google tool aims to help the studies of journalists and researchers by providing a search engine for news that has already been vetted by fact-checking agencies. In this way, it is possible, using a term or phrase, to obtain the most recent results published by fact-checking agencies and thus analyze the veracity of a given subject [Google, 2022c].

The sample space of the search carried out by *Fact Check Explorer* comprises any Fact Check Agency that follows Google’s guidelines, which include, for example: providing data formatting following a standard, the existence of a correction policy or mechanisms for users to report errors, the agency’s website cannot belong to a political entity and the fact check needs to be transparent

in relation to sources and methods - containing citations and references to primary sources [Google, 2022b].

There is also an API that allows the *Fact Check Explorer* to be used at runtime. Using this API, it was possible to obtain and display the main fact checks related to the news story analyzed in the system designed. The search string used comprises the first three keywords in the headline (obtained through *Keyword Extractor*) joined by the logical operator “AND”.

The fact-checks found are then displayed in the system along with their respective original links - allowing the user to access the websites of the fact-checking agencies and check the arguments put forward by the fact-checkers to demonstrate that the news is false. The aim of providing links to the fact-checks is to encourage users to do some lateral reading.

3. Websites:

- **Website Informer:** one of the pieces of information displayed in the system is the person responsible (Individual or Legal Entity) for registering the domain on which the news item analyzed is hosted. When a domain name is purchased through a particular provider, the information on the person responsible for the purchase is passed on to ICANN (Internet Corporation for Assigned Names and Numbers), a non-profit organization which, among other responsibilities, manages the DNS protocol (Domain Name System). Some of the data on these domains is made available for public access through WHOIS, a protocol also managed by ICANN. It’s worth noting that some providers offer the service of keeping subdomain owner data private. To do this, they submit their own data to ICANN instead of that of their clients.

Website Informer is a system that accesses the WHOIS and allows public subdomain data to be displayed. In the project described here, this platform was used to obtain and display, when publicly available, the name of the person responsible for registering the subdomain.

- **Wikipedia:** when analyzing a story, an important point is to know the media outlet responsible for spreading the news. To do this, the system displays information, taken from Wikipedia, about the source in which the news is published. This functionality is implemented in two stages:

- (a) In the first stage, a search is carried out using the *Google Web Search* API for the URL of the site on which the news item analyzed is published. For this search, the following filter is applied: only results that are in the “en.wikipedia.org” domain (Portuguese language subsection of Wikipedia). In this way, it is possible to find the link to the desired article on Wikipedia.

- (b) Next, an HTTP request is made to the Wikipedia article link and the text of the first paragraph of the article is extracted. This section of text is identified using classes and TAGs in the HTML returned in the request.

- **Google News:** as well as aggregating news from different sources, Google News allows you to search this news database. Another possibility is to organize news according to the user’s preferences [Google, 2022a].

In this study, this mechanism was used to display other news related to the story being analyzed. This is another piece of information that seeks to enhance lateral reading, after all it provides a range of related news and allows the user to have a broader view of the subject.

The news searches were implemented using the Google Search API. The search string used is made up of the three keywords in the title of the news item (obtained by *Keywords Extractor*) concatenated with the logical operator “AND”. The search is still restricted to news stories whose language is Portuguese and which have been published on Brazilian websites. The system displays the first 5 news items found.

6 Tool Operational Flow

The aim of this section is to detail the operating flow of the tool developed. Figure 10 shows the application’s initial screen, from which you can access each of the modules that make up the system. These modules will be discussed individually in the following subsections.



Figure 10. Screen Capture of the Homepage.

This New Analysis Module starts when the user inserts a

link to a news on the application's home page. The information highlighted in the module seeks to encourage and stimulate the user to understand the context in which the news analyzed is inserted, consult other sources and identify possible biases in the medium in which the information is published, thus encouraging the practice of lateral reading.

The intended and correct functioning of the system is subject to the insertion of textual news links, published on websites or blogs, and which have characteristics such as: title, date of publication and text. If any other type of link is entered, the information displayed by the system will not be feasible and, as a result, the tool will be unable to fulfill its purpose: to assist in the lateral reading process. In addition, an error message is displayed when the user enters a string in the appropriate field that does not have a URL format.

Figure 11 shows a screenshot of the result of analyzing a news item. One point to note is that there are situations in which the system is unable to retrieve the necessary information - either because the information is not actually in the news item or because of the technical impossibility of the tools adopted in the implementation. In these situations, messages are displayed explaining to the user that the information could not be obtained.

Two situations worth highlighting in this regard concern when it is not possible to find Related News or Fact Checks related to the news story being analyzed. When no Related News is found, a message is displayed indicating that no results were identified and explaining that this may occur in cases where the news story being analyzed has not been widely disseminated in news outlets - after all, the tool used for this search is the Google for News indexer, which gathers stories from many news sources.

What's more, if the search doesn't find false checks, the system notifies the user that the news analyzed may be true. This conclusion is based on the fact that, as no publications have been identified that deny the news, it may be real. It is worth noting that the message displayed is not intended to provide the user with certainty, but rather to serve as a basis, together with the other information displayed, for forming their own conclusion. A screenshot exemplifying the situations described above can be seen in Figure 12.

The New Analysis Module also provides explanations for each of the pieces of information highlighted in it, with the aim of making the user understand how each piece of information can be used in the process of understanding the news. These explanations can be accessed by clicking on the question mark icon ("?") located next to the title of each information box.

The Training Module was developed to give users the chance to exercise their skills in identifying fake news and, above all, as a way of applying the concept of Inoculation Theory. In addition, in order to provide a playful experience, the module also has gameplay elements, such as scoring, visual feedback and sound effects.



Figure 11. Screenshot Partially displaying the News Analysis Module.



Figure 12. Screenshot Partially displaying the News Analysis Module.

In one round of using the module, the user will be presented with 5 examples of real news. In order to allow the same user to use it several times, 20 different news items are registered and five of them are displayed randomly in each round. The screenshot in Figure 13 shows a previous explanation, displayed when the module starts running. Figure 14 shows an example of a news item.



Figure 13. Screenshot of the Training Module First Page.

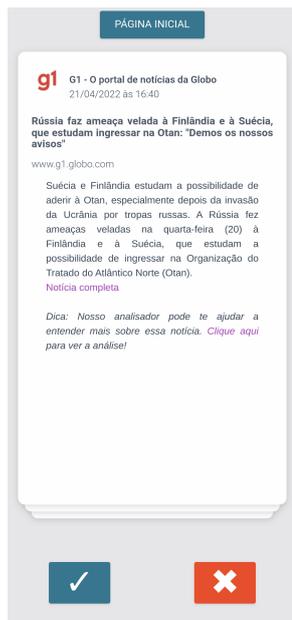


Figure 14. Screenshot of the Training Module First Page.

For each news item, the following information will be highlighted: media outlet, title, date of publication, text and link to the place where it was originally published (when available). It's worth noting that some of the news items reproduced in the module were published on messaging apps (WhatsApp and Telegram, mainly), and therefore don't have a link. For other news stories, the user can click on a button and access the News Analysis module, thus having access to information that can help them form a conclusion about the veracity of the story presented.

If the user's analysis of the veracity of the news is correct, they will receive an increase of 10 points in their score. This score will not be increased if the answer is incorrect. In such cases, a short explanation will be displayed to the user, show-

ing the reasons and arguments why the veracity of the news story does not correspond to what was answered (Figure 15).

At the end of the round, the user will be shown their score. The maximum total points that can be obtained is 50. If the user achieves a score lower than half the maximum score, the screen in Figure 16 is displayed. On the other hand, in situations where the score achieved is higher than half the maximum score, the system displays the screen in Figure 17.

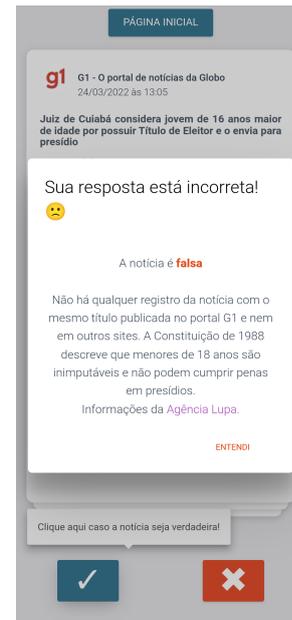


Figure 15. Example of the Explanation for an Incorrect Answer.



Figure 16. End of Round Failure Screen.



Figure 17. End of Round Success Screen.

7 Tool Validation

Once the application had been developed, the process of validating the product with potential users began. To this end, a validation protocol was adopted, as well as observation of use by an observer. This section presents both the methodological decisions and the results of this process.

The validation process took place in two phases, the first with the general public and the second with users in higher age groups. The methodology guiding the validation was predominantly quantitative - based on the collection, processing and statistical analysis of information [Richardson, 1985] - using the User Experience Questionnaire. Although predominantly quantitative, the research included aspects of qualitative evaluation, considering the speeches and reports of the research participants and, in the second phase, there were also one person - identified in this article as **Observer** - who helped their family members/testers to use the tool and, in this accompaniment, recorded observations of their perceptions.

7.1 User Experience Questionnaire

The structured questionnaire UEQ (User Experience Questionnaire) was adopted as the mechanism for data collection. The instrument is a software evaluation tool comprising 26 items, measuring both classic usability aspects and user experience characteristics. The understanding of these aspects/characteristics can be summarized in 6 indices, presented and explained in the list below [Laugwitz *et al.*, 2008; Schrepp, 2015]:

- **Attractiveness:** Overall impression of the product. Do users like or dislike the product?
- **Clarity:** Is it easy for users to become familiar with the product? Is it easy to learn how to use the product?

- **Efficiency:** Can users perform their activities in the tool without unnecessary effort?
- **Reliability:** Does the user feel in control when interacting with the product?
- **Stimulation:** Is the use of the product exciting and stimulating?
- **Innovation:** Is the product innovative and creative? Does the product capture the interest of users?

The Attractiveness scale is made up of 6 items in the questionnaire, while the others are made up of 4 items. The complete questionnaire, containing the 26 items, can be found in Table 7. Figure 18 shows a diagram explaining the items that make up the score for each of the indices.

The questionnaire is answered by assigning a score to each item. The scores can vary on a Likert scale of 7 items - scores in the range 1 to 7. Each score is assigned a weight between -3 (for the most negative answer: 1) and +3 (for the most positive answer: 7). Questionnaire factors such as reliability (ensuring the consistency of the scales used) and validity (ensuring that the scales actually assess what they are intended to) have already been investigated in 11 usability tests with 144 participants and through an online questionnaire with 722 participants [Laugwitz *et al.*, 2008].

In this study, validation involved sending a link from which the application could be accessed, along with a brief introduction to the project and the UEQ questionnaire. Once the information had been collected, we proceeded to analyze it and draw possible inferences - as provided for in the instrument adopted. The project and the collection instrument were duly submitted to and approved by the Research Ethics Committee (CEP) of the State University of Feira de Santana.

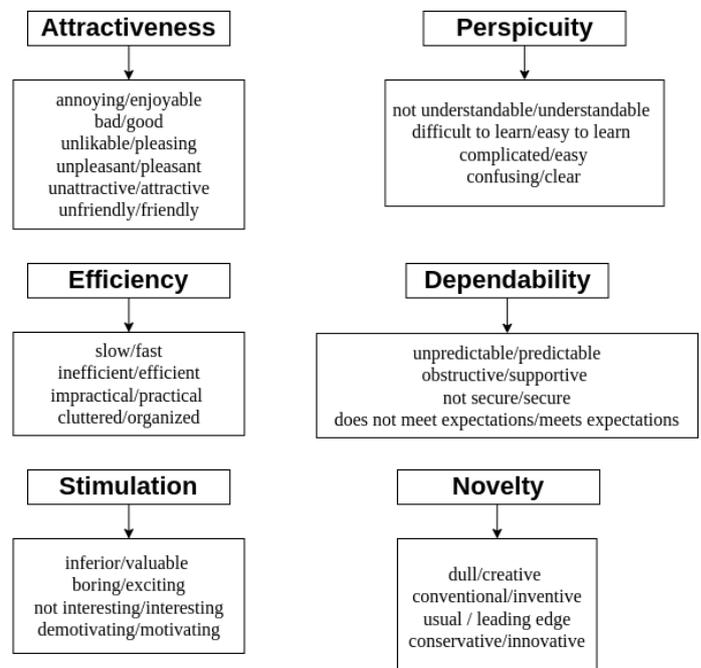


Figure 18. Diagram listing the scales and their associated items.

Table 7. User Experience Validation Questionnaire.

Item	1	2	3	4	5	6	7	Item
Annoying								Enjoyable
Not Understandable								Understandable
Creative								Dull
Easy To Learn								Difficult To Learn
Valuable								Inferior
Boring								Exciting
Not Interesting								Interesting
Unpredictable								Predictable
Fast								Slow
Inventive								Conventional
Obstructive								Supportive
Good								Bad
Complicated								Easy
Unlikable								Pleasing
Usual								Leading Edge
Unpleasant								Pleasant
Secure								Not Secure
Motivating								Demotivating
Meets Expectations								Doesn't Meet Expectations
Inefficient								Efficient
Clear								Confusing
Impractical								Practical
Organized								Cluttered
Attractive								Unattractive
Friendly								Unfriendly
Conservative								Innovative

7.2 Aspects of Qualitative Validation

Observing users from older age groups was one of the factors introduced in the second phase of validating the tool. This form of validation, with an observer who would also be able to help users, was based on the possibility that these participants might have a certain degree of difficulty using the system - since they were born at a time when technological tools were not yet accessible to the population [Iancu and Iancu, 2020]. The questions presented on the observation form are shown below:

- What interesting actions, reactions and statements did you observe when your father, mother, grandfather, uncle, father-in-law or others used the tool?
- Have you noticed any difficulties when they were the tool? If so, what were these difficulties?
- Did you notice any aspects that made it easier for users to use the tool, in order to give them autonomy? If so, what were these aspects?
- Were users interested in using the tool again? If so, what reasons did they give or did you notice? If not, what reasons did they give or did you notice?

In order to maintain the anonymity of participants and observer, during the analysis of the validation results in the Section 7.4, these people will be identified with numbers (e.g. Participant 1, Participant 2 etc.).

7.3 Execution

The validation process took place using a form consisting initially of questions about the participants' profiles and then the questions proposed by the UEQ instrument for usability evaluation. This stage of the project lifecycle was split in two phases.

In the first phase, the survey was released to the general public and 26 responses were obtained. However, it became clear that it was important to carry out an evaluation focused on older users, to find possible usability problems in the application with people who are not very familiar with digital tools. From this second phase, 16 people took part in the evaluation, making a total of 42 respondents in the two phases.

In both cases, the evaluation took place online, and the link to access the system and the evaluation form were distributed via an University of Feira de Santana (Universidade Estadual de Feira de Santana - UEFS) e-mail list and WhatsApp messages. The users also received a guide with instructions on how to use the application, explaining how to use both application modules. It is worth noting that in the second validation phase, an additional questionnaire was sent out. The purpose of this form was to obtain input for cases in which the validation was being conducted by an observer, who could also serve as an assistant to the elderly person while they interacted with the system.

7.4 Results and Discussions of the Validation

The following subsection presents and discusses the results of the tool's validation. These results include not only the values obtained for the scales evaluated by the UEQ, but also contextual information that helps analyze this data. In addition, the results obtained by observing the use of the tool by an observer will also be presented.

7.4.1 Participants' Profile

The first profile question was the participants' age. In the first phase (Figure 19), it can be seen that the largest proportion of responses (50%) are concentrated in the initial age group (between 18 and 28). In addition, both the 29-39 age group and the 40-50 age group comprise the same percentage of approximately 19.23% of the responses. Around 11.54% of the participants are in the last age group, which comprises any age over 50.

For the second phase, the results relating to age group can be seen in Figure 20. In this case, the majority of participants (37.5%) are between the ages of 51 and 61. However, there is a significant number of users aged between 40 and 50 (25%) and over 61 (31.25%).

The second profile question sought to understand the participants' level of education, in terms of schooling and academic training (Figures 21 and 22). In both phases of the validation, it was observed that there were no participants with a level of education in the first two categories (No access to formal education and Incomplete primary education).

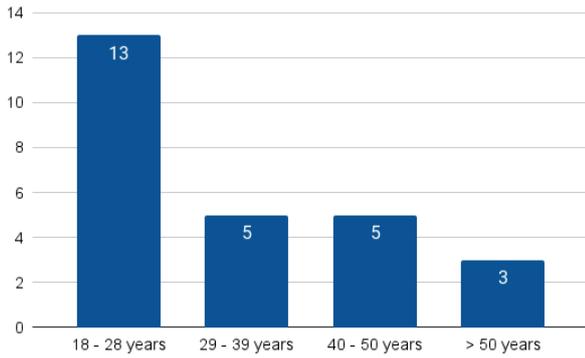


Figure 19. [PHASE 1] Graph showing age groups and number of responses for each age group.

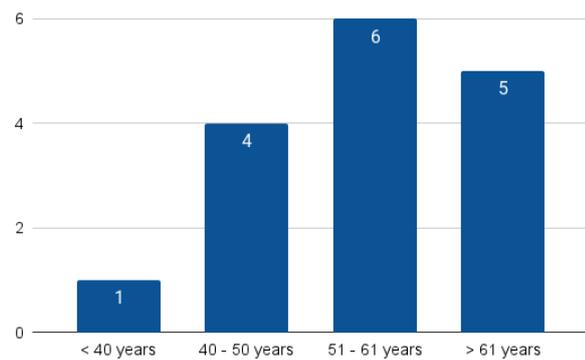


Figure 20. [PHASE 2] Graph showing age groups and number of responses for each age group.

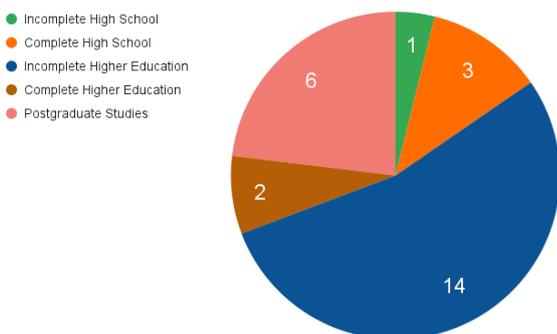


Figure 21. [PHASE 1] Graph showing the educational background of the survey participants.

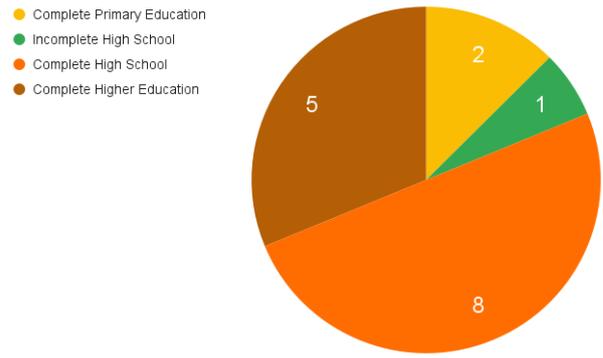


Figure 22. [PHASE 2] Graph showing the educational background of the survey participants.

In the first validation phase, there was a predominance (approximately 53.4%) of people with incomplete higher education. There was also a significant percentage (23%) of respondents with higher education (postgraduate). On the other hand, in the second phase, the majority of respondents had completed secondary school (50%) and another significant percentage (31.25%) had completed higher education.

The third and final question in the profile questionnaire sought to determine whether the participants studied or worked professionally in the field of Information Technology. The aim of this question was to identify whether the majority of participants had advanced prior knowledge in the use of technological instruments - which could affect their use and, consequently, their responses on the usability of the tool. The results of the first phase are shown in the graph in Figure 23.

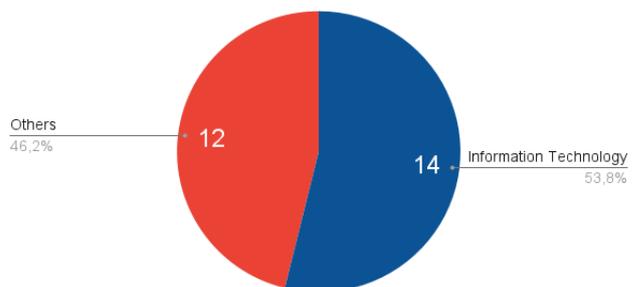


Figure 23. [PHASE 1] Graph showing the participants' area of study/professional activity.

Based on the responses, it is possible to see that just over half of the participants (53.8%) work in computing, while the remainder (48.2%) work in other areas of knowledge. However, as can be seen, there is an almost equal split between respondents who work in computing and other fields. In the second validation phase, the results showed that none of the participating users work in Information Technology.

7.4.2 User Experience - First Phase

The UEQ scales results for the first phase of validation are shown in the graph in Figure 24 and in Table 8.

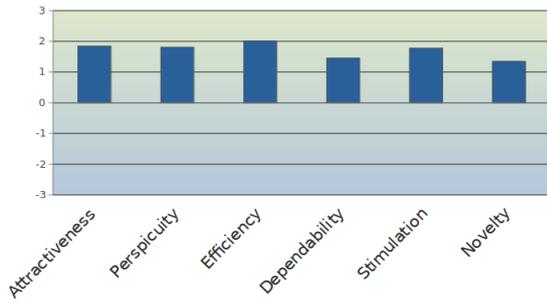


Figure 24. [PHASE 1] UEQ Questionnaire Scales - Results.

Table 8. [PHASE 1] UEQ Questionnaire Scales - Results.

Scale	Mean Value
Attractiveness	1.840
Perspicuity	1.808
Efficiency	2.010
Dependability	1.452
Stimulation	1.779
Novelty	1.346

For each scale, the resulting values are in the range between -3 (most negative response - very bad) and +3 (most positive response - very good). In this sense, values between -0.8 and +0.8 are considered neutral; values greater than +0.8 represent a positive evaluation; finally, values less than -0.8 show a negative evaluation for the respective scale [Schrepp, 2015].

Thus, in the first phase, all the scales obtained positive evaluations from the sample group. The first scale measured, Attractiveness, obtained an average of 1.8400, showing that the majority of users have a generally positive perception of the product. In addition, for the Perspicuity scale, the final average was 1.808; this value suggests that users considered the process of familiarizing themselves with the tool to have been successful, i.e. they were able to easily learn how to use the system.

The Efficiency scale obtained the highest average (2.010), which means the ability of users to carry out activities in the tool without unnecessary effort. Therefore, the evaluations showed that the artifact is also successful when it comes to guiding the user’s journey through the system’s execution flow.

Positive evaluations are also seen in the Stimulation and Dependability scales - which resulted in average values of 1.452 and 1.779, respectively. These values suggest that the product is able to offer a sense of control during the interaction process and also to positively stimulate and engage the user.

Finally, the scale with the lowest average value (1.346) was Novelty. However, this value is still well above the minimum value for the perception to be considered positive (+0.8). As such, there is a perception that the system presented is creative and presents something new to users - capturing their interest. However, a possible explanation for a lower average value compared to other scales may be related to a lack of perceived novelty in relation to the central theme of the tool, after all disinformation is a recurring theme

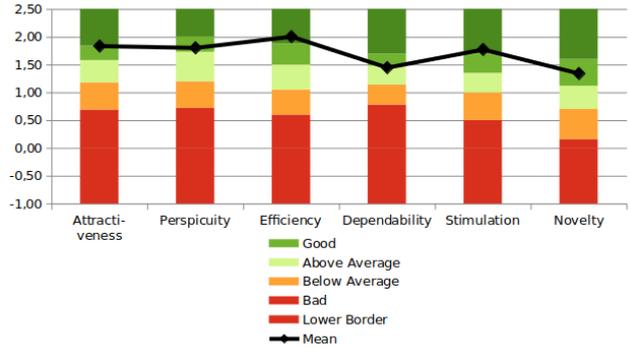


Figure 25. [PHASE 1] UEQ Benchmarking Results.

and one for which other possibilities for intervention are presented.

The UEQ instrument also provides a data set through which the ratings obtained can be compared with 468 ratings of different types of products (commercial software, web pages, online purchase pages and social networks). In this context, each scale can be classified into 5 categories in relation to the other evaluations in the data set (Excellent, Good, Above Average, Below Average, Bad and Lower Border) [Schrepp, 2015]. The graph in Figure 25 shows the rating achieved by each of the system’s scale in the first phase of the validation. In this way, it can be concluded that in the first validation phase, all the indices measuring the user experience in the tool achieved scores classified as Excellent, Good or Above Average.

7.4.3 User Experience - Second Phase

The results obtained for the user experience indices in the second evaluation phase can be seen in the graph in Figure 26 and in Table 9.

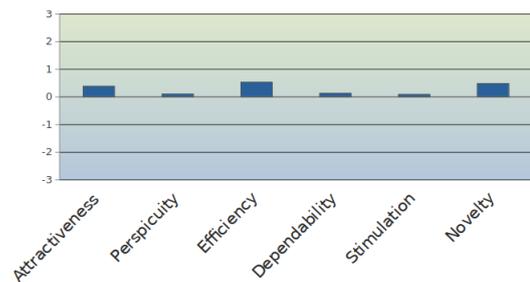


Figure 26. [PHASE 2] UEQ Questionnaire Scales - Results.

Table 9. [PHASE 2] UEQ Questionnaire Scales - Results.

Scale	Mean Value
Attractiveness	0.382
Perspicuity	0.103
Efficiency	0.529
Dependability	0.132
Stimulation	0.088
Novelty	0.485

Looking at the values, it can be seen that in this validation phase, all the indices obtained values greater than 0, but less than 1, indicating a neutral evaluation, according to the scale

that starts at -3 and goes up to +3. Efficiency was the scale with the highest score (0.529) - which was also the case in the first validation phase. Another scale with a significant score in this context was Novelty (0.485) which, by comparison, obtained one of the lowest scores in the first validation phase.

It is also worth noting that the scales with the lowest average values were Stimulation (0.088) and Perspicuity (0.103). As a result, it can be seen that users' biggest complaints are related to the difficulty of familiarizing themselves with the flow of use and the system's inability to promote motivation for use.

Benchmarking with the set of evaluations from the UEQ instrument, the graph in Figure 27 shows that all the scales were categorized as mostly bad, with Efficiency classified as below average.

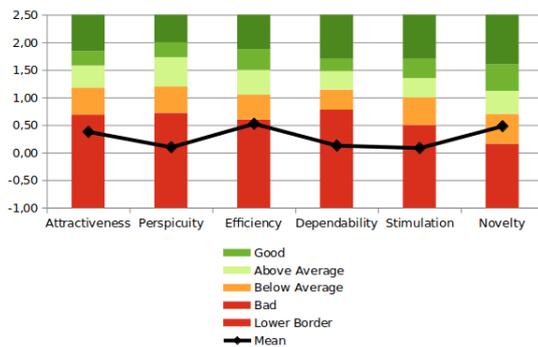


Figure 27. [PHASE 2] UEQ Benchmarking Results.

The process of observing older users interacting with the tool corroborates the difficulty of familiarization and also the system's inability to motivate these users - what was also noted on the UEQ results. Below are some quotes from these participants that demonstrate this more difficult process of engagement in the use of the application by users who were not born having contact with digital media.

Participant 1

"If I want to find out about fake news, Google tells me if it's true or false."

Participant 2

"If it was my granddaughter/grandson using this, it would be easier. These days children are using cell phones since they born."

Participant 3

"They [children] really need to use it [technology] from an early age, otherwise they'll be left out of the world."

The quote from **Participant 1** shows that some key aspects of the application, including the educational characteristics and the news metadata - both essential to identify fake news - were not clear enough to this user. The other two participants are talking about aspects related to the interaction of older people with technology. Especially from **Participant 2's** speech, it can be noted that his interaction with the tool was not fluid from the start.

Another point to note is that there was considerable resistance from these users due to political issues. Some of them pointed out that the news in the Training Modules could have an unfavorable bias toward news related to specific politicians. **Observer** pointed out that the news highlighted was obtained from a variety of media sources, but overall it was perceived that the political bias had a negative influence on the user experience.

Other difficulties that users faced were the need to add accessibility features; there were difficulties in reading textual information due to the font size used in the application. In addition, some important buttons, such as the question mark button that explains each of the tables in the news analysis module went unnoticed.

The second validation phase showed that the user experience deteriorated for individuals in age groups who are typically less familiar with using virtual media and digital tools in general. Although no scales with negative mean values were observed, the average values obtained are much lower when compared to the first phase, in which the sample was made up mostly of young people a significant proportion of whom work in the computer field.

In general, the tool's validation stage showed promising results, especially in the Efficiency scale, which indicates that it manages to capture users' attention and help them through the cycle of use. The second phase of validation, however, pointed to the need for more instructional elements in order to make the application more fluid for all user groups. The relevance of the tool is also revealed at a time when there is a shortage of similar instruments - as indicated by the results of the systematic mapping - to help identify fake news in Portuguese and aimed at Brazilian users.

8 Conclusion

In addition to contributing to the degradation of social debate on various social issues, fake news is currently also a challenge in the educational field. This paper presents the design and development of a tool that seeks to promote education by making users better able to identify disinformative content. In addition to all the theoretical background, the methodological steps for developing the application were presented, as well as the results, including Systematic Mapping, the product's workflow and validation with the public.

The product's design was based on enabling it to be used both as an aid in the news reading process and as an educational tool, capable of building and exercising new knowledge. With the news analysis module, the user has access to information that, in general, is not in evidence, but which corroborates to obtain a conclusion about veracity. In addition, the module enhances and facilitates the practice of lateral reading - which advocates searching different sources in the process of reading information - by providing links to other sources and encouraging the user to consult them.

The training module offers an environment with playful elements, based on games, in which the user is exposed to various examples of real news and is encouraged to analyze the veracity of each one - the news analysis module can be used in this process. The aim of this exercise is to make

the user more resistant to persuasive arguments that have no basis in reality. The workflow provides an alert when the user is unable to correctly identify the veracity of the news, and also provides consistent arguments if the news is false. Both aspects described are advocated in the inoculation theory, which served as the basis for the development of this module.

In its first phase, the tool's evaluation process was able to show that, within the group of testers, the product was able to meet the expectations of helping and guiding the user through a learning process, keeping them stimulated and presenting the necessary information in a fluid manner, thus culminating in an overall positive impression of the user experience. For this phase, these positive results are demonstrated even when the product described here is compared with the UEQ benchmarking.

On the other hand, the second evaluation phase showed that for an audience made up of older people, the tool still fails to provide a user-friendly experience. Based on the evaluations, it is possible to see that there are difficulties for these users, especially in relation to understanding the flow of use of the application and the information displayed. One of the reasons for this scenario is the fact that these people typically have difficulties with digital tools, due to being born into a generation in which this type of technology did not yet exist or was not accessible.

Some limitations of the evaluation process are mainly related to the fact that the study groups were made up of only 26 and 16 users. In addition, in the first phase of validation, more than half of the individuals correspond to users who have some advanced contact with the area of computing - either through studies or professional activity.

As future work, it is hoped, based on the second validation phase, to make the tool more accessible to older users. In this sense, the intention is to add elements that improve the user experience, guiding users through the flow of use. An example of an accessibility element would be instructional videos, which guide the user through the purpose of the application and the steps needed to use it correctly. Also, use larger sizes for text fonts and give more prominence to important buttons.

Other points for improvement are making the training module more flexible, in the sense of allowing system administrators to register and maintain new examples of news. Another point for improvement is to add more playful elements to the module and, possibly, phases with different degrees of complexity for the training. Finally, another possibility for improving the tool is to design and implement the possibility of analyzing other types of media (audio, video, text messages).

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