ACTA SCIENTIAE

ISSN: 2178-7727
DOI: 10.17648/acta.scientiae.6602

Fake News Phenomenon: Formation of Beliefs under Pragmatic Optics and Mathematical Education

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Received for publication 6 May 2021. Accepted after review 7 Dec. 2021
Designated editor: Claudia Lisete Oliveira Groenwald

ABSTRACT

Background: Few studies in mathematics education have been looking at the new dynamics of communication with focus on the analysis of speeches propagated by false news. This social phenomenon is worrying: news that uses mathematical arguments to guide, shape, and reflect public opinion and popular thinking based on misleading information. **Objectives:** The aim of this investigation was to understand the role of mathematics education in the process of strengthening democracy. **Data collection and analysis:** A video published on a YouTube channel, in which mathematical arguments are used to convince public opinion about a certain point of view, was the object of the study whose result is presented in this paper. **Design:** With theoretical-methodological procedures that are based on the pragmatic theory of fixation of beliefs and on the verification of the mathematical content, the analysis adopted a qualitative approach. **Setting and Participants**: This is a study about a video considered false by news agencies, aired by a famous Brazilian journalist. **Results:** The study of fake news and desinformation scenario has allowed us to observe that mathematical speeches linked to the ideology of mathematical certainty are responsible for the establishment of beliefs and the formation of opinions by authority and tenacity methods. **Conclusions:** We conclude that mathematical models and mathematical discourses used in virtual communication environments can be responsible for camouflaging the human factor in political decisions and obscuring the visibility of ethical and morality variables.

Keywords: False news; Opinion formation; Mathematical education; Ethics and morals; Disinformation.

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O fenômeno das fake news: formação de crenças sob a ótica pragmatista e a educação matemática

RESUMO

Contexto: Poucas pesquisas em educação matemática têm se debruçado sobre as novas dinâmicas de comunicação com foco na análise de discursos propagados por notícias falsas. É preocupante este fenômeno social: notícias que se utilizam de argumentos matemáticos para nortear, moldar e refletir a opinião pública e o pensamento popular a partir de informações enganosas. **Objetivo:** Objetivou-se compreender o papel da educação matemática no processo de fortalecimento da democracia. **Coleta e análise dos dados:** Um vídeo divulgado em um canal do YouTube, em que são utilizados argumentos matemáticos para convencer a opinião pública a respeito de determinado ponto de vista, foi objeto do estudo cujo resultado se apresenta neste artigo. **Design:** Com procedimentos teórico-metodológicos que se apoiam na teoria pragmatista de fixação de crenças e na verificação do conteúdo matemático, a análise adotou uma abordagem qualitativa. **Ambiente e participantes**: Trata-se de um estudo sobre um vídeo considerado falso por agências jornalísticas veículado por um famoso jornalista brasileiro. **Resultados da Pesquisa:** O estudo sobre um cenário de fakenews e desinformação permitiu observar que discursos matemáticos atrelados à ideologia da certeza matemática são responsáveis pela fixação de crenças e formação de opinião pelo método da autoridade e tenacidade. **Conclusões:** Conclui-se que modelos matemáticos e discursos matemáticos utilizados em ambientes virtuais de comunicação podem ser responsáveis por camuflar o fator humano das decisões políticas e ofuscar a visibilidade de variáveis éticas e de moralidade.

Palavras-chave: Notícias falsas; Formação de opinião; Educação matemática; Ética e moral; Desinformação.

INTRODUCTION

The popularisation of technological tools and internet access has resulted in numerous benefits to humanity in terms of facilitating communication, the congregation in social networks, access to information, the democratisation of consultations and research, production of journalistic content, and expanded freedom of expression.

The ability to express oneself and the freedom to do so are indispensable rights in democratic societies. In Brazilian education, this right is endorsed in the general competencies of the National Common Curricular Base (BNCC) (Brasil, 2018), which guide the students' formation and imply the targeting of content and pedagogical approaches in the various areas of knowledge. Our hypothesis is that throughout schooling students learn to act

individually and collectively, making decisions based on ethical, sustainable, and supportive principles, to know how to collaborate to build a fairer, democratic, and inclusive society. Another competence highlighted by the BNCC is that students learn to "express and share information, experiences, ideas, and feelings in different contexts and produce meanings that lead to mutual understanding" (p. 9).

In this text, when using the word "democracy", we will not be referring only to the political system that provides for the election of its representatives directly or indirectly by the population, but to the very capacity of the population to understand, to deliberate, to express themselves, and to act on the problems that permeate their lives. Democratic competence here must be understood as the ability to interrelate a basic series of knowledge, to be able to question authorities to face injustices, make social criticisms from a political view, and ensure the questioning of power structures in society (Valero, 2015). This competence is linked to the subjects' ability to maintain good communication relations and to be critical of the contents to which they are exposed. In particular, we understand that the dissemination of false information on social networks that use mathematical arguments in their discourses can destabilise the development of democratic competence.

Until recently, the production of information content was restricted to the media, which disseminated it through mass media (TV, newspapers and radios), but nowadays all of this can be – and is – done by any organisation or individual interested in propagating an idea, ideology, or personal belief (Romanini & Ohlson, 2018). As a result of the popularisation of technological tools, the forms of interactions between individuals have changed and expanded on the internet and on social networks. This phenomenon, which expanded the possibilities of expression and, for some time, was seen as fascinating from the point of view of strengthening the democratic regime, controversially generated an abundance of information, which also causes a complex situation: disinformation, i.e., false information given with the purpose of confusing, inducing error, or giving a false image of reality.

According to Prior (2019), these new forms of communication bring to contemporary society great concerns that expand in politics and sometimes endanger the democratic regime itself. This is because the communication system powered by narratives based on false data aims to meet particular and questionable political and economic interests. This way of acting confuses the population and causes individuals to lose the ability to understand problems that permeate their lives. Thus, people start to have difficulties making

collective decisions for the common good and acting on local problems that cause social injustices.

Those forms of contemporary social interaction have challenged schools and educational processes. This is reflected in the BNCC (Brasil, 2018), which, in the Portuguese Language area, is directly concerned with guidance on information reliability, proliferation of fakenews, manipulation of facts and opinions, and dissemination of hate speech in social media. In this sense, the BNCC suggests that teachers develop skills with their students to compare and analyse news in different sources and media. Moreover, regarding the propagation of hate speech, the document advises teachers to pay attention to the development of skills related to dealing with and respecting differences, ethical and respectful participation in discussions, and consideration of the debate of ideas. In the section on mathematics teaching, although it does not directly mention dealing with fake news, the BNCC suggests that mathematical skills related to reasoning, representation, communication, and argumentation be developed with students, together with the enhancement of computational thinking.

The term fake news (Egelhofer & Lecheler, 2019) will be used in this article to refer to a false narrative, presented in a journalistic format, created from data and, in particular, from manipulated mathematical arguments, with the apparent intention of deceiving and guiding a political agenda. Thus, this research is motivated by the most recent communication scenarios, which make use of mathematics to make robust discourses and advertisements. We are concerned about understanding the role of mathematics teaching practices in the process of strengthening democracy.

This study considers some more general questions for reflection: does the mathematics education we offer in schools help to establish democratic postures?; how does mathematics used in journalistic discourses establish beliefs in new communicative environments? In this article, we analyse a narrative published in two videos on a YouTube channel, discussing information related to the fight against and preventing Coronavirus. Our research aimed to analyse such discourses conveyed from the perspective of communication theories that rely on pragmatist logic and critical mathematics education. The theoretical analysis fell on three prisms – Charles Sanders Peirce's pragmatic logic on the concept of belief fixation (Alzamora & Andrade, 2019); the ethical challenge of dealing with fake news (Stroud, 2019); and critical mathematics education as a tool to strengthen democracy (Skovsmose & Valero, 2001) – which will be discussed later. Our starting point, however,

will be the video presentations and initial mathematical analysis of the disclosed content.

A COMMENT, NEWS, OR REPORT?

Before discussing from a theoretical point of view, we will contextualise our study from information reported by a journalist and digital influencer who based a narrative about the disease Covid-19 on mathematical arguments. The term "digital influencer" refers to the subject who, in contemporary society, works with the production and dissemination of content on digital platforms such as YouTube, for example. According to Karhawi (2017, p. 3),

> influencers are those who have some power in a subject's decision-making purchase process; power to put discussions into circulation; power to influence decisions about the lifestyle, preferences, and cultural assets of those who are in their network.

People who access their communication channels often trust their opinion. The choice of the excerpts discussed here was based on a digital influencer's use of mathematical arguments to validate an opinion and give it reliability.

Alexandre Eggers Garcia is a well-known Brazilian journalist who has served as a presenter and political columnist for more than 30 years in one of the largest communication companies in Brazil, Rede Globo. In this company, which incorporates a television station, Garcia, besides having served as director of journalism, presented and commented on the main TV news. Currently, Garcia has a YouTube channel and is considered, by some communication channels, one of the ten largest right-wing digital influencers in the Brazilian political scenario (Dimenstein, 2019).

Regarding his role in the channel, it is complex to understand the professional role that Alexandre Garcia plays at every moment of his narratives. While informing, he also comments and issues opinions. His journalist history garners some credibility from the content reported. On the channel, the news is reported with a journalistic tone, accompanied by comments. His approach is less formal compared to the more traditional media in which he has worked. In the presentations, the approach to the listener is made through a relaxed narrative exposing the journalist's opinions.

The excerpts from the videos that we will analyse were released by Alexandre Garcia on his channel during the pandemic period in 2020. At the time of this article, this channel had approximately 1.84 million subscribers. The first video (now unavailable) analysed brings one of the journalist's comments comparing the number of deaths in 2019 and 2020 in Brazil to raise a reflection as he minimised the severity of the Covid-19. Below, we transcribe an excerpt from the video reported by Alexandre Garcia.

> I glanced at, you know that every time I glance at the transparency of the civil registration on the site. So, I decided to compare the daily deaths of last year and this year, and I was surprised. Last year there were 4,889,000 deaths; this year, in 186 days, 2,000,336. Divided by the number of days last year (2019), 365 days, we had 13,394 daily deaths on average in Brazil last year. This year (2020), dividing 2,000,336, until July 5, 186 days, we have 12,559 deaths [per day]. We are experiencing fewer daily deaths this year than last year, 835 fewer deaths every day if we compare. I repeat: deaths per day last year 13,394, daily deaths this year 12,559. According to (pause and emphasis with change of tone in speech) the death record in the civil registry offices. From Brasilia, Alexandre Garcia. (Speech transcript published on July 6, 2020. Excerpt clipping – at 9min53s to 11min33s)

The information disclosed by Garcia was checked and challenged by Agência Lupa (Moraes, 2020) in a report that is part of a news verification project. The answer states that, when extracting the data from the Civil Registry Transparency Portal, Alexandre did not only separate the deaths, using a total number of records of three types for the periods analysed. To get an idea, the total number of deaths of people in Brazil registered in 2019 was 1,260,326, according to the portal data (Portal da transparência, 2021). This number is much smaller than the one informed in the narrative.

According to the report, Garcia's calculation included births, marriages, and deaths and, thus, the average of deaths calculated was distorted, not representing reality. Also according to the agency, in another video published on July 6, 2020, Garcia recognised the mistake and corrected the data. “I wanted to apologise to you, because yesterday I used the wrong numbers. I took numbers from the Civil Registry, the numbers were there, but there were also other records, besides the death records", he said. When recalculating, he concluded that there were, on average, 3,367 deaths in 2019, compared to 3,609

in 2020. With this, there would have been an increase of 7.18% in the total number of deaths, comparing the two periods, and not a drop, as the journalist had previously stated. The report also disputes this correction, claiming that "it is not correct to compare the average of a full year with the average of only a part of the subsequent year", because events are affected by seasonality.

In fact, both pieces of information can be questioned from the analysis of the graph presented in Figure 1. In the comparative graph of the number of deaths in 2018, 2019, and 2020, we noticed a significant increase in 2020 from March, a fact that contradicts the first information reported by Garcia. Moreover, a close look will identify that there is a peak in the number of deaths in July, and this occurrence is common to the three years of the comparative graph. Some hypotheses could be raised to justify this fact, such as winter in the most populous regions of Brazil, which would increase the incidence of respiratory diseases and, consequently, cause more deaths in this period. In addition, from an analysis of the graph, we can see that it would be statistically wrong to compare, in different years, two different periods, for example: the period from June to August 2019 compared to the period from January to March 2020. Thus, we would observe a higher daily average of deaths in the period of 2019. As an example, in the periods above, using the data presented in Table 1, the average daily deaths would be, 3,651 in 2019 (arithmetic average between 3,493 deaths per day in June, 3,630 in July and 3,924 in August 2019) against 3,412 deaths per day in 2020 (arithmetic average between 3,579 deaths per day in January, 3,213 in February and 3,445 in March 2020). A difference of 239 deaths per day.

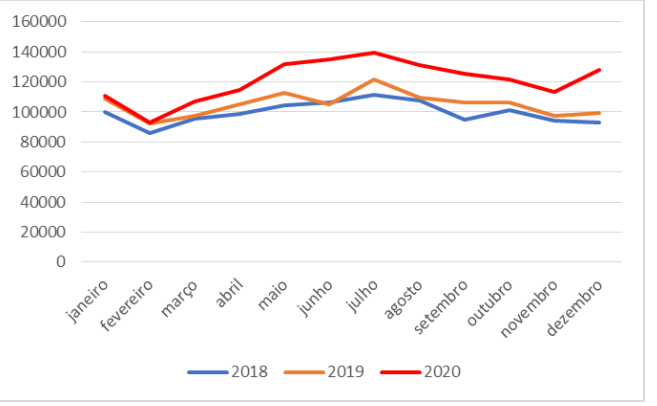
Given the context of the discussion about the disease Covid-19, it would be necessary to compare the data collected in a period that took into account the first death reported in Brazil. This death allegedly occurred on March 12, 2020 (Globo, 2020). From March to July 2019, compared to the same period in 2020, the approximate average of daily deaths in the five months jumped from 3,541 to 4,102, representing a percentage increase of almost 16%. Also, if we take into account only the difference in the averages for 2019 and 2020, month by month, we will find that the difference in the average daily deaths (Table 1) jumped from 298, in March, to 1,010, in June.

The videos published by Alexandre Garcia, given his former professional relationship with Rede Globo and his journalistic skills, always have great repercussions and are watched and shared thousands of times. For this reason, it is likely that the mathematical information disclosed on the

journalist's channel will also be read and shared thousands of times more than what we present in this article.

Figure 1

Number of deaths in Brazil in 2018, 2019, and 2020. (Portal da transparência, 2021)



In the next section, with a focus on pragmatist logic, we will discuss how the dissemination of this information seeks, through mathematical arguments, to guide, shape, and reflect public opinion and popular thinking and, thus, to establish beliefs to guide people's actions.

Table 1

Deaths in Brazil in 2018, 2019, and 2020, and the average daily deaths in 2019 and 2020. (Portal da transparência, 2021)

	2018	2019	2020	Daily average 2019	Daily average 2020
January	100126	108975	110955	3515	3579
February	85896	92439	93179	3301	3213
March	95823	97543	106799	3147	3445

April	98954	105336	114368	3511	3812
May	104676	112536	131924	3630	4256
June	106572	104800	135076	3493	4503
July	111669	121652	139379	3924	4496
August	107592	109657	131385	3537	4238
September	95142	106345	125249	3545	4175
October	101220	106676	121441	3441	3917
November	94472	97332	113244	3244	3775
December	93278	99155	128349	3199	4,140

THE FIXATION OF BELIEFS AND THE PHENOMENON OF THE FAKE NEWS

To understand the fake news phenomenon, it is necessary to first understand the tools that operate the communication system on the internet and make false information resonate. Some studies (Shao et al., 2017) point out that in the initial phase, the propagation of fake news is usually done by robots, whose construction is based on mathematical algorithms, which are used to spread information. Thus, fallacious news tends to reach users – human beings – who, on the one hand, may be vulnerable to this information and, on the other, share beliefs analogous to the content, and therefore, are exposed to selective sources of information that will influence or confirm their worldview. Then, in the intermediate phase, the agent (human being) enters the game and starts to feed the system, rerouting information that will spread through artificial intelligence, becoming viral, i.e., disseminated on a large scale and gaining great repercussion. All this problem leads us to ask a question: why do people share news and information?

According to Alzamora and Andrade (2019), there is a combination between algorithms and the human mind. Algorithms act on repetition relationships, and the human mind is based on beliefs that manifest themselves in habits of action. The action of sharing news starts from a common belief shared by groups that are based on historically and culturally established social conventions. The mechanism of algorithms seeks to bring people closer to their beliefs and, thus, brings them content of personal interest that constantly

reiterates them. Some tools used by the algorithms are based on data collected through geolocation resources or by internet browsing histories.

Enabling those forms of interaction promised to bring, with the internet and social networks, a decentralised and democratic environment, which would group people who share similar values (Törnberg, 2018). However, in practice, if on the one hand, this approach led groups of individuals with common beliefs to unite, on the other hand, it led those same individuals to isolate themselves from everything that disagreed with their beliefs. This interactive dynamic, according to Törnberg (2018), is responsible for forming, on the internet, bubbles – groups of individuals who interact with each other because they have similar convictions –, which start to consider other bubbles as inconvenient, whose members would not have an affinity with their beliefs. And, therefore, they begin to practice contempt or verbal attacks on the members of those other bubbles. This interactive path is responsible for accentuating the polarisation of political and social relations and brings with it the fuel necessary to feed hate speech.

For Törnberg (2018), all these technological apparatuses that intended to strengthen ties between humans has led society to wear, as it divides them into social groups with worldviews separated by content. For the author, this dynamic can bring out the worst of human instincts, because we regroup as tribes that comfort us from the reaffirmation of our beliefs and that protect us from disagreement. Those virtual environments, called echo chambers or bubbles, reinforce the perspective of the subjects and promote confirmation biases, and thus the content produced becomes viral. The video starring Alexandre Garcia, for example, received 79 thousand likes and was viewed approximately 300 thousand times until 12/09/2020. Videos like this are responsible for forming opinions and, therefore, will be disseminated in other media, such as WhatsApp, Twitter, Facebook, among others. According to Duffy et al. (2019), people share news to appear informed before society. The information that they most often share is that whose contents either have some use for life, i.e., can be used in some way in daily actions, or harbour stories with some emotional impact.

This transmedia dynamic, responsible for the propagation of false news, according to Alzamora and Andrade (2019), can be analysed from the pragmatic conception of truth and fixation of beliefs proposed by Charles Sanders Peirce (1839 – 1914).

Peirce's (1877) pragmatism exposes the dissimilarity between the sensations of doubting and believing, in order to explain how beliefs establish

opinions and are fixed in the mind. Belief brings to the individual a sense of security that guides their desires and, consequently, shapes their opinions and actions. On the contrary, doubt generates a state of discomfort and dissatisfaction that we wish to free ourselves from in order to return to the state of belief. The state of belief is calm and satisfying, while the state of doubt causes impatience and irritation, and this is the immediate reason that leads us to the struggle to reach the state of belief and fix it. In Peirce's conception, the feeling that our beliefs are true is more satisfying, so they can guide our actions to satisfy our desires. This state of comfort makes us reject any belief that does not appear to have been formed to ensure this state. Imagine a small merchant who has his/her routine affected by the restrictions imposed by the pandemic in 2020 and has not yet had the experience of losing someone close. His/her wish will be to continue working to secure his/her earnings. It would be much more comfortable for him/her not to have to change his/her routine, so it is difficult to believe that something serious is happening.

A doubt triggers an internal struggle for the individual to reach a state of comfort, i.e., to cling to a belief that establishes opinion, not any opinion, but a true opinion, which leaves no room for doubt, at least in the individual's conception. For him/her, when a belief is reached, what matters is his/her state of satisfaction. His/her internal struggle is against doubt, and not against belief (that he/she assumed to be true), and, therefore, it is more attractive for the individual to accept the content to which he/she is exposed, whether true or false, to avoid his/her return to the state of doubt that causes discomfort. “It is the belief that outlines the formation of opinion, not the truth” (Alzamora & Andrade, 2019, p. 111). Currently, the algorithms are programmed to continuously distribute to people information that is of interest to them (Barsotti, 2019). People's attention is captured thoroughly by content selected, classified, and categorised exclusively for them based on their individual preferences, geographical location and their state of belief. The result is the strengthening of this state.

In the current political context, where information and misinformation are drivers of polarised and heated discussions, it is important to understand how beliefs are fixed in the human mind and how they could be modified. Peirce (1877) proposed four methods to explain the fixation of beliefs: tenacity, authority, the a priori method, and the scientific method. Alzamora and Andrade's (2019) study on the propagation of false news in the political sphere noted that there is a collective effort to fix beliefs by the first two Peircean methods: tenacity and authority.

The tenacity method takes into account the fact that an opinion is established to ensure one's own beliefs. “Social engagement based on this method tends to ignore contrary evidence and disregard divergent opinions” (Alzamora & Andrade, 2019, p. 122). The unshakeable faith of a subject has the natural purpose of calming the state of mind. The method consists of regularly reiterating to ourselves the belief for which we have sympathy and then learning to look with contempt and indignation at what may disturb us. Pereira (2012) explains that this method can be exemplified with the fanaticism that causes a subject to refuse the introduction of new experiences that would be able to modify their beliefs. For example, he/she would be unable to realise that different cultures or manifestations of faith can have things as good as his own faith. This method also explains the need for subjects to group socially, share common beliefs, and distance from their group those who have different opinions. Fear of doubt terrifies them, so they cling to the position they already had and feed on opinions similar to their own. For Skovsmose (2005), this dogmatic system can also be fed by mathematical discourses when an institutionalised authority propagates a set of beliefs as being true.

According to Romanini and Ohlson (2018, p. 69), the tenacity method can be exemplified by the “bubbles” created by social networks – Facebook, YouTube Channels, Twitter – or by social groups, such as WhatsApp. In those groups, communities usually have user profiles with certain homogeneous characteristics in relation to a given theme, so it is common for users to mutually reinforce their opinions, “often prejudiced or backed by false information, tenaciously assuming a political and ideological position against all evidence”.

In the video – now unavailable – , published on the following day on Alexandre Garcia's channel with apologies, it was possible to notice the application of the tenacity method to fix beliefs. By presenting the data in another way, Garcia uses expressions such as “rose a little” and avoids dealing directly with the Covid-19 theme to argue about the increase in the number of deaths. Regarding the mathematics used, Garcia presents the daily average of deaths, not the absolute difference of deaths in the two years analysed. Those numbers would sound a lot higher. Resuming the data presented in Table 1, from March to July, if we compare 2019 and 2020, we have 85,679 more deaths in 2020. If we increase this count by December, the number will double, 186,182. By way of comparison, the Maracanã football stadium, which has already been considered the largest in the world, comprises approximately less than half of that last number. In 2020, if we count from March to December, the number of deaths exceeded that of 2019 by approximately more than twice

the capacity of this stadium in a world cup final. Presenting the numbers in this way, it would resonate as a real disaster, which would be different from saying "*The number of deaths was 3,609. It was 187 days this year and 365 days last year, wasn't it? The daily average then, [YES!] there was a small change, wasn't there?*" Garcia's narrative belittles the problem by using mathematical data that cause less emotional impact, by comparing different periods, and by using expressions such as: "*rose a little*"; "*small change*"; "*did not rise that way catastrophically, right*!?"; and others that are highlight in italics in the following excerpt:

> I wanted to apologise to you, because yesterday I used the wrong numbers. I took numbers from the civil registry, the numbers were there, but there were also other records besides the death records... but then I redid the numbers and here they are. The daily average of deaths recorded in the registry, i.e., the official number of deaths last year was 3,367 deaths. This year, the population increased, right? And we have Covid-19. Yes! The number of deaths was 3,609. It was 187 days this year and 365 days last year, wasn't it? The daily average then, [YES!] there was a *small* change, wasn't there? " This comparison I wanted to register here, it rose a *little*, but it *did not rise* catastrophically, right!? Precisely because the quarantine *decreased* activity and there were *fewer* traffic accidents, *fewer* bar fights and shootings in the streets, right? This is what happened. [Emphasis in original] (Speech transcript published on July 7, 2020. Excerpt clipping at 2min03s to 3min35s)

Note the communicative strategy in this excerpt: "Precisely because the quarantine *decreased* activity and there were *fewer* traffic accidents, *fewer* bar fights and shootings in the streets, right!? This is what happened. [Emphasis in the original]". The influencer avoids confronting the beliefs of listeners who have a profile that adheres to the political approach given to their channel, the denial of the impacts of the disease. In this last excerpt, when closing the comment, Alexandre overshadows the context of the discussion and disseminates the idea that the number of deaths in 2020 decreased, even having stated otherwise previously. After all, if there was a decrease in the number of traffic accidents and deaths caused by situations of violence in 2020, the increase in the number of deaths for other reasons that year, such as the disease, should be highlighted.

Another way to fix beliefs is by authority. Peirce believed that there is no better method to drive people's opinions on a large scale. The method (Pereira, 2012) consists of establishing beliefs through some authority's enunciation of the subject (e.g. state, political organisation, religious organisation, press, academia, economic authority, etc.). Those institutions are supposed to enjoy control of the truth. In the conception of Peirce (1877), to avoid the state of irritation that doubt causes, there is a natural impulse to accommodate human beings to delegate to the authorities the management of what is assumed to be true. The institutions of authority appropriate this impulse to maintain control and regulate opinions. "The contrary evidence is here purposely isolated by a regulatory institution" (Alzamora & Andrade, 2019 p. 122). The will of an organization will act on the individual, so an institution is created to maintain correct doctrines and perpetuate them. This method also consists of instructing young people to prevent contrary doctrines from being taught, supported, or manifested.

Since ancient times, communication by the method of authority has been used as one of the main means to sustain theological and political doctrines. In history, this approach is accompanied by the most varied levels of cruelty, which, when analysed through a prism of rationality, become the most barbarian atrocities. We can, for example, cite the advertisements used in the holocaust.

Peirce points out that this method is the most effective to fix beliefs on a large scale, although it also has its imperfections. No institution is able to administer opinions on all matters. Institutions are effective in managing only the issues that are most dear to them.

It is possible to perceive the presence of the method of authority when memes and fake news use quotes from phrases of personalities and political authorities recognised and admired by a particular group, as well as by the cunning use of the graphic design and the discursive form of the media, which aims to validate a lie from the confidence that the journalist or journalistic vehicle enjoys (Romanini & Ohlson, 2018). In addition to his recognized professional career, Alexandre Garcia relies on the data collected on the transparency portal of the National Association of Registrars of Natural Persons (ARPEN) and uses statistical data and mathematical models to explain his point of view and thus gain credibility. For the subject who is exposed to the content, it is complex to differentiate information from opinion and commentary news.

Particularly, our research is concerned with the discourses that make use of mathematical arguments based on false data, with the manipulation of

numbers and with the influence of mathematics education on the phenomenon of communication on social networks. The BNCC (Brasil, 2018) understands that a discussion about strengthening democracy will fall on the fight against disinformation that is associated with the formation of critical citizens, i.e., those who are able to form their own opinion, expose and debate ideas, without taking the opinion of other people, advertisements, and the media as absolute truth. According to the document, the new literacies refer to a set of specific practices and point out that digital media operate from a new mentality, governed by a different ethic, and therefore, from our point of view, they need to be understood. In this dynamic, besides the mathematical technology involved in the propagation of information, it is possible to note the frequent use of discourses made from mathematical arguments that aim to fix beliefs and ideologies for political purposes.

To broaden the reflection on our objective in this text – to analyse the phenomenon of fake news from the theoretical perspective of pragmatic logic and to discuss the phenomenon from the perspective of critical mathematics education – we study the phenomenon of transmedia communication also from a perspective that considers moral, ethical, social, and cultural aspects, which we will examine in the next section. Studying those variables is necessary when people are able to express and share information, experiences, ideas, and feelings in different contexts and produce meanings that lead to mutual understanding.

Finally, we will return to the discussion specifically for mathematics education, reflecting on its influence on the establishment of beliefs in those communication environments.

DEMOCRACY AND ETHICS IN THE PRAGMATIC CONCEPTION AND ITS RELATIONSHIP WITH FAKE NEWS

On some video sharing platforms, there are content regulation policies that involve ethical issues and fake news. For example, YouTube published on May 20, 2020, a policy that specifically addresses medical misinformation and Covid-19 (YouTube, 2020). The company states that it does not allow the disclosure of erroneous medical information that contradicts guidelines from local authorities or the World Health Organization (WHO) on health, and the company's policy is limited to guidelines on treatment, prevention, diagnosis, and transmission. The platform exemplifies the contents that are not allowed

for publication, and some of them are statements that deny the existence of the Covid-19; statements that people did not die from Covid-19; statements that a specific treatment or drug is guaranteed cure for diseases, among others. The punishments involve from suspension of the channel to its complete blockage.

Even with a regulation by the platform, some problematic questions could be raised: what to do if an authority is responsible for publishing content that hurts such policies?; who determines which authorities are supposed to be allowed to deal with such matters? By reflecting on these issues, it is possible to perceive that we have entered a vicious cycle of legitimising an authority and giving it more power. On the one hand, a character or an institution will be responsible for producing, disseminating, and expressing an opinion on the information. On the other hand, we will have established those responsible for the control and regulation of such information.

Taking as an example the videos published by Alexandre Garcia, we can ask ourselves: 1) Does the video violate the platform's publication policies?; 2) Would blocking the video hurt a basic right of democracy, that of freedom of expression?; 3) How to regulate a content from an ethical point of view? At first, answering those questions could be unrelated to the mathematical arguments used in the videos. Before addressing them, however, we will discuss the ethical component in the pragmatic conception.

The terrain of social values is complex and conflicting. For this reason, Stroud (2019) argues that tackling the phenomenon of false news also depends on the analysis of pragmatism from a prism that takes into account ethical, moral, and social issues.

Ethics and morals, in Dewey's (1916) conception, are associated with the search for a collective good that is regulated by social interactions. This search is based on the weighting of three variables: the good, the right, and the virtuous. There are two systems that are opposed in moral theory: the morality of ends and that of laws. The first system is discussed in terms of what is good and is linked to situations involving individual desires and interests that cause happiness, pleasure, or self-fulfilment. The second system, that of laws, is dependent on the first but is distinguished from it. The core of this action is the analysis of the means or the individual's way to achieve what would be good for him. The concept of law emerges from the need to regulate clashes of subjects or groups that seek different ends to satisfy their desires and interests. Humans demand each other and, therefore, if they want to avoid conflicts, they need to self-regulate. In seeking and making efforts to satisfy their desires, human beings must consider the implications of their actions on the interests

and desires of others. It is necessary to counterbalance actions, interspersing the look between the ends (which is good) and the laws (which is right). The third variable, which Dewey calls "virtuous," is related to reason. It has the function of moderating and directing impulses, considering the consequences they entail. The reason would be the individual's ability to predict and compare and is linked to an agent's socialised or communal reactions to the virtues or vices it perceives in the actions of others (Stroud, 2019).

The definition of what is good, right, and virtuous does not occur in a static way, as it depends on dialogue and conflict that continually need to be reviewed, with respect as a premise. Reaching a consensus on the balance of actions taken to achieve the collective good depends on the beliefs, history, culture, and experiences lived individually and collectively by social groups. Those variables involve transient perceptions and beliefs and therefore need to be negotiated. Different groups interact with each other, and it is in this environment that ethical and moral aspects are regulated, and thus politics and democracy emerge.

Dewey updated the concept of pragmatism, adding to logical nature (Peirce, 1877) a language that deals with cognitive, ethical, and social values that sought to sustain pillars of participatory and inclusive democracy based on education (Kinouchi, 2007). The pragmatism reviewed by Dewey considers education as a culture of scientific dissemination and exercise of democracy. For him, the exercise of democracy depends on other factors built collectively and socially. From this conception, it is necessary to look at the moral values, which are established socially and culturally. The more conscious and reflective about these values a subject becomes, the more careful and time he/she devotes to analysing the quality of his/her actions, and then realises the complexity of the problem of discovering what is good and for whom it is good; what is true and for whom it is true.

Dewey considers that impulses and desires are constant traits in human action and therefore play a great role in determining the direction that an attitude will take. When an impulse or desire operates without regulation, the subject does not compare, reflect, or judge the values employed in an action. The will to satisfy desire leads to a strong inclination to make efforts in its direction. When the consequences that may result from the fulfilment of the desire are foreseen, the situation changes. Impulses that we could not measure become measurable when their results are considered; we can glimpse the consequences of the action and, thus, compare different results. Those acts of judgment, comparison, calculation, are repeated and they develop in proportion

to the increase in the capacity for reflection. Judgments applied to such a situation can be thoroughly examined, corrected, made more accurate by judgments carried over from other situations; the results of estimates and previous actions will be available as work materials.

The scenario of technological innovations, social networks, and internet communication brings new experiences to human beings and, therefore, new problems emerge and need to be regulated by moral and ethical components.

Such considerations lead us to the videos analysed in this article. Let us go back to them. It is not easy for a listener to separate news from opinion and reflect on it. This happens because of the format of the presentation, the journalistic authority of the narrator, the authority of the source of consultation on deaths, and the authority and certainty of the mathematical arguments used in the narrative. There are many components to be placed in an analytical game of mistrust that would require time for anyone who came to challenge such content.

In Dewey's pragmatism, ethics emerges from environments regulated by the interaction of humans who demand each other in social groups. The problem posed here is that virtual environments have particular interaction characteristics, quite different from those examined by Dewey. In addition to being able to filter or block subjects who want to interact with the content, a platform, such as YouTube, for example, has an interactive environment that is limited to comments. Another issue is that in a video sharing platform, the subjects exposed to the contents usually have more homogeneous characteristics (tenacity method), which inhibits the contestation. In an open television network, for example, the content is exposed to different social groups with more heterogeneous characteristics. Even if it is not possible to interact directly with the content, the divergent opinions of society are responsible for regulating the comments from an ethical point of view. Moreover, it is the television company that is responsible for the content, not the subject that produces it, which makes the company more attentive to morality issues.

In the virtual environment, the person responsible for producing the content is often immune to the censorship of co-workers, the company he represents, or the listeners themselves. In other words, the subject's desire to expose their point of view operates without interactive regulation, and this frees them from the need to compare, reflect, judge, or anticipate the consequences of the action they will undertake. Moreover, given the tenacity of the

environment, a contesting comment is likely to receive a large number of virtual attacks, which could contribute to reinforcing the beliefs of the group and the narrator him/herself. Another factor is that, from a financial point of view, the remuneration of the narrator is linked to the number of views and likes that a video receives, not to the quality of the information. Thus, it does not matter the veracity, but the guarantee of an audience faithful to the content.

When analysing Alexandre Garcia's comments, it is quite possible that we ask ourselves: were the numbers intentionally manipulated? Although we can admit that there could be no intention in manipulating the numbers, that the journalist was naive or made a mistake, when issuing an opinion, the discursive enterprise ceases to be neutral. On the other hand, a problem raised by Skovsmose (2005) on ethics and morality is that these are human categories, and understanding mathematics disconnected from the empirical world brings a kind of neutrality to the entire discursive enterprise. Thus, when mathematical arguments are mobilised to support some statement, the non-neutrality of the discourse may be camouflaged by the alleged neutrality of the mathematical discourse.

Let us return here to the questions we asked at the beginning of the section: 1) Does the video violate the platform's publication policies?; 2) Would blocking the video hurt a basic right of democracy, that of freedom of expression? ; 3) How to regulate a content from an ethical point of view? If a platform analyst takes into account that Alexandre Garcia issued his opinion instead of conveying information, he could conclude that blocking the video would violate the right to freedom of expression. However, the mathematical arguments used in the narrative, while giving rise to certainty about the content, also raise doubts about the journalist's intentions. Did he make a mistake, was he naive, or did he make an intentional narrative? If you were wrong or naive, rectification would be enough. But who analyses the quality of a rectification?

In such a complex scenario, in which information competes with political and economic interests, it is important to ask ourselves: Is there any intentional desire behind the mathematical arguments produced? What would be the consequences of underestimating the severity of the problem? Who benefits and who loses in each scenario? Besides allowing a description of reality, mathematics can provide a kind of hypothetical reasoning that makes it possible to analyse the consequences in an imaginary scenario. Skovsmose (2005) understands that the idealisation of technological solutions through mathematics is fundamental to establishing spaces for discussion that raise alternative, technological ways to solve a present situation. The big problem is

that the fixation of the belief by the methods of tenacity and authority and the manipulation of the data prevent collective planning to establish technological solutions to an emerging problem. It would be desirable, then, according to Skovsmose and Valero (2001), that mathematics education be planned to bring contributions to the democratic shaping of society.

MATHEMATICS EDUCATION, THE FIXATION OF BELIEFS AND ETHICS IN THE THE FAKE NEWS PHENOMENA

Fake news is attractive to read; therefore, when there is any, the human being reacts by sharing. These human actions together trigger a system of algorithms, and thus thousands of people are exposed to news that, whether true or false, is accepted as true by many. This movement feeds back into the system and triggers a human response system. As we saw in the previous sections, many of those fake news have political objectives, and mathematics is customarily used in political debates and argumentation structures to provide credibility to information.

In addition to the information narrated by Alexandre Garcia, other examples of false news and advertisements about the disease Covid-19 could be observed in Brazil in 2020. Despite facing a serious problem that plagued the entire world, the Ministry of Health was forced to create a channel to inform and check the spread of false news about the Coronavirus. On the website of the Ministry of Health (Ministério da Saúde, 2020), we can verify more than a hundred titles analysed and answered by the Ministry. In some titles, we noticed the direct relationship with mathematics content: “Drinking water every 15 minutes cures Covid-19”; “Coronavirus stays alive for nine days”, “Coronavirus dies at 26º C”; “Coronavirus patient cured in 48 hours with AIDS drugs”, “Thai doctors cure coronavirus in 48 hours”; “Government hides numbers on new coronavirus”; “Research published by Chinese scientists says that coronavirus will make most male patients infertile”; “Chinese court will kill 20,000 patients with coronavirus”; etc.

Mathematics education can or could contribute to such debates in the political arena. For Hannaford (1998), democracy depends on trust and respect between people. This relationship must go beyond the boundaries of family or bubbles, so that it includes members of a more globalised society. To establish positive relationships and mutual respect, people need systematic, clear and open arguments, through which they can communicate and cooperate.

Mathematics is a tool used to ensure agreements through respectful arguments. Moreover, according to Skovsmose (2005), mathematics helps to simulate and build hypothetical situations, analyse such situations in detail, and perceive the hypothetical state of things.

Communications such as those made by Alexandre Garcia, in addition to guiding public policies, aim to gain popular support. There are several risks when making political decisions based on mathematics disclosed through manipulated or false information: for example, the ability to establish agreements and to simulate and analyse hypothetical actions is lost. Another problem is that the implications of actions from an ethical and moral point of view lose visibility. This is because the responsibility of the acts is placed on an external agent, in this case, mathematics, which would supposedly have neutral characteristics.

Hannaford (1998) understands that, because mathematics itself is considered by some to be ethically neutral, during the mathematics teaching process it is highly relevant to address the ethical principles that produced it and produce democracy. According to the author, teachers should understand and teach it everywhere. Given the new political context, a democratic society needs to have subjects prepared to focus on content conveyed on social networks so that the mathematics inserted in the information is questioned. Replicas and rejoinder are necessary, as it is the analysis of discursive intentions from an ethical and moral point of view. For this to occur, Skovsmose (2005) suggests that mathematical learning happens in a collective process of interaction based on dialogue.

All analysis of the phenomenon of transmedia communication and mathematics related to it goes far beyond the title and content of the news. When discussing the perspectives of mathematical modelling in mathematics education, Araújo (2007) criticises that attitude - often disseminated in schools and society - that assumes that mathematics will provide neutral responses to the problems of reality, responses free of social, political or ideological interests. The neutral stance, according to the author, is based on the ideology of certainty in mathematics education (Borba & Skovsmose, 1997) and brings consequences for the subjects' formation. Araújo (2007) proposes that the perspective of modelling in mathematics education should be concerned with the mathematics role in society. Other lines of research in mathematics education are also oriented in this way and still focus on the social role of mathematics education (Souza, Lopes, & Fitzallen, 2020).

By contesting the ideology of certainty, Borba (1992) questions the way mathematics was promoted in television science programs, newspapers, and universities. These communication networks brought with them an idea of a solid and unquestionable structure about a world that does not have these particularities. Borba recalls some phrases commonly used in the media that aim to empower arguments by reaffirming mathematical certainty: "it was mathematically proven"; "the numbers express the truth"; "the numbers speak for themselves"; "the numbers show that...". Several other replicated sentences reinforce this idea of power and certainty that mathematics provides to the information disclosed, for example: "Mathematics is in everything"; "Mathematics does not lie"; "Mathematics is the alphabet with which God wrote the universe"; "Numbers govern the world". In the excerpt from the second video, Alexandre Garcia uses the ideology of certainty to support his arguments, when he says, for example: "*I* took numbers *from the civil registry,* the numbers were there*, but there were also other records besides the death records... but then I* redid the numbers and here they are [emphasis in the original]".

Although we are dealing here with another information transmission environment, different from those mentioned in the first studies on the ideology of certainty in mathematics education, the entire indisputable culture of accuracy in mathematical arguments remained. This way of presenting mathematics is responsible for establishing beliefs by the method of authority that tend to disguise or hide social problems. By criticising the ideology of certainty, Borba also warned about the risks of the formatting role that mathematics has on society, especially when it is associated with technological resources. The ideology of certainty emerges in many social environments of communication, but it is in school that it is reinforced, according to Borba and Skovsmose (1997). In the school context, when teachers focus on checking algorithmic procedures or their results, taking for granted a pre-established answer, ideology is established. The scenario is still fed when the teacher, the textbook, the answers at the end of the book, and the assessments become authorities that hide the scenario of correction and development of knowledge. When an environment of argumentation and exchange of ideas is not created, beliefs are fixed by the method of authority. We are not attributing this responsibility to teachers, but to the educational system historically instituted by society, which has its own firm beliefs.

For Skovsmose (2005), the direct attack on the ideology of certainty in mathematics education may be linked to the philosophical principle of fallibilism, which takes into account that human beings may be wrong about

their beliefs, expectations or their understanding of the world, assuming that we are not sure whether what we know is right. This current assumes that the search for truth in the scope of science

> reveals at most[...] that a given theory is "good", in the sense that it adequately explains the world, that it allows predicting with some degree of reliability and that it presents itself as a better explanation than others available. (Rosario, 2018, p. 290)

Less research in mathematics education has focused on the new communication dynamics focusing on the analysis of discourses propagated by false news and hate speech. We believe that the scarcity of research may be related to the ethical dimension of scientific language, silenced by a logical positivism that reflected on the curricula of the courses of sciences, technologies and mathematics. According to Skovsmose (2005), discussions about dehumanisation of work processes, democracy, inclusion, racism, gender inequality, and politics are not topics of courses related to mathematics and applied mathematics; however, in a democratic society, they would be necessary.

Skovsmose and Valero (2001) argue that mathematics taught in schools takes into account the historical and social processes where it was created, without separating values, intentions, and interests from the subjects who developed it. Making students more prone to reflect and develop skills in critical thinking depends on a pedagogical approach that interrelates among the most varied school disciplines, as well as with the social, historical, and cultural contexts in which they develop and will develop. Presenting fragmentation of contexts with a view only to the results weakens the understanding of the open nature of the democratic process. It is essential that teachers strengthen their scientific thinking skills in the most diverse areas of knowledge, to inspire and help their students in the art of questioning truths and discourses.

With a view to critical education, many studies in the mathematics education area advocate that schools develop a pedagogical approach focusing on quantitative literacy. Bredberg (2020) recommends stimulating students' ability to evaluate and understand whether a numerical statement is reasonable or absurd. For example, from the title "Drinking water every 15 minutes cures Covid-19" it would be interesting to ask: What amount of water are we talking about? Is it possible to ingest this much water in a day? How would we have to get organised? What is the scientific basis for such a statement? Answering these questions requires basic mathematics knowledge, and this involves not

only technical numerical skills but also understanding the context in which mathematics is conveyed. In addition to answering about the reasonableness of information, other questions of social interest could be raised: how much would it cost the poorest to face this disease without government assistance? Who is responsible for elaborating and disseminating such statements? Whose interest and advantages would be behind the spread of information about the disease? How are the richest and poorest penalised during a health crisis?

Reflecting more on this topic would require understanding statistics; being able to read and produce graphs and tables, and understanding the idea of using samples to make predictions about populations. Moreover, it would require understanding that statistical producers could purposely present data in a way that makes a certain impression on people, a quick look at the information conveyed is not enough to draw conclusions, and the way of collecting data could also have been formulated in a biased or biased way. Other basic knowledge, such as economics, for example, may be necessary, such as understanding that the good or bad performance of an economy is not always linked to political leaders. Or estimating how a pandemic would affect people's social context and influence levels of inequalities.

In a democracy, mathematics should not be isolated and naturalised as intention-free, even when presented as science. Democracy is a complex concept, as it is based on the search for freedom and the guarantee of individual rights. However, this guarantee is only admissible if there is a collective commitment of the company in its search. Governments fail to ensure social equity, and every route involves open dialogue, intentions, and negotiations. Skovsmose and Valero (2001) question the idea of attributing the democratic role to institutions, for example, “the government is democratic” or “school is democratic”. Democracy comes from individuals who understand intentions, discourses, and share values such as respect, equality, justice, and social responsibility. Relying on critical citizens, who become politically and collectively active, who seek equality through the registration and consolidation of rights, would be the most viable way of guaranteeing democracy.

Due to the complexity of the communicative phenomenon and the emerging risks to democracy, we understand that in schools it is necessary to study a mathematics that is more solidary and less assertive, freer and less authoritarian, more collaborative and less competitive, more multidisciplinary and less fragmented. An active mathematics that helps recognise false news,

and yet goes beyond the idea that we must be prepared to denounce and disqualify those who misuse those argumentative resources.

CONSIDERATIONS

In this article, we focus specifically on the news that uses mathematical arguments to guide, shape, and reflect public opinion and popular thinking based on false information. Thus, we also seek to understand the role of mathematics education in the process of strengthening democracy. We understand that it would be important in all areas of education for researchers to focus on the new communication dynamics, focusing on the analysis of discourses propagated by false news, in the face of the contemporary problem of denialism and the attack on science. We analysed, from the perspective of communication theories that rely on pragmatic logic and critical mathematics education, two videos published on a YouTube channel, in which mathematical arguments were used to convince public opinion about a certain point of view.

With the study, we conclude that mathematical arguments used in discourses can give credibility to false news and be responsible for fixing beliefs and forming opinions. We also ponder that mathematical models and mathematical discourses used in virtual communication environments may be responsible for camouflaging the human factor of political decisions, overshadowing the visibility of ethical and morality variables in communication systems.

We suggest that, given the complexity of the communicative phenomenon, false news, and risks to democracy, it is necessary to study, in the field of mathematics education, pedagogical strategies that seek more solidary, interactive, collaborative, and multidisciplinary environments. Some questions emerge from this research and we recommend that they be objects of study in future research: How could mathematics education help in the ethical and democratic regulation of society from the study of fake news? How do teachers and students interpret and reproduce mathematical information from this news? What kind of pedagogical strategies and proposals would be desirable to help the population interpret opinions more critically?

We suggest that studies on these questions start from the premise that, in a democratic society, mathematics could not be isolated and naturalised as intention-free, nor given as the authority of absolute certainty in arguments. We propose that mathematics in this context be investigated as a communicative tool strongly associated with the strengthening of democracy, in which values

such as respect, equality, justice, and social responsibility are at the very core of the studies.

ACKNOWLEDGEMENTS

This work had the collaboration of the Study and Research Group on Mathematics Education, Modeling and Technologies – UFMG

AUTHORSHIP CONTRIBUTION STATEMENT

LOS and JLA worked together on the idealisation, planning, and execution of the project. LOS was responsible for the initial data collection and analysis and JLA was responsible for supervising and monitoring the execution of the project, analysing the data, and discussing them in the Study and Research Group on Mathematics Education, Modeling and Technologies. Both authors actively participated in the discussion of the results, 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, LOS, upon reasonable request.

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