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THE FANER METHODOLOGY: A DIDACTIC APPROACH TO SCIENTIFIC FAKE NEWS

A METODOLOGIA FANER: UMA ABORDAGEM DIDÁTICA ÀS FAKE NEWS CIENTÍFICAS

LA METODOLOGÍA FANER: UN ENFOQUE DIDÁCTICO ANTE LAS NOTICIAS FALSAS CIENTÍFICAS

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ABSTRACT

The widespread dissemination of scientific fake news online presents a significant societal challenge, affecting decision-making and eroding trust in traditional information sources. In response, the FANER (FAke News Education Reaction) methodology offers a classroom-centered approach, engaging students in critical analysis and debunking of distorted scientific topics. FANER goes beyond classroom boundaries to involve social networks and community actions, empowering students to actively combat disinformation and advocate for accuracy. By implementing FANER, students not only can develop skills in discerning evidence-based science and reliable media but also contribute to building a more informed and resilient society against scientific misinformation. This approach underscores the importance of promoting truth and combating falsehoods in an era where digital communication shapes public perception and policy decisions.

Keywords: FANER Methodology; scientific literacy; disinformation; science; fake news; information literacy; news literacy; critical thinking.

RESUMO

A ampla disseminação de fake news científicas na internet representa um desafio social significativo, afetando a tomada de decisões e corroendo a confiança nas fontes tradicionais de informação. Em resposta a essa problemática, a metodologia FANER (FAke News Education Reaction) propõe uma abordagem centrada na sala de aula, engajando os estudantes na análise crítica e na desconstrução de temas científicos distorcidos. A FANER ultrapassa os limites do espaço escolar ao envolver redes sociais e ações comunitárias, capacitando os estudantes a combaterem ativamente a desinformação e a promover a precisão informacional. Ao implementar essa metodologia, os alunos desenvolvem habilidades para distinguir ciência

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baseada em evidências e mídia confiável, contribuindo assim para a construção de uma sociedade mais informada e resiliente frente à desinformação científica. Esta proposta destaca a importância de promover a verdade e combater a falsidade em uma era em que a comunicação digital molda a percepção pública e as decisões políticas.

Palavras-chave: Metodologia FANER; alfabetização científica; desinformação; ciência; fake news; letramento informacional; letramento midiático; pensamento crítico.

RESUMEN

La difusión masiva de noticias falsas científicas en internet constituye un importante desafío social, al afectar la toma de decisiones y erosionar la confianza en las fuentes tradicionales de información. Como respuesta, la metodología FANER (FAke News Education Reaction) ofrece un enfoque centrado en el aula, que involucra a los estudiantes en el análisis crítico y la refutación de contenidos científicos distorsionados. FANER trasciende los límites escolares, integrando redes sociales y acciones comunitarias, y empodera a los estudiantes para combatir activamente la desinformación y defender la precisión informativa. A través de esta metodología, los estudiantes desarrollan habilidades para discernir entre ciencia basada en evidencias y medios confiables, contribuyendo así a la construcción de una sociedad más informada y resiliente frente a la desinformación científica. Este enfoque subraya la importancia de promover la verdad y combatir la falsedad en una era en la que la comunicación digital configura la percepción pública y las decisiones políticas.

Palabras clave: Metodología FANER; alfabetización científica; desinformación; ciencia; noticias falsas; alfabetización informacional; alfabetización mediática; pensamiento crítico.

INTRODUCTION

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In contemporary education, one of the core challenges is not only teaching scientific content but fostering the ability to evaluate and discern trustworthy sources of information. As societies become increasingly digitized, the educational system is called upon to play a central role in cultivating students' critical and media literacy skills. This becomes particularly urgent in the face of scientific disinformation, which threatens both public health and democratic values. Within this context, schools emerge as strategic spaces for countering misinformation and promoting evidence-based reasoning.

Fake news, spread with overwhelming speed through the vast information network that is the internet and its social networks, has emerged as one of the most pressing challenges facing contemporary society in the first quarter of the 21st century (Miró-Llinares e Aguerri, 2023). The complexity and breadth of this phenomenon is rooted in its deep social penetration and the multifaceted impact it has on the most diverse strata of society (Rochlin, 2017). This impact manifests itself not only in personal decisions (Bastick, 2021), but also in public policies (Lee, 2019; Rose, 2017) and collective behavior (Chan, 2022), casting a shadow over the veracity and reliability of the information that surrounds society. As a result of modern social megatrends, a post-truth world is emerging, there is a decline in social capital. There is also an increase in polarization and economic inequality from an increasingly fractured media environment (Lewandowsky; Ecker; Cook, 2017).

Among the various forms of disinformation that are proliferating, the dominance of scientific fake news deserves special mention (Scheufele; Krause, 2019). Often focused on critical issues such as vaccination and the environment, such fake news raises justified concern, since their potential impact extends to individual and collective health, as well as the public policies that guide the preservation of the planet. The dangerous propensity of these fake news stories to induce harmful behavioral changes, such as resistance to vaccination (Chiou; Tucker, 2018), and the influence on misguided public policies, such as those

surrounding the response to the COVID-19 pandemic (Galhardi *et al.*, 2022), resound like alarms echoing in the consciousness of global society.

In a context in which the traditional means of general and scientific information, such as newspapers, TV news and magazines, are experiencing an erosion of their influence, often relegated to the limbo of discredit and supposed untruthfulness (Hachten, 2005), society is increasingly turning to the internet and its social networks as its main sources of information (Ghosh; Scott, 2018). However, this paradigm shift is not accompanied by the proper ability to discern between what is true and what is false, or perhaps the unwillingness to verify what is reality or reverie (Tandoc Jr, 2019), aggravating the problem. Furthermore, there is a hidden danger: as fake news begins to predominate in an environment of information dissemination, people begin to regard real news as fake. This difficulty, or inability, to differentiate fiction from fact, falsehood from truth, causes a lack of trust in the traditional media and cynicism, facilitating the emergence of authoritarian governments that take advantage of this situation (Mcintyre, 2021).

It is therefore imperative to consider that this phenomenon is growing and insidious, already ingrained in people's (and societies) routines (Guedes *et al.*, 2016), and that the continued influence of fake news undermines the reliability of the traditional media, creating a vicious circle that alienates those who are daily followers of these platforms (Kondamudi *et al.*, 2023). Every day, new Fake Fresh Fake News emerges, whether of a scientific nature or not, and can be in the form of conspiracy theories which, despite seeming strange but which announce that humanity is hiding the "truth", although seemingly outlandish, such as the absurd idea that the Earth is flat (Mohammed, 2019), find followers willing to question their improbability and embrace the breaking of paradigms.

Issues as important to humanity as controlling a pandemic and mitigating climate change are significantly influenced in political decision-making by the presence of scientific disinformation. The production and acquisition of knowledge by human beings is a collective process, in which knowledge is perceived, criticized,

and filtered, then shared, so massive disinformation reverberates and impacts on various spheres of society. Scientific communication and education must work together to promote democratic engagement with evidence-based knowledge (Lewenstein, 2015). In addition to the internet and social networks, it is important to recognize that academic production can also be used for disinformation, through exaggeration, sensationalism, distorted citations, predatory journals, and information bubbles (West; Bergstrom, 2021). It is important that academia is not used for distorted information, so it is important that evidence-based science is highlighted and differentiated from all forms of pseudoscience (Silva, 2024).

This fake news, linked from different sources, through various digital platforms, under the action of very efficient algorithms, infiltrates the social imagination, becoming truth for individuals, social groups and, worryingly, for significant portions of the population in various countries around the globe (Dennis; Galletta; Webster, 2021; Lazer *et al.*, 2018). Such adherence knows no social, economic or cultural barriers, as evidenced, for example, by the adherence of a considerable number of doctors in Brazil to the anti-vaccine movement (Silva, 2021a), spreading unfounded fears about vaccines and promoting the use of ineffective medicines to fight COVID-19 (Ferrari *et al.*, 2022).

Educational theorists have long emphasized the emancipatory potential of critical pedagogy, particularly in contexts marked by ideological manipulation and unequal access to information (Freire, 1996; Giroux, 2018). Thus, despite formal education, both in its initial and continuing aspects, it is undeniable that current training does not offer the necessary tools and knowledge to confront and suppress the spread of scientific fake news (Kendeou; Robinson; McCrudden, 2019). How can we do better? Be ensuring that schools (and society as a whole), whether at primary, secondary or tertiary level, can provide solid and effective science education capable of preparing students and teachers to tackle this serious issue of scientific misinformation (Silva *et al.*, 2024) - especially by integrating critical media literacy into curricula, who argue that equipping students to question and decode media is

essential in the digital age (Kellner; Share, 2019). Again using the Brazilian example of vaccine denial, it is urgent to understand why and how those with more schooling end up being more susceptible to scientific fake news (Silva *et al.*, 2023), demonstrating how urgent it is to react to fake news in the school environment, so that this space can be a barrier thanks to its potential to disseminate proven knowledge, providing students with tools to tackle the problem.

Given this situation, there is a pressing need for a pedagogical approach that can be used in any classroom and at all levels of education, an approach grounded in sociocultural theories of learning (Vygotsky, 1978) and in science education perspectives that value epistemic development and the social construction of scientific knowledge (Hodson, 2009). It is not just limited to subjects traditionally associated with science, such as chemistry, physics and biology, and science content at primary level, but also extending to fields such as history and geography, among others (Keselman *et al.*, 2021). Such an approach is a possible way to build a more enlightened and resilient society in the face of the risks of scientific Fake News that threaten our contemporary world (Cherner; Curry, 2019).

The development of the FANER (FAke News Education Reaction) methodology is grounded in constructivist and socio-interactionist theories of learning, drawing on Vygotskian principles of mediated action and on inquiry-based approaches to science education. It seeks to bridge the gap between media literacy and science teaching through active, participatory, and community-anchored learning processes (Vygotsky, Lev Semenovich, 1978). This article aims to introduce and analyze the FANER methodology, a didactic and interdisciplinary strategy designed to be implemented in diverse educational contexts. It seeks to empower students to identify, critically analyze, and act against scientific fake news, while simultaneously promoting epistemic responsibility, critical thinking, and scientific literacy. In times of increasing epistemic uncertainty, pedagogical strategies capable of engaging students in the active deconstruction of falsehoods and in the reaffirmation of scientific values are no longer optional, they are essential. The FANER methodology

searches responds to this urgent demand, offering not only a critical lens through which to read the media, but also a structured path for didactic intervention and tries empowers students to act as knowledge agents who challenge misinformation and engage actively with science in socially meaningful ways in line with the vision of critical pedagogy (McLaren, 2015).

Methodological Procedures

The development of the FANER methodology (FAke News Education Reaction) is the result of a theoretical–propositional process grounded in the author's professional experience as a teacher educator in Brazil, as well as in recurrent observations made throughout his work in Elementary and High School education, and in the initial and continuing education of teachers. It is therefore a didactic proposal constructed from the empirical recognition that the dissemination of scientific fake news directly affects school life, influencing perceptions, decisions, and pedagogical practices among both students and teachers. This methodology was not applied in its entirety in classroom settings, nor does it derive from a systematic or experimental study. Rather, it constitutes a pedagogical suggestion structured in response to real needs observed in day-to-day teaching practice.

The starting point for constructing FANER was the identification, over years of professional practice, of situations in which misconceptions, pseudoscientific arguments, and direct references to widely circulated misinformative content frequently emerged in discussions, schoolwork, and classroom interactions. These recurring observations revealed that schools lacked structured tools to address scientific misinformation, especially in the context of increasing reliance on social media as the primary source of information.

In response to this diagnosis, an extensive theoretical review was conducted, drawing on literature in scientific literacy, media and information literacy, critical thinking, critical pedagogy, and the epistemology of science. This body of work provided guiding principles for designing a methodology adaptable to different

educational levels and disciplines, capable of integrating media analysis, scientific inquiry, and community-oriented educational engagement.

Based on the articulation between theory and practice, two major pedagogical stages were outlined for the FANER methodology:

1. **Critical analysis of topics frequently distorted by scientific fake news**, accompanied by conceptual reconstruction grounded in scientific evidence.
2. **Active investigation of digital misinformation**, including the use of fact-checking tools, identification of rhetorical strategies, and development of educational actions aimed at the school community.

These stages were organized into operational phases that include: selecting themes vulnerable to misinformation; searching scientific and reputable journalistic sources; contrasting legitimate information with falsified content; analyzing psychological and sociotechnical mechanisms underlying adherence to misinformation; and producing educational materials for dissemination within the school or on social media. The delineation of these phases reflects gaps identified by the author in teaching practice, such as students' difficulties in assessing the credibility of sources and teachers' uncertainty about leading discussions on fake news.

Although isolated elements of the proposal were explored in specific activities during teacher education programs and in Elementary and High School classes, such as analyses of viral videos, debates about vaccines, exercises in source verification, and discussions on climate change or pseudoscience, these experiences did not constitute a full application of the methodology. They served as preliminary pedagogical indications supporting the development of FANER but did not involve formal data collection or systematic evaluation procedures.

Regarding ethical considerations, the present methodological development did not require submission to a Research Ethics Committee, as it did not involve human participants, the collection of personal data, or the systematic analysis of participant-produced materials. It consists solely of the systematization of a pedagogical proposal derived from professional experiences and theoretical–practical insights.

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Nevertheless, future implementations involving data collection, interviews, questionnaires, or detailed analysis of student work must undergo prior ethical review in accordance with current Brazilian regulations.

Thus, the methodological procedures described here characterize FANER as a flexible, theoretically grounded educational proposal inspired by teaching practice, designed to support teachers and schools in the urgent task of confronting scientific misinformation and promoting critical literacy in the contemporary educational landscape.

The FANER Methodology

In this context, the FANER methodology, an acronym for Fake News Education Reaction, is presented as a useful and accessible response to tackle this worrying reality. FANER was developed based on research into media literacy and critical thinking strategies, and was designed to be applicable across various disciplines, not just in science. The methodology seeks to address the broader issue of misinformation, focusing on the systematic debunking of distorted information and fostering a critical mindset among students. Under this proposal, classrooms, schools and their various disciplines become crucial pillars in building solid barriers against the spread of fake news (Keselman *et al.*, 2021). Not just as places of learning, but as sources for promoting the indisputable value of science; teachers and students are called upon to take an active role in containing this phenomenon and thus reaching their families and reverberating in their social groups, which can create a virtuous cycle of disseminating reliable information (Cherner; Curry, 2019). The FANER methodology is grounded in the principles of critical media literacy, which aims to empower students to analyze, evaluate, and create messages across a variety of media environments. This pedagogical stance is essential for fostering the critical thinking skills necessary to distinguish reliable information from disinformation (Hobbs; Jensen, 2009). The success of FANER also depends on sustained professional development for educators, who must be equipped to mediate complex

discussions on disinformation and guide students in developing critical digital literacies (Hobbs, 2010).

It is important to note that the FANER teaching methodology is intended to be applicable in the classroom due to its simplicity and accessibility. It does not require specialized materials or high costs, making it feasible in any educational context, even those with limited resources. The fundamental premise is to use the very digital technological tools and media that often propagate scientific Fake News as instruments to dismantle untrue information and to rescue the value of science based on evidence (Pulido *et al.*, 2020). Moreover, the methodology integrates preventative "prebunking" strategies, which prepare students to recognize and resist manipulative rhetorical patterns before exposure. These educational interventions have proven highly effective in enhancing individuals' resilience to misinformation (Bertolotti; Catellani, 2023; Heley *et al.*, 2025)

The central purpose of this methodology is to create a school environment that not only reacts to scientific fake news (Rosenzweig, 2017), but also helps to prevent it. The aim is to train students not only to discern truth from falsehood, but also to become critical consumers of information, equipped with the necessary skills to check the veracity of news, making use of the vast opportunities offered by the internet and social networks. The structure of the FANER methodology aligns with active learning pedagogies such as project-based learning and inquiry-based instruction, which promote student agency and the collaborative construction of knowledge (Kellner; Share, 2019). This educational process not only enhances students' verification skills but also contributes to the development of critically engaged citizens, capable of participating meaningfully in democratic societies (McDougall, 2019).

First stage of the pedagogical proposal

Choosing the central theme: The first stage of the methodology begins with choosing the central theme, by the teacher (that can be discussed with the students). This theme should be a topic that is often distorted by scientific Fake News, covering

areas such as history (denial of the Nazi Holocaust (Lipstadt, 2016)), geography and physics (flat-earth belief (Weill, 2022)), biology (creationism (Plutzer; Branch; Reid, 2020) and climate change denial (Lett, 2017; Silva, 2022) and global warming denial (Al-Rawi *et al.*, 2021)), and health sciences (vaccine denial (Ehreth, 2003; Silva, 2020) and promotion of ineffective or actually dangerous medicines (Silva, 2021b)). The teacher could give a basic introduction to the chosen topic, so that the students have an idea of the subject at the beginning of the methodology, so that there is no great disparity in the students' prior knowledge when approaching the subject of Fake News. However, teachers of any subject who notice Fake News related to their content can adopt this methodology. The teacher could give a basic introduction to the chosen topic, so that the students have an idea of the subject at the beginning of the methodology, so that there is no great disparity in the students' prior knowledge when approaching the subject of Fake News. The teacher should also be careful when choosing a topic, avoiding controversial and sensitive subjects that could lead to a more aggressive and unproductive discussion.

Relating the Theme to the Students' Reality: With the central theme established, the teacher sets out to identify events that confirm the occurrence of that phenomenon, which is often untruthfully denied on the internet and social networks. If feasible, the teacher tries to illustrate this with events taking place in the community (city, state or country) in which the students live, such as intense heat waves in the region or any extreme weather event that has directly affected their surroundings, highlighting and enabling them to experience climate change. Incorporating real examples of misinformation from the local context can enhance relevance and engagement, enabling students to perceive the immediate implications of disinformation in their communities (Popescu, 2020).

Presenting Events Against Fake News: The teacher should present the students with events or news stories that debunk the claims of scientific Fake News, showing how the denial of the phenomenon in question is not backed up by reality. For example, again discuss more intense heat waves in the students' region and their

obvious effects due to global warming, and even suggest talking to the family, especially the elderly, so that they can tell what the weather was like decades ago in terms of forecasts, better-defined seasons, scheduled planting and harvesting possibilities, noticeable signs of the seasons, etc. This type of action can be extended to certain sectors of the community, such as talking to small farmers, for example.

Group formation and research: The next stage involves forming groups of students to analyze the chosen event or fake news story. The groups should use electronic devices, such as computers, tablets, or smartphones, to carry out a search on websites previously selected by the teacher. The groups should meet to begin this search at a predetermined time in the classroom, but it is recommended that the students continue this investigation at home, and that the groups can meet online via free platforms, thus continuing the discussions and preparing the next stages of the activity.

Use of reliable and scientific sources: On these sites, students will find scientific information that explains the consensus on the topic, supported by data, research and perspectives presented by renowned researchers in the field. In addition, students can search for scientific article access sites such as Google Scholar, among others, to understand the foundations of scientific consensus. They should read at least the abstracts of some of these articles to understand how the foundations that gave rise to the scientific defense of the theory or phenomenon in question were constructed. Based on this reading and broader research, a discussion should be held with the class to show how a scientific consensus based on evidence is built.

Consultation with Traditional Media and Social Networks: The research also includes consultation with traditional media websites, such as magazines and newspapers, which corroborate the claims made on scientific websites and articles, serving as a bridge between academic knowledge and the general public. It's important for students to realize that these websites of the main traditional media outlets don't broadcast scientific Fake News. On the contrary, they try to disprove it,

for example by showing that no major newspaper reports unfounded risks about vaccines. In addition, social networks are used as a tool for direct communication with researchers in related fields, allowing students to obtain testimonials or even conduct short interviews to validate the information and seek to better understand the topics suggested.

Scientific Fake News vs. Reality: In a comprehensive approach, the groups also explore social media in search of testimonies from ordinary citizens, such as students and others, who have directly experienced the events or phenomena often denied by scientific Fake News. These testimonies provide concrete validation of the facts and highlight the reality that underlies the distortions disseminated on denialist social networks. For example, you could contact students from regions that have been affected by more extreme climate change around the world, and through these shared testimonies make them realize that the climate has changed in these regions, which were not affected by such intense summers or any other very significant change. In the case of biological evolution, or the efficacy of vaccines, for example, online contact with researchers in these areas would be productive in deconstructing the related Fake News

Presentation of results: Finally, the students present the results of their research to the other groups, demonstrating how there is a solid consensus between academic circles and the traditional press on the subject. They can present podcasts, short interviews, and social pages that reaffirm the value of reliable scientific information, either from a scientist in the suggested field or from a citizen who has experienced in some way the phenomenon denied by the fake news. In addition, an approach that explains how scientific knowledge has been built up over time is encouraged through a classroom debate, emphasizing the importance of extensive research, research groups, investment, publication of peer-reviewed articles, conferences, and other means of disseminating and discussing scientific knowledge. This approach enriches students' understanding of the process of building scientific knowledge and reinforces the reliability of evidence-based information. To ensure the effectiveness of the

methodology, it is advisable to implement assessment tools that measure students' critical thinking and media literacy development. Meta-analytic studies show that well-structured interventions can significantly enhance students' ability to detect misinformation (Jeong; Cho; Hwang, 2012).

Second stage of the pedagogical proposal

Searching for untrue information: The second stage of the methodology involves challenging students to actively search for untrue information on the topics they have been assigned. This is done in order to sensitize them to the existence of disinformation and to develop their critical analysis skills and reflect on how, after this initial search, the algorithms of social networks will continue to send them information that will try to confirm the content of fake news.

Identifying Types of Argumentations: Students are guided to identify the types of argumentations used on pages that spread fake news. This includes analyzing rhetorical strategies such as exploiting emotions, creating engaging narratives, and using selective data to support false claims. For an example of the latter, consider the narratives that use a very intense drop in temperature in a normally hot area (for example, a normally warm US state like Texas could face an abnormally cold snap) to announce that there is no global warming, disguising the fact that climate extremes are actually occurring. Thus, the average global temperature is rising (something that has been widely established), which does not prevent extremes of cold from occurring in unusual places.

Understanding the Construction of the False Narrative: It is essential that students understand how websites and social networks often employ fragments of truthful information to construct false narratives that appear plausible to most people. This tactic can result in behavioral changes, acceptance of absurd events, and denial of obvious facts. It is important to note that the creation of Fake News often involves creativity and intentionality, so that students don't perceive this phenomenon as a possible inconsequential prank. For example, a fake report claiming that a particular COVID-19 vaccine causes AIDS was embellished with the use of logos of highly

credible scientific institutions, such as the BBC (British Broadcasting Corporation) and Oxford University and was supposed to be associated with the British government. Although this link to a renowned institution is not essential for the acceptance of scientific Fake News, it undoubtedly increases its supposed "credibility". Even though this sounds absurd, many uninformed people believed that the fake report was legitimate, including then Brazilian President Bolsonaro, who even cited this report in a live broadcast emphasizing the supposed risks of the COVID-19 vaccine (Ventura; Aith; Reis, 2021).

Introduction to Fact-Checking Sites: Students are introduced to fact-checking sites, with a focus on the scientific aspects. They learn how these checks are made and what criteria identify fake scientific news. This education enables students to understand the process of debunking misleading information. It is recommended that each teacher find out about verification sites in their country. In Brazil, reputable institutions such as Agência Lupa, Fato ou Fake, UOL Confere, Public Agency and E-Farsas play this role. In addition, innovative tools such as Fake Check, developed by researchers at USP (University of São Paulo) and UFSCar (Federal University of São Carlos), simplify verification using artificial intelligence. Another highly recommended resource is the Checkology platform, developed by the News Literacy Project, which provides interactive modules for teaching media literacy and fact-checking in accessible and engaging ways (Kajimoto; Fleming, 2019; Tully *et al.*, 2022). These tools promote media literacy and help create a more informed and critical society in relation to information in the digital age, something that teachers should emphasize to students, especially when using social networks.

Deconstructing Belief in Questionable Sources: It is extremely important that students understand that information or discourse those conflicts with scientific consensus and traditional news sources is probably Fake News. The notion that contents that is challenging, irreverent, or contrary to the status quo is more reliable needs to be debunked. It is essential to recognize that the belief that questioning scientific truths is synonymous with innovation and challenge, is a phenomenon that

requires critical analysis. This mistaken view can create an environment conducive to the spread of scientific Fake News, often feeding conspiracy theories and propagating the idea that scientists who challenge received opinion are deliberately censored by academia. In many cases, this unfounded narrative suggests that these researchers have their findings rejected by reputable academic journals, which in reality is not in line with the fundamental principles of scientific research. However, the persuasiveness of this argument, when presented skillfully, can create an illusion of credibility, emphasizing the importance of critical discernment.

The Role of Social Networks and Algorithms: Understanding how social media algorithms operate is crucial for students to realize how their preferences and online interactions influence the content they are exposed to – often reinforcing confirmation biases and isolating them within information bubbles (Buckingham, 2023; de Sousa Marquêz, 2024). Students are taught how social networks often use algorithms to present information that seems pleasing to users, even if it is false. It is crucial that they recognize this dynamic and its influence on the spread of Fake News. The spread of Fake News through algorithms represents a significant challenge for contemporary society. These algorithms analyze users' online behavior, identifying their interests and preferences. Based on this digital profile, the algorithms tend to show information that confirms the user's existing beliefs, creating a confirmation bias. This strategy aims to keep users engaged on the platform, since information aligned with their beliefs generates more interactions. The risks of this practice are diverse, since these algorithms can promote misinformation and polarization, hindering informed decision-making and contributing to social fragmentation. Therefore, education and awareness of the dangers of these technological tools are fundamental, enabling people to assess and question the information found online, thus strengthening society's resilience in the face of this contemporary challenge (Prado, 2022).

Listing and Analysis of Scientific Fake News: Students are encouraged to compile a list of the main scientific Fake News circulating on topics such as vaccines, climate

change, and medicines and cancer. The analysis of this news aims to identify common patterns, even in apparently absurd claims, such as the idea of a flat Earth or theories of secret cures for cancer. The teacher must prepare for this stage, in which he or she will have to follow the footsteps of each piece of fake scientific news with the students, showing their inconsistencies and misconceptions, thus demonstrating their characteristics, their false character and avoiding the risk of any student having any doubts about whether that event or piece of news could be true. The relevance of this exercise lies in the opportunity for students to deepen their understanding of the strategies often employed by propagators of false information. By examining this misleading information, students can reveal recurring patterns and tactics that explain why so many people are influenced by it. In addition, this activity offers a valuable lesson in the importance of scientific literacy, encouraging students' critical ability to distinguish reliable information from deception.

Reflecting on Dependence on Social Media: It is essential to discuss with students the growing use of social media as a source of information, especially among young people. The time spent on these platforms often restricts access to traditional news sources, which generally do not report false scientific information. It is extremely important that students understand how addiction to social media can play a significant role in the dissemination and acceptance of scientific Fake News. The algorithms of these platforms are designed to continuously deliver targeted information to users, creating an information bubble that insulates them from divergent perspectives. As a result, addiction to social media consumes much of the time dedicated to the search for knowledge, leaving little room for access to alternative and reliable sources. This leads to the transformation of the individual into a mere consumer and subsequent disseminator of fraudulent news. This phenomenon is particularly relevant in hyper-connected societies such as Brazil, where the average daily use of these platforms reaches around five hours, making it imperative to promote critical skills for analyzing information and raising awareness about the harmful effects of this behavior in the context of scientific disinformation.

Discussing the Causes of Fake News Acceptance: Students are encouraged to reflect on why many people believe in scientific Fake News. This implies considering that a significant portion of the population is informed mainly through social networks, making them more susceptible to misinformation. It is of the utmost importance that students dedicate themselves to analyzing the underlying reasons for believing in scientific fake news, as well as the persistent phenomenon of doubt even after this information has been debunked. Understanding the psychological, social, and cognitive factors that lead to initial acceptance and resistance to abandoning these distorted narratives is crucial for the development of critical education. This not only enables individuals to distinguish true from false information, but also contributes to building a more resilient society against the spread of misinformation and its harmful consequences, especially in the context of science and public health.

Possible Role of Traditional Media as a Barrier: The discussion addresses why traditional news outlets don't broadcast news that denies climate change or promotes fictitious vaccine risks, for example. Of course, even the traditional media can occasionally make mistakes, especially small and/or marginal press outlets, but the risks are much smaller. The importance of seeking out reliable and verified sources of information, such as newspapers, TV news and other traditional media, becomes particularly essential in the current context, characterized by the phenomenon of scientific Fake News. These media outlets generally follow rigorous reporting and editing processes, with the supervision of professional journalists who take responsibility for each story, generally. In contrast, the lack of oversight and veracity in much of the information propagated in the vast digital sphere including social media reinforces the imperative need for students and society in general to maintain a solid link with these traditional channels, as an effective means of combating the spread of scientific misinformation and guaranteeing access to information that is based on evidence and investigated with editorial responsibility.

Challenges in Social Classes and Education: Surprisingly, even people with access to education can be influenced by Fake News. This emphasizes the need for

schools to play their part in informing and protecting against disinformation, something that has been neglected. It is crucial that students understand that the harmful influence of scientific Fake News is not restricted to a lower educational, cultural, or economic level. Many individuals with educational, cultural, and economic privileges have more time and access to social media and the internet, making them more susceptible to this insidious phenomenon. This is evident in a host of situations, such as vaccine hesitancy in Brazil (Castilho *et al.*, 2023), where resistance to immunization with the most modern vaccines is more common among the more affluent and educated social strata (Larson *et al.*, 2016). This reality highlights the urgent need to promote media education and critical thinking in all strata of society, so that resilience in the face of misleading information is cultivated regardless of socio-economic status, thus ensuring a more enlightened society that is less vulnerable to the pitfalls of Fake News.

Reflecting on Supposed Intellectual Superiority: It is crucial to address the false idea that rejection of scientific consensus or mainstream sources of information somehow reflects superior acumen. Most of the time this isn't explicit, but it's as if it appears that everyone is looking for it in the traditional media, but since I'm "better informed" and have a better education, I look for the "truth" on social media and I'm not fooled. Students should understand that questioning an individual's educational status quo is not a reliable route to more accurate information and that the search for truth must be based on solid evidence. A dramatic example of this was the significant number of Brazilian doctors who prescribed innocuous medicines and were against vaccination against COVID-19, even with all their educational background, and who often justified these indications because their knowledge was above common sense and traditional ways of being informed. Denying facts from the mainstream media or the scientific consensus does not represent intellectual daring but is often the result of access to misinformation and ignorance of established knowledge. Science develops through critical questioning, but it is crucial to distinguish between this, and baseless questioning based on conspiracy theories or any other false elaboration,

that cast doubt on scientifically established facts, threatening the integrity of scientific knowledge and actions crucial to the preservation of the planet and society. It is therefore crucial that students adopt a responsible and informed approach when questioning established scientific paradigms, always based on solid evidence and intellectual rigor.

Reflection on the Interests Behind Fake News: Students are encouraged to reflect on how commercial (or political, or religious) interests can promote the spread of scientific fake news, exemplified by the case of pharmaceutical companies profiting from false information about drugs against COVID-19 (Bortone, 2021). This highlights the economic implications behind such fake news. It is vital that students understand the complexity involved in the spread of this fake news, which is often permeated by shady interests. When the role of humans in climate change and deforestation is questioned, for example, there are often agendas that seek to justify opening new areas for agribusiness, even when there is no plausible basis. These narratives are often linked to ideological motivations present in political parties and their followers around the world. Political parties and candidates exploit the disbelief of their voters, taking advantage of the influence of social media algorithms to disseminate information without scientific backing. Understanding these nuances is fundamental for students to develop a critical sense capable of discerning between reliable information and the pitfalls of fake news, contributing to a more informed society that is resistant to misleading manipulation.

Breaking the Chain of Dissemination: It is essential to ask students how many members of their family or social circle believe and propagate fake science news and based on this, promote discussions about strategies to interrupt this chain of dissemination and discourage the spread of false information. Students need to understand the importance of breaking the chain of dissemination of fake scientific news from their own social circles. Often, our families, groups of friends, and communities play a significant role in spreading fraudulent information, which can lead to the adoption of risky behaviors, such as the use of ineffective medicines or

those with potentially serious side effects. It is therefore the responsibility of students to act as agents for blocking and raising awareness of this harmful phenomenon. They can play a vital role by promoting the use of fact-checking websites, demonstrating how to use them effectively and spreading the importance of questioning and rejecting fake news. In addition, it is crucial that students highlight the risks associated with adhering to false information within their closest groups.

Communicating the analysis of Fake News: Students should present in class their findings on the formation of scientific Fake News, the reasons for its dissemination and acceptance, and possible strategies for dealing with this phenomenon. It is of the utmost importance that students share with each other their findings related to scientific Fake News, as well as the causes behind its spread and acceptance. By promoting an open and collaborative dialog, students could deepen their collective understanding of this complex phenomenon. Sharing insights into the motivations that drive Fake News, such as political, economic, and ideological interests, provides a more comprehensive understanding of the forces behind this disinformation. Furthermore, by discussing effective strategies to combat Fake News, such as promoting media literacy, encouraging critical thinking, and raising awareness of information manipulation techniques, students can contribute to the development of a more informed and resilient society in the face of this growing threat to the integrity of scientific knowledge. It is also recommended that awareness activities extend beyond the classroom to involve families and community groups, fostering a collaborative network for critical education and misinformation resistance (McGuinness, 2006).

Drawing up Action Plans: The methodology also encourages students to develop comprehensive action plans to combat Science Fake News, actively involving the school, family, and community. This stage aims to enable students to take on roles as agents of change in promoting accurate information and preventing the spread of misinformation. The development of these plans, derived from the activities carried out to understand the extent and dangers of scientific Fake News, plays a crucially

important role. Critical analysis and awareness of the spread of this false information are vital steps in building a more informed society that is resilient to manipulation. Therefore, the creation of concrete strategies to tackle this problem, which may include the promotion of media literacy, the dissemination of information based on scientific evidence and education aimed at critical thinking, is essential to empower students to face this complex challenge and preserve the integrity of scientific knowledge in our society.

As a complementary activity to the two stages of the pedagogical proposal: Have the students watch, or present in the classroom for discussion, the Netflix documentary *The Social Dilemma* (2020) (Diniasti; Haqqu, 2022). This documentary can summarize the previous analysis and demonstrate to the students how the issue of alienation and alignment bias is provided by the algorithms used by social networks. It is suggested that the students reflect on a thought-provoking fact from the documentary: those who created social networks and the technologies that generate them prefer their children to stay away from these digital media.

Possible actions by students at school, based on the FANER methodology.

The application of the FANER methodology, proposed as a way to tackle the challenge of scientific Fake News in an educational environment, requires a multifaceted approach that goes beyond the analysis stages. Education should not only inform but also transform social reality. In this context, combating disinformation through educational means becomes an emancipatory task, grounded in critical literacy and dialogic pedagogy (Freire, 2014). As participants – both teachers and students – follow the path of critical understanding of false scientific information, it is essential that they commit themselves to implementing effective actions aimed at mitigating this phenomenon and cultivating robust information literacy.

1. Reflective presentation of results: The teacher and students should carry out a joint reflection on the way in which they wish to present the results obtained from applying the FANER methodology. These practices resonate with what is defined as “critical literacy”, enabling learners to interpret and produce discourses that reflect

awareness of the social function of information (Soares, 2018). This discussion covers the preparation of rigorous reports, the production of elucidating graphics, and the creation of clear and accessible summaries that can be shared both in the school environment and on digital platforms.

2. Exploring Social Networks as an Educational Tool: An exciting suggestion is to use social networks as a vehicle for disseminating the results of the analysis. Each group of students could be tasked with producing and sharing content resulting from the investigations, with the aim of feeding social pages dedicated to tackling scientific fake news. Critical media literacy involves using digital platforms not only as consumption spaces, but as arenas for student voice, agency, and democratic participation (Kellner; Share, 2019). For this action, it would be important for the teacher to provide guidance on educational websites.

3. Diversification of Digital Platforms: In order to reach a diverse audience, different groups can focus on different platforms, such as creating a YouTube channel, an Instagram page, another on Facebook, among others. In this context, inter-group cooperation is essential for the collaborative production of content, with an efficient division of tasks. From an educommunication perspective, the strategic use of multiple platforms contributes to multimodal learning and encourages interaction with different audiences (Souza Oliveira, Ghisleni, 2020).

4. Engaging the School Community: The entire school community, made up of teachers, staff, students and families, should be called upon to access and interact with the social pages created to disseminate truthful and scientifically based information. Engaging and sharing content contributes to raising awareness and combating Fake News. Fostering collective engagement in media literacy initiatives enhances civic resilience and prepares communities to respond critically to misinformation (McDougall, 2019).

5. Producing Podcasts and Interviews: One team could dedicate itself to creating periodic podcasts related to debunking scientific Fake News. Another team could seek out experts on the phenomenon and conduct interviews that deepen

understanding of the problem, its causes, and consequences. This type of activity promotes not only dialogical construction of knowledge but also skills in verifying, contextualizing and communicating information—essential components of media literacy (Hobbs, 2017).

6. Deconstructing Fake News and Online Verification: Another group of students can take it upon themselves to present the most prevalent scientific Fake News on a weekly basis and then demonstrate how they can be dismantled using verification tools available on the internet, stimulating critical thinking. It was demonstrated that structured media literacy interventions significantly increase students' ability to detect and challenge misinformation (Jeong; Cho; Hwang, 2012).

7. Debunking Conspiracy Theories: Students and teachers can address conspiracy theories that lack scientific foundation, elucidating the reasons for their fragility and presenting how scientific knowledge is built and consolidated to refute them. A key educational challenge in the digital age is to unveil the algorithmic logic that amplifies conspiracy narratives, promoting instead a culture of epistemic responsibility (Calixto, 2025). Show these conclusions about these theories to colleagues.

8. Awareness and Community Involvement Events: The school can promote events to raise awareness about scientific Fake News, involving not only families, but also the entire school community and, as far as possible, the surrounding community. In this way, the aim is to tackle a widespread phenomenon that causes significant damage to society. **S**chools must engage families and local communities in coordinated actions to resist disinformation and co-construct informed practices of knowledge sharing (Almeida Silva, Souza Ribeiro, 2020; Silva, 2021).

9. Reversing the Devaluation of Science and Traditional Media: Teachers and students must recognize that it is possible to undo the contemporary devaluation of evidence-based science, the distrust of traditional media and the overvaluation of social networks and the internet as sources of information. Find ways to present this to the school community and its surroundings, using, for example, ironically, social

networks. Encouraging metacognitive reflection on the credibility of sources can help students deconstruct false equivalencies between scientific knowledge and pseudoscience, reinforcing trust in evidence-based media (Hobbs, 2017; McDougall, 2019).

10. Adaptation to Reality and Context: The FANER methodology proposal can be adopted in its entirety or adapted, complemented, or modified according to needs and curricular availability. The key is that the school and its teachers remain committed to their social responsibility to tackle this pressing problem, which affects human behavior, induces avoidable risks, and promotes alarming levels of alienation in our society. Educational interventions must be sensitive to socio-cultural particularities and curricular realities, adapting their language and strategies to promote true engagement and agency (Soares, 2018).

The approach outlined here represents an ethical and educational commitment to promoting a more aware and informed society, based on actions within the classroom, through an active methodology that promotes student participation in tackling the problem. The fight against scientific Fake News is not only a battle for accurate information, but also an effort to safeguard the integrity of science, the media and democracy.

Results and Discussion

Although the FANER methodology has not been implemented in its entirety in formal research contexts, central elements of the proposal were explored in a punctual manner during teacher-education activities and classroom practices in both Elementary and High School settings. These moments, although not systematized as an empirical study, offer preliminary indications of the pedagogical relevance of the approach and its potential impacts on confronting scientific misinformation within the school environment.

First, it was observed that introducing critical-analysis activities involving content circulating on social media, such as viral videos, sensationalist headlines, and pseudoscientific claims about vaccines, climate, or evolution, generated strong

engagement among students. Their prior familiarity with such material, often already incorporated into their everyday informational repertoire, facilitated the establishment of meaningful connections with the scientific topics addressed, thus enhancing motivation and active participation in discussions. This finding is consistent with trends noted in the literature (Jeong; Cho; Hwang, 2012; Kellner; Share, 2019), which indicate that pedagogical approaches rooted in the media environment of students tend to increase cognitive engagement and foster critical-literacy processes.

It was also noted that comparative exercises involving reliable sources and disinformation platforms helped students identify recurring patterns in the construction of scientific fake news, such as the use of emotionally charged narratives, manipulation of decontextualized data, and appeals to pseudo-authority. Awareness of these mechanisms, even at an introductory level, contributed to strengthening students' ability to question information and mobilize basic verification criteria, aligning with recommendations from media-literacy interventions (Hobbs, 2010; Hobbs; Jensen, 2009).

Additionally, participating teachers reported that structured discussions on the role of algorithms, filter bubbles, and selective exposure improved students' understanding of the technological dynamics that facilitate the spread of false content. This is particularly significant, as it indicates that the methodology may support not only the analysis of content but also the comprehension of digital infrastructures that condition informational behavior, a point emphasized as essential by contemporary authors (Buckingham, 2023; de Sousa Marquêz, 2024).

Finally, in activities focused on creating communicational products, such as podcasts, short videos, posters, or online posts, students demonstrated interest in acting as disseminators of evidence-based information. This suggests that FANER has potential to promote epistemic responsibility and civic participation. The literature indicates that media-production practices within the school context can be effective strategies for combating misinformation, as they combine creative expression,

community engagement, and the development of critical media competencies (McDougall, 2019).

Taken together, these preliminary observations suggest that the FANER methodology, even when applied partially and exploratorily, shows promising potential to promote critical thinking, scientific literacy, and informational autonomy among students and teachers. However, these findings are descriptive in nature and do not result from a systematic process of data collection or analysis. Future studies, conducted with more robust research protocols, will be essential to more precisely assess the effectiveness and limitations of the proposal across diverse educational contexts.

Conclusions

The FANER methodology, as presented, constitutes a consistent and necessary didactic–methodological proposal in light of the growing impact of scientific misinformation on school environments and teacher education. Throughout the article, it was demonstrated that the spread of false information on scientific topics, particularly those related to health, climate, evolution, and pseudoscientific controversies, has produced significant effects on the perceptions, attitudes, and pedagogical practices of both teachers and students, thereby requiring structured educational responses.

FANER proposes a formative pathway that integrates critical media analysis, evidence-based conceptual reconstruction, and the production of communicational interventions aimed at the school community. This organization allows the articulation of conceptual, procedural, and attitudinal dimensions, fostering the development of scientific literacy, informational autonomy, and critical-thinking skills. The description of the methodology's stages highlights its flexibility, making it applicable to different educational levels and disciplinary areas.

Although it has not yet been fully implemented as an empirical study, elements of the proposal explored in teaching practices and teacher-education activities indicate its pedagogical potential. Preliminary observations suggest that the methodology elicits

high student engagement, enhances their ability to identify rhetorical patterns of misinformation, and contributes to a deeper understanding of the sociotechnical dynamics that shape the circulation of false content. These indications reinforce the relevance of FANER as an educational tool for confronting scientific misinformation.

It is recognized, however, that this is an initial construction, developed from professional experience and grounded in consolidated theoretical foundations. Thus, FANER should be understood as a starting point for future, more systematic investigations that evaluate its effectiveness, examine its limitations, and allow for the refinement of its stages. Empirical studies may, for example, analyze students' conceptual learning, measure changes in epistemic attitudes, investigate impacts on teacher training, and identify institutional conditions that facilitate its implementation.

Thus, the FANER methodology contributes to strengthening the role of the school as a privileged space for scientific and critical education, providing tools for teachers and students to understand, analyze, and confront misinformation in an informed and reflective manner. By promoting investigative, reflective, and communicational practices, FANER aligns with contemporary efforts to build an education committed to science, informational democracy, and the development of citizens capable of navigating the complex digital ecosystem of the twenty-first century with discernment.

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