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New Evidence of the Effect of Literacies in Reducing Disinformation and Fake News

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ABSTRACT

Context: The production of scientific knowledge is not clearly understood by most individuals. In the information age, society faces challenges generated by discrediting institutions, including science, the proliferation of false news, disinformation and the relativisation of truth. These are significant issues that the school cannot refrain from discussing if it wants to educate for citizenship. **Objectives:** To investigate how conceptions about science influence and are influenced by fake news conveyed by the media and the contribution of literacy to minimise the effects of misinformation. **Design:** The methodology used in this research used a mixed-methods approach through content analysis of students' responses combined with descriptive statistical techniques. **Environment and participants:** The research was carried out with 32 students, divided into two groups, attending the 9th grade of an elementary public school in Bom Princípio/RS. **Data collection and analysis:** Two questionnaires were applied: one for the conceptions about science and another to identify fake news. **Results:** Most students have a limited view of science and find it difficult to identify fake news through verification criteria. A correlation between student perceptions and the identification of false news was observed. **Conclusions:** Knowledge about science possibly enhances students' perception of doubtful information. It is crucial to develop mediatic and information literacy skills as they can positively impact the identification of fake news and reduce its shares.

Keywords: Fake news; Nature of science; Science teaching; Disinformation.

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Nova evidência do efeito das literacias na redução da desinformação e das fake news

RESUMO

Contexto: A produção do conhecimento científico não é claramente compreendida pela maioria dos indivíduos**.** Na era da informação, a sociedade enfrenta desafios gerados pelo descrédito em instituições, inclusive a ciência, a proliferação de notícias falsas, desinformação e relativização da verdade. São questões significativas às quais a escola não pode se abster de discutir se desejar formar para a cidadania. **Objetivos**: Investigar de que forma concepções sobre a ciência influenciam e são influenciadas pelas *fake news* veiculadas pelas mídias bem como a contribuição das literacias para minimizar os efeitos da desinformação. **Design**: A metodologia utilizada nesta pesquisa utilizou uma abordagem de métodos mistos mediante análise de conteúdo das respostas dos estudantes combinada com técnicas de estatística descritiva. **Ambiente e participantes**: A pesquisa foi realizada em duas turmas de alunos do 9º ano do Ensino Fundamental, com 32 alunos, em escola da rede estadual em Bom Princípio/RS. **Coleta e análise de dados**: Foram aplicados dois questionários: um para as concepções sobre a ciência e outro para identificação de fake news. **Resultados**: A maioria dos alunos possui uma visão limitada sobre a ciência e tem dificuldade em identificar fake news mediante critérios de verificação. Foi observada uma correlação entre as percepções dos estudantes e a identificação de notícias falsas. **Conclusões**: O conhecimento sobre a ciência aparentemente potencializa a percepção dos estudantes sobre informações duvidosas. É essencial desenvolver habilidades de literacias científica, midiática e informacional, pois podem impactar positivamente a identificação de fake news e redução de seus compartilhamentos.

Palavras-chave: Fake News; Natureza da Ciência; Ensino de Ciências; Desinformação.

INTRODUCTION

We live in the age of science (Granger, 1994), of voluminous and instantaneous information dominated by the mystique of number (Mattelart, 2006) and networks (Castells, 2014). But these are also times of uncertainty (Meirelles et al., 2013), where truth and lie have become ambiguous (Keyes, 2004). Those factors make us wonder whether we are experiencing a time of change or living a change of time (Bursch, 2005)?.

Credibility and trust in institutions such as science are questioned. Increasing levels of disruptive communication (Bennet & Livingstone, 2018), dissemination of fake news, conspiracy theories (Douglas et al., 2019; Enders

et al., 2021), and denialism (Diethelm & Mc Kee, 2009; McIntyre, 2020) feed on disinformation (Wardle & Derakhshan, 2018) that -paradoxically in an information age- competes strongly with scientifically proven facts and knowledge.

Being an institution inserted in this social context, the school cannot remain on the sidelines of these transformations and their implications for society. Cachapuz (2012, p. 14) defends the development of a scientific culture that allows "to participate in rational decisions, to minimally understand the most complex decision-making processes and the sense of techno-scientific development".

Thus, the need to incorporate aspects of the nature of science (NdC) into Science Education, according to assumptions of several authors (Durbano, 2015, Lederman, 2006, Cloug, 2000, McComas et al., 2002). The construction of scientific knowledge is an assumption present in several documents of scientific education standards, as it is considered that this understanding is crucial to scientific literacy (Clough & Olsson, 2004).

On the other hand, disinformation has become a weapon for creating and propagating half-truths or even false information, characteristic of fake news. In a developed technological structure scenario and users eager for active participation in information practices, the false news found fertile ground for its propagation (Oliveira & Souza, 2018).

That scenario leads to minor positive substitutions: rationality threatened by emotion, diversity by nativism, freedom by autocracy (D'Ancona, 2018), characteristic of the post-truth phenomenon that transformed the notion of fluid truth, shaped by the personal view and beliefs of individuals or social groups, either in a relativistic perspective (Villa, 2010) or through a perspectivist view (Massimi & McCoy, 2020).

These factors act by undermining the ability of individuals and society to make choices based on reliable evidence. For Frau-Meighs (2017), in the context of digital use and misuse of information, literacies – scientific, media, information - can help facilitate the digital transition, since democratic societies are subject to pressures from both the ubiquitous media and big data.

The considerations presented guided the hypothesis that there is a relationship between the individuals' conceptions about science and susceptibility to the manifestations of disinformation. The objective of this study was to investigate how those conceptions influence and are influenced by

the fake news transmitted by the media, and the contribution of literacies to minimise the effects of disinformation.

THE NATURE OF SCIENCE AND THE TEACHING OF SCIENCE

Science is a human enterprise, historically constructed and directed to the search for truth (Matthews, 2015). Science is inserted in a historical context, influences and receives influences from the needs of this moment, by the political, social, and cultural factors of this society (Durbano, 2015), impacting practically all aspects of modern life (McComas et al., 2002).

For Durbano (2015), science teaching must take into account the historical and collective construction of scientific knowledge, the technological advances incorporated into people's daily lives and their influence on society. The Nature of Science (NdC) construct, according to Clough et al. (2010), typically refers to issues related to what science is, how it works, its epistemological and ontological foundations, how scientists operate as a social group, and how society influences and reacts to scientific work.

Table 1

Arguments on the importance of the NdC (Lederman, 2006)

Aspect	Understanding the NdC is important for
Utilitarian	giving meaning to science and managing objects and technological processes in everyday life.
Democratic	an informed decision making on socio-scientific issues.
Cultural	appreciating the value of science as part of contemporary culture.
Moral	developing an understanding of scientific community norms that incorporate moral commitments that are of general value to society.
Education	facilitating the learning of science content.

When considering the inclusion of the NdC in several educational documents as a crucial component for scientific literacy, Lederman (2006), supported by arguments of Driver et al. (1996), establishes a justification for the importance of NdC. These arguments are shown in Table 1.

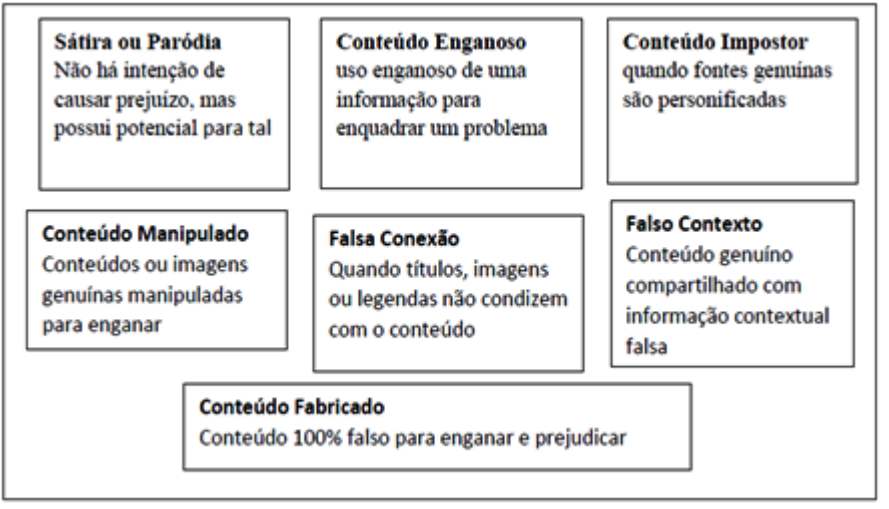
Forato (2009) expresses that knowledge about the sciences, their assumptions, validity limits, and contextual influences constitutes a form of development of reflective and critical thinking about the characteristic dogmatism of science teaching.

IN THE SEA OF INFORMATION, THE WAVES OF DISINFORMATION

In the current informational context, the quantity and speed of propagation of the messages that are being copied, disseminated, reproduced and amplified is a decisive factor in the digital culture. And this propagation, without any filtering or selection criteria as to the validity of the content, spreads just like a contagious infection, a phenomenon called information zombification (Leite & Matos, 2017).

Figure 1

Classification of types of disinformation. (Wardle & Derakhsshan, 2017)



This informational avalanche favoured the creation and replication of distorted or biased news and information, the fake news, present in the most diverse contents of human interest. According to Martins (2018), scientific information is most impacted in the digital world. This is because scientific news relies on the information of both public and political interest and also depends on research, theses, and scientific analysis.

Pennycook and Rand (2019) consider fake news to be information that mimics the form of media news, but not in its organisational process or purpose. They constitute a subgenre of the broader category of disinformation.

Much of the speech about fake news brings with it the notion of disinformation. Disinformation is distinguished in three distinct aspects:

a) **Disinformation**, false information deliberately created to harm a person, social group, organisation or country;

b) **Misinformation**, false information created without the intention of causing harm;

c) **Malinformation**, being genuine information shared to cause harm, transferring private information in the public sphere (Wardle & Derakhsshan, 2017).

Figure 1 presents the seven types of disinformation in Wardle and Derakhsshan's (2017) classification.

According to Del-Fresno-Garcia (2019), disinformation and fake news constitute information disorders. Farkas and Schou (2018) argue that, gradually, the fake news became a floating signifier, that is, a signifier used by political projects as a means of building political identities, conflicts, and antagonisms. Regardless of the definition assigned, what they generally have in common "is the way fake news appropriates a real appearance, the way *websites* are presented, the way content is written, and the way photographs are shared" (Sintra, 2019, p. 11), constituting a deliberate way of disinformation and manipulation of the truth.

Levitin (2016), however, categorically states that truth matters and that the age of post-truth is a time of obstinate irrationality, which subverts many of the great advances that humanity has conquered. For Keyes (2004) argues that:

> As the only species that can really speak, *Homo sapiens* is the only one that can lie out loud. This ability gave the first human

> beings a great evolutionary advantage. They had already demonstrated their mastery of the deceptive arts by hunting prey with cleverly concealed traps or tricking them into running to cliffs. As the human ability to speak developed, so did our ability not only to deceive prey and to deceive predators, but also to lie to other humans. (Keyes, 2004, p. 22)

The possibility of permanent access, instantaneity, collaboration, and continuous production allows each user to become a potential producer and replicator of information (Oliveira & Souza, 2018), generating a "concern with the veracity and reliability of information disseminated on the web, which end up forming opinions and building alleged knowledge, based on false or inaccurate information (Leite & Matos, 2017, p. 2336).

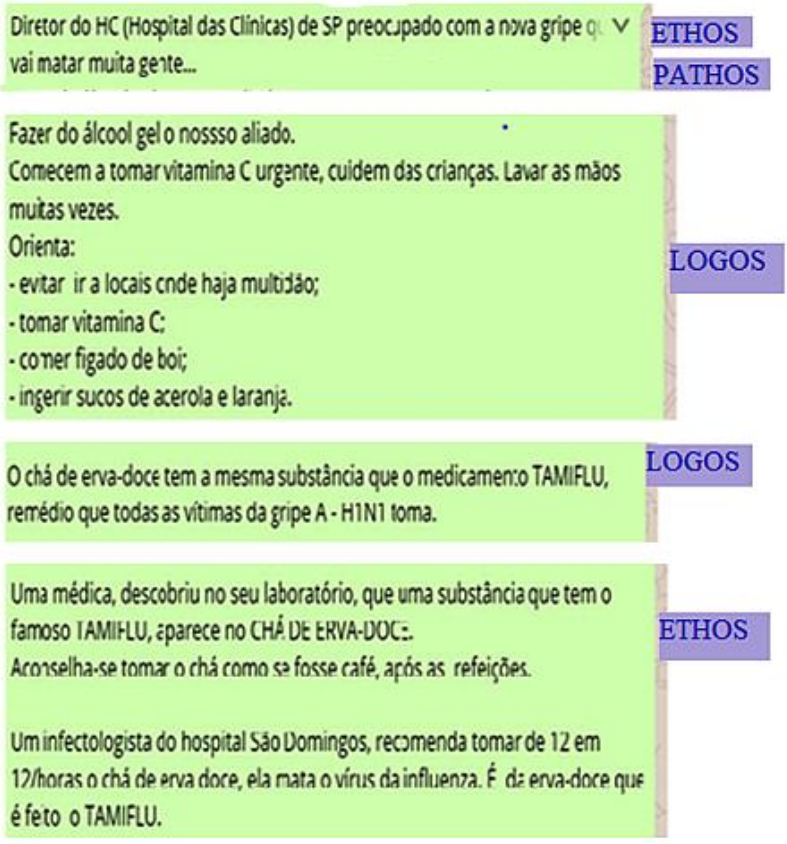
D'Ancona (2018) recalls that the art of deception already existed in primitive societies, but what characterises this era of post-truth is the public's response to this problem: "indignation gives way to indifference and, finally, to connivance" (D'Ancona, 2018, p. 34) making lying a rule instead of an exception.

Gomes et al. (2020) indicate a factor thought around 350 BC favouring fake news credibility. They refer to the persuasion that, according to Aristotle, is dependent on three variables: *logos*, *pathos*, and *ethos*. According to Seixas (2019), the *ethos* instance refers to how the subjects that produce the discourse show themselves as competent, responsible for putting themselves in the condition of reducing the distances between the different individuals. The *pathos* represents the dimension of the discourse recipients and their emotions related to a given issue. The role of *pathos* is to solve the questions of the discourse recipients by managing their emotions. Finally, *logos* refers to the logical way the speakers express themselves through discourse (Gomes et al., 2020).

In Figure 2, we present an example of how false news can be configured in the variables indicated by Aristotle. The fake message circulated on social networks in 2018 and was recently shared again.

Figure 2

Persuasive structure evidenced in fake news. (Adapted from Gomes et al., 2020)



Besides the fake news, another element "leads to misinformation, causes doubts about the content, and causes errors, sometimes used by online media, with priority on social networks" (Pedro et al., 2019, p. 31): the clickbaits in ad titles. The objective is to increase access to the content produced to enhance the increase in advertising. They are formulations of a sensationalist character or even omissions aiming to deceive the reader. We consider that the artifice used in this type of ad has characteristics of fake news. For Wei and

Wan (2017), to attract clicks, online news editors use several strategies to make their headlines captivating. Figure 3 presents an illustrative headline.

In this message, it seems that the Pentagon admits the existence of UFOs, sharpening readers' curiosity and, in a way, reinforcing the belief of individuals who believe in extraterrestrials. By clicking on the title, one goes to the news itself and, only at the end, it clarifies what the Pentagon understands by unidentified flying objects.

Figure 3

Sensationalist headline. (https://www.istoedinheiro.com.br/pentagono-diz-que-ovnis-representam-risco-para-a-seguranca-nacional/)

D'Ancona (2018) warns that, given the information overload, we must filter, check, and evaluate what we read – and share. This stance is essential because, as Keyes (2004) states, there are no longer truths or lies, but rather a third category of ambiguous information, located in an ethically grey area, which enables people to conceal themselves, without, therefore, considering themselves dishonest. Individuals tend to accept statements that fit facts stored in memory and reject incompatibilities (Brashier & Marsh, 2020). In this regard, several influential factors in the acceptance, credibility, and sharing of fake news were identified. Figure 4 presents some of those factors.

Wurman (1991) mentions selective processes of our memory to deal with information. According to the author, those processes are divided into four defence circles, as we tend to "perceive things that relate to our pre-existing interests and attitudes, either to reinforce them or to refute them" (Wurman, 1991, p. 265). Consciously or not, we tend to discard information that contradicts our interests and attitudes.

Figure 4

Factors that influence the credibility and sharing of fake news.

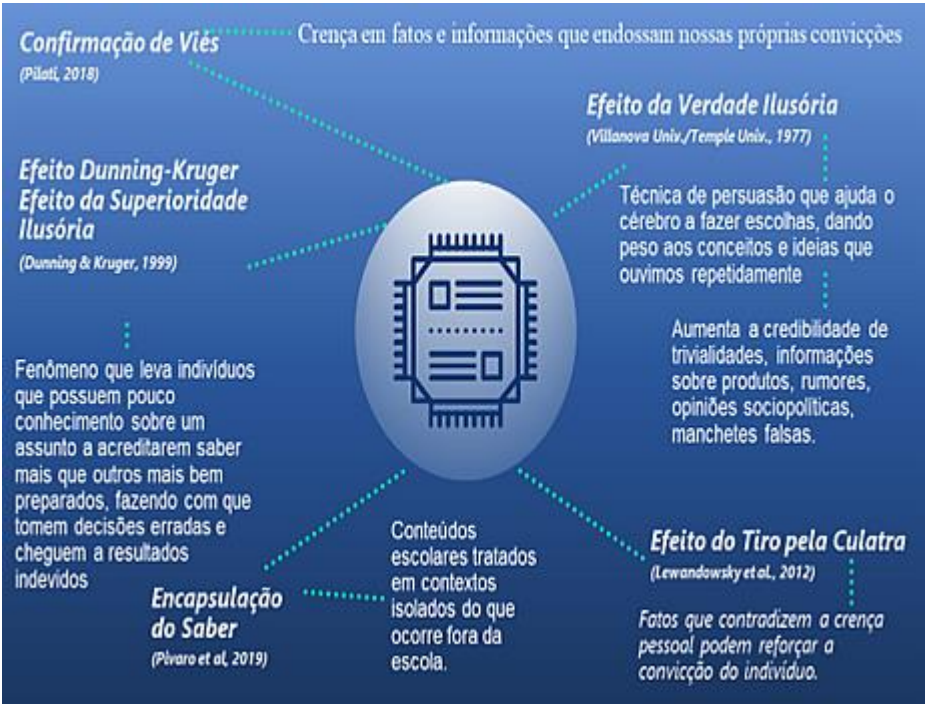


Figure 5 presents the four defence circles of our memory.

Thus, our perceptions are, as a rule, polarised by our points of view. For Bruno and Roque (2019), the thesis that people pass on false news because they believe it to be true is simplistic since news that generates trust does not necessarily have to be true. Studies (Lewandowsky et al., 2012) show that information initially considered valid continues to influence people's judgment, even if it is proven false.

Greifeneder et al. (2021) confirm that social media sites decide their users' news feed through algorithms. The details of those algorithms are unknown to users and undergo frequent changes, and it is only known that the algorithm favours information that fits the user's preference profile. The resulting filter bubble (Pariser, 2011) presents broadly consistent information that reinforces the user's worldview and presents few challenges, leaving users confident that their own opinions are correct and the opinions of others, at best, wrong and, at worst, malevolent.

Figure 5

The four circles of memory defence in selective processes. (Wurman, 1991)

Shao et al. (2017) consider that a complex mixture of cognitive, social, and algorithmic biases contributes to our vulnerability to online disinformation manipulation. They claim that even in an ideal world, where individuals tend to recognise and avoid sharing low-quality information, "information overload and infinite attention limit the ability of social media to discriminate information based on quality" (Shao et al., 2017, p. 2). As a consequence, online disinformation is as likely to go viral as reliable information.

Latour (2000) presents the concept of translation of interests, which we also believe serves to understand phenomena inherent to the context of post-truth. The author states that "we need other people to help us transform a statement into a fact" (Latour, 2000, p. 178), and the best way to achieve this objective is to adapt the object in a way "that it meets the explicit *interests* of these people" (Latour, 2000, p. 179), i.e., what is between the actors and their objectives. Similar to the confirmation bias, this translation of interests will lead to a convergent selection for what, in their opinion, helps them to achieve those goals.

On the other hand, post-truth times favoured the strengthened resurgence of pseudoscience. For Marcos and Rovira (2014, p. 1), "the presence of pseudo-scientific content in the media reflects the problem of the toxic capacity of the media system" because the massive amount of information to which we are submitted produces an informational overload of difficult assimilation and decoding. In this context, we understand pseudoscience as a set of practices that:

> (1) seeks to take possession of scientific status (2) exposing isolated, undemonstrable and subjective results, (3) obtained in an uncritical, unsystematic, interested, and inaccurate manner, (4) to generate knowledge that is neither cumulative nor scientifically valid, that (5) acts in areas where science does not reach or where it has not offered satisfactory results and that (6) is usually skilled in dealing with the media and the emotions of the public. (Marcos & Rovira, 2014, p. 2

Pivaro et al. (2019) consider that theories such as flat-Earth and the anti-vaccine movement, for example, are examples of discontinuity between learning in school and cognition outside it. In Branco's view (2017), it is essential to invest in education so that students learn to distinguish false information shared on the internet more clearly.

EDUCATIONAL CHALLENGES IN THE (DIS)INFORMATION AGE

The construction of a citizen formation requires autonomy of the subject to critically elaborate their views on reality, which means not living passively, naively accepting anything that is presented, having a voice and making oneself heard in this discursive plot (Gomes et al., 2020). In this sense, citizens must be given the necessary skills to understand the world adequately

(Moreira, 2021) and participate actively in decision-making processes. Those competencies are related to the concepts of learning alphabetisation, reading skills, and literacy (*alfabetização*, *letramento* and *literacia*) that, although they admit a range of definitions, are essential for the achievement of full citizenship. Thus,

> Education - largely as part of developing life skills and specifically in the culture and methods of science - is an essential part of the long-term solution, so that young people are equipped with the knowledge, skills, and tools to be able to criticise/examine the information and assess its veracity. (Hopf et al., 2019, p. 5).

Most young people no longer get their information only within classrooms (Larkin, 2017) but are increasingly seeking it mainly on social media (Hopf et al., 2019). Considering that media do not always offer reliable content, it is necessary to face this problem through the development of literacies.

Currently, as at no other time in our history, however, the threat of disinformation is at its highest, and this also applies in the field of education" (Kendeou et al., 2019). In this regard, education plays an important role, but this does not mean that the only responsibility to solve these problems is education (Kendeou et al., 2019, Feinstein & Waddington, 2020), as the solution requires combined regulatory, social, technological, and educational measures (Barzilai & Chinn, 2020).

The report of the Commission on Fake News and the Teaching of Critical Literacy Skills in Schools (National Literacy Trust, 2018) pointed out that, in the United Kingdom, 46% of young people aged 12 to 15 use social media to access online news claim to have difficulty telling whether social media news is true or not. Coiro et al. (2015) warn about the deficiencies evidenced in high school and university students in evaluating internet sources and the consequent lack of questioning of the accuracy of the information obtained from those sources.

At the same time, rapid developments in the online news ecosystem, such as the increasing role of advertising and algorithms in determining news feeds and search results, can be challenging to understand, even for adult news consumers. (National Literacy Trust, 2018)

Faced with those challenges, Lord and Vogt (2021) argue that we need to invest more in human-centred solutions, focused on improving people's

education in the media and information. Not only do they demonstrate a much deeper, longer-lasting impact, but they can also be easier and cheaper to implement than is commonly believed.

Different forms of literacy have been pointed out as desirable and necessary resources for a critical formation of individuals, especially students. Literacy derives from the Latin *literatus* and generally refers to skills required for good social performance. For Santos et al. (2016, p. 38), "the person who manages to obtain adequate skills to use and utilise information resources accurately, effectively, and critically will certainly become more efficient and effective in their choices".

Competence to use the accessed information is relevant when considering the degree of literacy of the population and the relationship of individuals with false or distorted news and information. Data from the National Household Sample Program (Programa Nacional de Amostra por Domicílio - PNAD) (IBGE, 2019), the illiteracy rate is still high, affecting more than eleven million Brazilians – and functional illiterates are not included in this data. Associated with the low educational level of a considerable part of the population, the ability to critically understand the information becomes a problem that cannot be neglected.

Such challenges are not limited to a simple solution equation, since the qualities of distorted narratives are increasingly constructed in an elaborate way and mimic reliable news. Add to this the growing distrust in science, especially when it comes to scientific issues that have become politically contested, such as climate change, vaccines or genetically modified organisms (Wikforss, 2019).

In this work, we preferentially adopt the term literacy to refer to the skills that favour significant and critical reading and analysis of the world that is presented to us, in three categories: scientific and mathematical, mediatic, and informational, as pillars for the engagement of the individual in society and with conditions to position themselves in the face of contemporary challenges, including post-truth and fake news.

The definitions of literacy are varied, and even new will come in the light of the new contexts of scientific and technological development. Likewise, new technologies will continue to impact education and how teachers handle literacy tasks (Pilgrin & Martinez, 2013). Table 2 presents some definitions proposed for the literacies considered in this work.

UNESCO (Wilson et al., 2013) proposes a unification of two distinct areas in a single concept: media and information literacy or AMI, to incorporate essential knowledge about the functions of the media and other information providers in society, for example. Frau-Meighs (2017) argues that AMI should include among its concerns what data does with the media, since user information is captured through the regulation of algorithms linked to people's search history.

Table 2
Definitions for scientific, mathematical, mediatic, and informational literacies.

Literacies	Definition
Scientific Literacy	Ability to examine problems from different perspectives and look for explanations for different phenomena with a sense of critical analysis. (Cachapuz, 2012)
Mediatic Literacy	Ability to access the media, to understand and critically evaluate different aspects and media contexts, as well as to create communications in different contexts. (Mc Dougall et al., 2018)
Informational Literacy	Ability to recognise when information is needed and to locate, organise, evaluate, and ethically use information. (Wilson et al., 2013)
	Ability to use mathematical knowledge to solve everyday life problems – specifically knowledge related to numbers and numerical operations and the ability to interpret statistical information. (Ponte, 2002)

Current science teaching may not provide students "with a good enough understanding of how authentic scientific research is conducted, in all its complexity and confusion, and how scientific evidence is produced and evaluated" (Barzilai & Chinn, 2020, p. 111). According to these authors, science education may also be neglecting the competencies that scientists can employ in their everyday interactions with science, as well as collaboratively using science to solve complex real-world problems (Feinstein & Waddington, 2020).

In this sense, Latour (2000) considers that many of the questions raised by scientists from different areas of study, when thinking outside their respective networks, now present a different form. Thus, one should seek answers to the question about how "there are still people who believe in all kinds of absurdity" (Latour, 2000, p. 299) and why even educated people believe in things that obviously do not exist.

Barzilai and Chinn (2020) consider that current education may be aggravating the problems inherent to the context of the information society and the post-truth by not offering students sufficient opportunities for the development of relevant skills, especially in terms of civic education, media literacy, and critical thinking.

In this sense, Tenreiro-Vieira and Vieira (2013) consider that, despite the relevance attributed to critical thinking in education, there is still no consensus on the meaning of the expression. In different perspectives, however, critical thinking is related to the idea of a rational, reflective way of thinking, assessment of the results of thought, and transposition of information.

Reflective thinking, stresses Wikforss (2019), can be used in motivational reasoning, i.e., in situations where, as humans, we tend to do what we can to cling to beliefs that, although lacking in foundation, we wish to perpetuate by a need to adhere to them. This is independent thinking, but it is not strictly critical, precisely because it is not directed towards precision.

Frau-Meighs (2017) emphasises that critical thinking must understand the added value of digital considering participation, contribution, transparency, and responsibility, as well as disinformation and the game of influences. For the author, the subject who thinks critically can act to exercise resistance to ideological propaganda and conspiracy theories.

Thus, it is essential that in the educational process, several literacies are developed to allow the student to become a critical and conscious participant of their society, being able to face the scientific, technological, social, and cultural challenges in an efficient and participatory way. In this approach, scientific education combined with the development of literacies "must be an instrument for raising awareness about the world's problems and for understanding everyday realities and, above all, for acting on them (Tenreiro & Vieira, 2013, p.181).

METHODOLOGICAL PROCEDURES

We present in this study the partial data of ongoing research whose objective is to investigate how those conceptions about science influence and are influenced by the fake news transmitted by the media and the contribution of literacies to minimise the effects of disinformation.

To obtain those data, we used two questionnaires, as characterised below.

For this research, we adopted a methodology based on mixed methods through a combination of quantitative and qualitative data and techniques.

Our research involved thirty-two students of the final grade of an elementary public school in a municipality of Rio Grande do Sul, Brazil. The data was collected from two questionnaires. To identify conceptions about the nature of science, we used the VNOS-E, a tool developed by Judith Lederman and Eun Kyung Ko, a specific version for elementary school students. The identification of fake news was evaluated through an instrument based on Hunsberger (2017).

The students' answers were analysed based on reference milestones (Lederman et al., 2002; Akerson & Donelly, 2009) to evaluate the adequacy of students' perceptions in the questions that constitute the instrument. We considered a classification in three dimensions of students' understanding of the topics of the NdC (Yoon et al., 2014): a) inadequate knowledge, without understanding, or a naive perception was for responses that showed a lack of understanding in relation to the subject, b) adequate vision, when the student showed some understanding of a concept but also showed persistent misconceptions and c) informed vision, of developed understanding, when the response showed a complete understanding and a lack of contradictory responses. A value of 0 was assigned for unclassifiable, 1 for inadequate, 2 for adequate, and 3 for informed answers.

Table 3 shows examples of answers given by students to the different questions of the VNOS-D+ questionnaire and their classification according to those criteria.

Table 3

Classification of students' responses according to the dimension of knowledge on topics of the NdC.

Question	Inadequate Vision	Adequate Vision
In your view, what is science?	- Science is everything - Accurate or theoretical study on certain subjects - It is the future - That is what makes things interesting	- Science is the study of topics such as living beings, nature, among others - It is knowledge about nature's phenomena.
How are the science contents different from those other contents?	- Science explains everyday things better - Science is more accurate	- They are based on observation in real facts; they are tested to prove the veracity
Scientists are always trying to learn more about the world. Do you think that what scientists know could change in the future?	- Perhaps, it is not known what will happen in the future	- Knowledge can change through new discoveries and technologies
How do scientists know that dinosaurs lived on Earth?		- Scientists are quite sure about the existence of dinosaurs because of evidence (fossils)
How sure are scientists about what dinosaurs look like? Why?	- It is not possible to be very sure about the appearance of dinosaurs based only on the fossil evidence	- The evidence gives a lot of certainty to scientists about the appearance of dinosaurs

If scientists know the same facts about the extinction of dinosaurs, why do you think they disagree on this issue?	- Each scientist has their own point of view and only accepts their own theory - Because scientists were not present at the time	- Because there may be different evidence that can provoke different ideas
How sure do you think meteorologists are about the figures (maps) they present? Why?	- Meteorologists are very sure because of the equipment they use to predict the weather	- They are not very sure because the weather conditions are often unpredictable
Do you think scientists use imagination when doing their work?	- No, because they need to be objective and very focused	- Sometimes they need to imagine something before they're sure

The data obtained demonstrate that many students do not fully understand aspects of the nature of science, such as a) the empirical character of science, b) the provisionality of scientific knowledge, c) observation and inference, d) creativity, e) subjectivity (YOON et al., 2015).

Table 4

Units and categories of analysis of question 1 of the VNOS-E questionnaire

Analysis Unit	**Primary Category**	**N**
It is a study	- Of the Planet/the world	2
	- Of the nature	5
	- Of living and non-living beings	9
	- Of the technologies/inventions	4
	- Of the theories	2

It is an explanation	- For everything/almost everything in the world	1
	- Of how things work	1
	- Of the causes of the events	
	- About humans	2
	- Of the cure of diseases	1
	- Of the development of the world and humanity	1
It is all / It is the future		2
It is solving questions that many think had no answer		1
Learning everyday things in a more complex and in-depth way		1
	Total	**32**

In the analysis of the answers given to question 1, six units of analysis were constructed, which we describe in Table 4.

We observe in several answers the association of science with curricular contents, notably the "study of our planet, and everything related to nature" (Student 1). In this regard, there is a lack of reference to natural phenomena and physical and chemical transformations of materials, subjects that were being addressed in this series during the school year. Only four students cited the association of science with innovations and technologies.

Similar results were obtained in a survey conducted by Reinke and Sangiogo (2017). For the authors, the curriculum and the organisation of the teaching of the discipline of natural sciences are characterised by a tradition strongly supported by textbooks, and that contributes to the view that students make of science in association with nature and excluding chemistry and physics – whose initial concepts are studied in the final grade of elementary school – from this disciplinary field.

Another aspect that we consider relevant is the distinction made by several students between the study of living/non-living beings and of nature. Possibly students do not have a clear perception of the interrelationship between the environment/nature and its elements. This fragmented view may

stem from the compartmentalisation of curricular contents, which does not favour a more integrated view of the various contents studied.

In some answers, it is also possible to perceive the notion of science as something magical and infallible, as is evident in the statements of student 11, "just as religion, science is a way of explaining the world", or in the view of student 15, for whom "science is everything because it discovered almost everything". Those statements possibly imply the idea of absolute certainty of scientific knowledge, capable of explaining everything satisfactorily.

In general, students presented great difficulty in expressing their conceptions about science, but the traditional, positivist view of science as capable of explaining natural phenomena unfailingly and constituted by a set of exact and a-historical knowledge predominates, as can be seen in student 7's conception, for whom science is "an exact or theoretical study on certain subjects".

The second questionnaire used in the research consisted of ten questions in two blocks. The first block consisted of nine closed questions - six multiple-choice questions and three with a Likert scale -, to investigate the students' perceptions and attitudes about the dissemination of scientific news in different media and their habits and preferences of information consumption.

The data obtained indicate that 96% of students seek information through websites or on social networks. However, 60% of the participants considered those very media as the least reliable in news dissemination.

We found that 37.5% of the students would probably trust some scientific news that contradicts the concepts learned in class, while 44% would not.

Regarding the elements of a news piece, students were asked to assign a score from 1 to 6 to each element presented, 1 being the least important and 6 being the most important. The sum of those scores indicated that, in general, the most important factor for the students corresponded to the person who shared the news, i.e., confidence in the information directly related to the individual who passed it on. The title of the news was considered the least significant element. And the source of information obtained only the fourth score among the six possible.

This data, to a certain degree, is supported by Larkin's (2017) argument that students do not obtain more information only in the classroom or reliable media services, but turn to social media sites as sources of learning about the

world. Stanford Research Group (Wineburg & Mcgrew, 2017) points out the students' difficulty deciphering the information they find online. Little do they understand that the websites they use have reputational limits.

The tenth question constituted the second block and presented eight news and images obtained on websites or disclosed in the *Whatsapp* app. Students were asked to indicate with the letter V or F if they judged the news to be true (V) or false (F), respectively. In case of doubts or if they are not confident to assign the V or F, the student could indicate the letter I (to be investigated).

The reliability – or not – of the selected information was initially consulted on specialised websites for fact-checking. In this research, we selected the Fake Check, Boatos, Ministério da Saúde, and Agência Lupa *websites*.

When a news item did not find a corresponding result on any of the *websites* listed above, as occurred with the news (A, C, and E), other sources of confirmation were sought and considered reliable in news dissemination. In news A and E, we adopted the classification 'true, but' due to the fact that no other source was found than the one that disclosed the fact, such as news A, or because it was not possible to fully confirm, as in news E. The answers given by the students were also assigned scores according to the following criterion: 0 = did not answer/identified incorrectly; 1 = identified, but did not justify, 2 = would verify, 3 = identified and justified.

The selected news, its themes, checking, and classification are presented in Table 5.

Table 5

News selected for the instrument and its characterisation.

News	Theme	Source	Verifier	Classification
A	Benefits of the pinion	G1	-	True, but
B	Contaminated milk	Bligz	Boatos.org	False
C	Plastic trash in the Arctic	Observatório do clima	Deutsche Welle	True

D	Human chimaeras created in laboratories	Chris Loterina	Fake Check	False
E	Nutella can cause cancer	Superinteressante magazine	Proteste.org	True, but
F	The key rings blow	Whatsapp	Boatos.org	False
G	Threat of the planet Naburu	Unknown	Boatos.org	False
H	Adidas promotion	Facebook	Boatos.org	False

The data set showed that students have not yet developed consistent criteria for identifying news characterised as fake news. This finding is confirmed in McGrew et al. (2017)'s study, which concluded that young people find it difficult to evaluate information from the internet. For those authors, the credibility of information for citizenship is as important as air and pure water for human health.

In this sense, "scholars argue that teaching and learning to use online news in critical and constructive ways is absolutely essential for an informed and engaged citizenship" (Nygren & Guath, 2019, p. 23). Concepts such as digital literacy, media literacy, and digital competence are necessary aspects to access, analyse, evaluate, and create *online* information (Nygren & Guath, 2019).

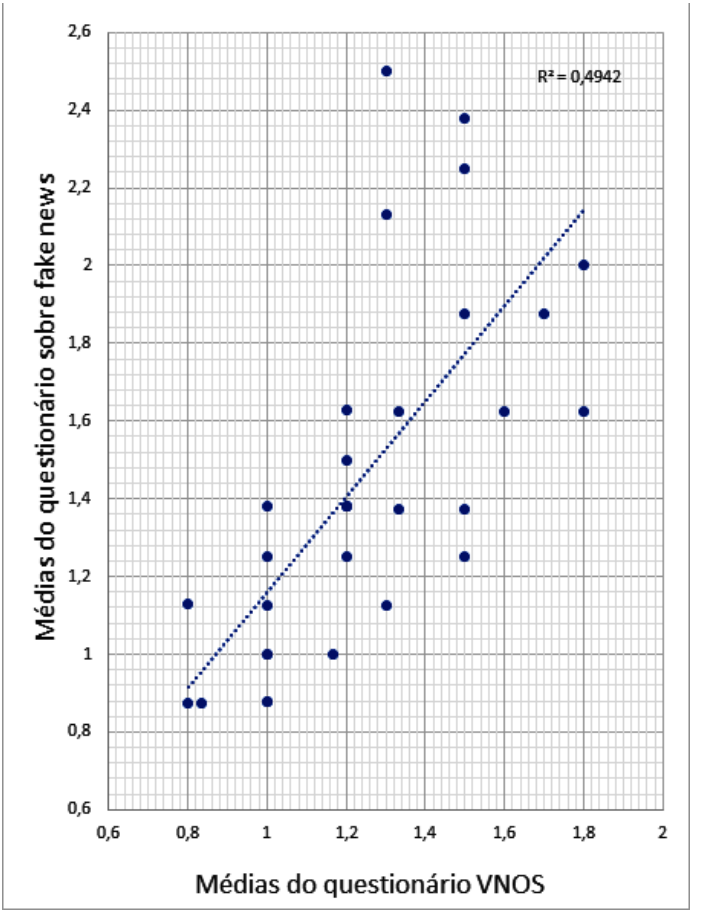
Another relevant aspect refers to the immediacy of information consumption, characteristic of this generation of digital natives, which probably influences the difficulty of articulating value judgments about the accessed content (Manalu et al, 2019).

The quantitative analysis, using descriptive statistics, was performed from the points attributed to the answers given to the questions of the VNOS-E

and on the fake news and calculating the average obtained per student, as shown in Figure 6.

Figure 6

Graph of the relationship between the averages obtained per student in the questionnaires.



The analysis of the graph suggests the possibility of there being a relationship between the view of the nature of science and the ability to identify

fake news. There is, however, a slight discrepancy in the region between the means 1.2 and 1.6 of the VNOS-E. We considered the hypothesis that possibly the fake news test had some element that should be adjusted.

The Spearman correlation test showed a result of $\rho = 0.703$. Despite not being such a significant value, the result of the t-test was $p = 0.016$, which was considered relevant and able to justify the probable relationship between the two aspects evaluated in the questionnaires.

FINAL CONSIDERATIONS

Science teaching, in general, tends to focus on well-established areas, where scientific knowledge seems solidly confirmed and for which there are no issues to be debated. This knowledge, although provisional, is taught as absolute and factual, rather than theoretical, and obviously derives from data rather than being an interpretation based on the human imagination (Taber & Akpan, 2017).

Understanding the construction of scientific knowledge theoretically bases the conception that the individual develops about science. Thus, identifying what and how the student understands what science is becomes fundamental for the teacher to create opportunities for learning about aspects of the nature of science. As Durbano (2015, p. 55) states, "to avoid a deformed view of science, the teacher must know a little about metascience".

On the other hand, the context of the information society has brought new challenges to the educational process, which can no longer only be limited to the teaching of watertight curricular contents, it must also meet the demand for the development of literacies that allow students to become critical and reflective citizens both regarding socio-scientific issues, increasingly present in the most different sectors of human activity and in the face of the abundance of disinformation that permeates the media.

To face the hyperinflationary production of information and the consequent production and dissemination of false or manipulated information, since the current media market favours this type of content, it is necessary to adopt measures and multisectoral actions, involving government institutions, the press, academia, educational systems, among other sectors of society.

The ability to read and evaluate the reliability of online information presents challenges that are different from traditional printed sources. It is also possible that students, even knowing strategies for evaluating sources, may not

put them into practice, even when asked to do so. Having skills, strategies, and willingness to think critically about information on the internet will play a central role in students' success in the information age (Coiro et al., 2015).

The issue is complex and does not admit an easy solution. It is not enough to provide the student with knowledge of information verification techniques. Nor just adopt specific approaches to the nature of science. Integrated actions are needed to minimally enable students to understand how scientific knowledge is generated and the different factors involved in the production and dissemination of disinformation.

We believe that understanding the relationship between individuals' perceptions about the production of scientific knowledge and the mechanisms for generating and disseminating disinformation contributes to the development of informed participation of all citizens, especially at this historical moment, when the truth is so relativised.

As the theme addressed in this work does not seem to be being developed in academic research, we consider it essential to discuss and elaborate proposals that, at least, contribute to minimising the negative effects of the proliferation of disinformation. The results of the research show that an adequate view of science and the development of skills in different literacies play an important role in combating fake news.

The analysis of the results verified in the application of the questionnaires shows a possible relationship between the students' perception of science and their competence to identify fake news through the use of criteria to confirm the reliability - or not – of the media news, which corroborates our initial hypothesis. As this research is on an issue that has not yet been explored, we believe that the evidence found can offer a relevant contribution to the struggle against disinformation.

AUTHORSHIP CONTRIBUTION STATEMENT

J.R.L. and R.P.S. conceived the idea presented. J.R.L. developed the theoretical foundation, performed the activities and collected the data under the guidance of R.P.S. J.R.L. and R.P.S. analysed the data. All authors actively participated in the discussion of the results. R.P.S. reviewed and approved the final version of the work.

DATA AVAILABILITY STATEMENT

The data supporting the results of this study will be made available by the corresponding author, J.R.L., upon reasonable request.

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