Decoding algorithmic literacy among journalists

Methodological tool design and validation for preliminary study in the Portuguese context

Descodificando a literacia algorítmica entre jornalistas.

Desenho e validação de um instrumento metodológico para um estudo preliminar no contexto português

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Abstract

Recent developments in generative Artificial Intelligence (AI) have revitalized academic discourse on algorithmic systems, particularly on their potential, ethical considerations, risks, and regulatory challenges. Extensive research has examined how algorithms affect communication processes, focusing on their influence on news organizations, journalistic practices, public-media dynamics, media literacy, and combating disinformation and filter bubbles.

An emergent strand of research defines and measures the multidimensional concept of algorithmic literacy. However limited research exists on the intersection of algorithmic literacy and journalism. This gap is particularly concerning given the pivotal role of journalism in shaping public discourse, informing citizens, upholding democratic values and contrasting disinformation. Understanding how journalists perceive and engage with algorithms is essential, as these technologies significantly influence their professional tasks, including content production and distribution.

In Portugal, where newcomer journalists work in precarious conditions and digital media transformation is rapidly evolving, understanding how journalists interact with and perceive algorithms is vital. Our study, through a multi-phased approach, aims to fill this gap questioning how can algorithmic literacy, encompassing cognitive, attitudinal and behavioural dimensions, be effectively assessed among professional journalists?

The exploratory results present a validated methodological tool, instrument based on a multi-dimensional analytical framework and specifically designed to measure algorithmic literacy levels and to assess journalists' experiences. Critical discussion addresses the methodological procedures and preliminary findings from the pre-test, offering insights into Portuguese journalists' understanding, perceptions, and competencies regarding algorithmic systems.

By shedding light on the cognitive, affective, and behavioural aspects of journalists' engagement with algorithms, this study contributes to a deeper understanding of the algorithmic literacy among journalists, which is essential to sustain the quality of their work and for an effective counteraction against disinformation. It also opens avenues for similar studies in other geographical or professional contexts.

Keywords: Algorithmic literacy; Journalists; Methodology; Questionnaire; Portugal.

Resumo

Os desenvolvimentos recentes na Inteligência Artificial (IA) generativa revitalizaram o discurso académico sobre sistemas algorítmicos, particularmente sobre o seu potencial, considerações éticas, riscos e desafios regulamentares. Vasta literatura analisa a forma como os algoritmos afetam os processos de comunicação, centrando-se na sua influência nas organizações noticiosas, nas práticas jornalísticas, nas dinâmicas entre os meios de comunicação e os públicos , na literacia mediática e no combate à desinformação e às bolhas de filtro.

Uma vertente emergente define e mede o conceito multidimensional de literacia algorítmica contudo a investigação é ainda incipiente no que respeita a literacia algorítmica e jornalismo. Esta lacuna é particularmente preocupante dado o papel fundamental do jornalismo na formação do discurso público, na informação dos cidadãos, na defesa dos valores democráticos e no combate à desinformação. Compreender como os jornalistas percebem e interagem com os algoritmos é essencial, uma vez que estas tecnologias influenciam significativamente as suas tarefas profissionais, incluindo a produção e distribuição de conteúdos.

Em Portugal, onde os jornalistas recém-chegados trabalham em condições precárias e a transformação dos meios digitais está a evoluir rapidamente, é vital compreender como os jornalistas interagem e percebem os algoritmos. O nosso estudo, através de uma abordagem multifásica, pretende preencher esta lacuna questionando como pode a literacia algorítmica, abrangendo dimensões cognitivas, atitudinais e comportamentais, ser efetivamente avaliada entre jornalistas profissionais?

Os resultados exploratórios apresentam uma ferramenta metodológica validada, baseada num quadro analítico multidimensional e especificamente concebido para medir os níveis de literacia algorítmica e avaliar as experiências dos jornalistas. A discussão crítica aborda os procedimentos metodológicos e as conclusões preliminares do pré-teste, oferecendo insights sobre compreensão, percepções e competências dos jornalistas portugueses em relação aos sistemas algorítmicos.

Salientando os aspectos cognitivos, afetivos e comportamentais do envolvimento dos jornalistas com algoritmos, este estudo contribui para uma compreensão mais profunda da literacia algorítmica entre jornalistas, que é essencial para sustentar a qualidade do seu trabalho e para uma luta eficaz contra a desinformação, desbravando caminhos para estudos semelhantes em outros contextos geográficos ou profissionais.

Palavras-chave: Lietarcia algoritmica; Jornalistas; Metodolgia; Inquerito por questionario; Portugal.

Introduction

In *The elements of journalism* Kovach and Rosenstiel (2014) defend that the purpose of journalism is not defined by technology, nor by journalists or their techniques, but by the function played by news in citizen's the lives. Nonetheless, journalism practice, not its purpose, has been shaped by technology throughout its history, and this happens in at least four areas: "how journalists do their work; the content of news; the structure or organization of the newsroom; and the relationships between or among news organizations, journalists and their many publics" (Pavlik, 2000, p.226).

The algorithmic pervasiveness is widely recognized in our society (Koulu, 2020). Algorithms are not monolithic, varying in their ownership, design, rules and functional objectives (Saghiri et al., 2019). Algorithmic systems are critically defined as opaque black-boxes (Gillespie, 2019; Pasquale, 2015). Scholars and professionals are growingly concerned about the implications of their implementation, usage and governance on issues related to trust, ethics, social justice, fairness, accountability, transparency and explainability (Zuboff, 2019; 2023).

Currently, due to the rapid expansion of Artificial Intelligence (AI) and its generative systems, the discussion about the validity and justification of important decisions made by algorithms (Hargittai et al. 2020), their governance and regulation (European Commission, 2021; Ulbricht et al., 2022), and to what extent people know what algorithms and such systems are, or how they work (Bishop, 2019) is amplified and extremely relevant.

The skills of people to find, consume, evaluate, and produce information through media have been studied under the umbrella term media literacy (Livingstone, 2004), comprising a set of concepts and definitions related to – individual and collective – competencies and abilities, developed and specified along the technological and social evolution. Media literacy is key leverage in the construction of more equitable, democratic, free, and inclusive societies, as well as is essential to effectively embrace the fight against disinformation and misinformation (Frau-Meigs, 2023; Tomé & De Abreu, 2023).

In particular, algorithmic literacy is framed as a specific form of digital media literacy, related to people's awareness of the presence and impact of algorithm-based systems and to owning knowledge and critical perspectives about how to use this understanding (Dogruel, et al., 2021; DeVito,2021).

The definition of algorithmic literacy is still fluid and it has been studied in relation to heuristic processes and according to analytical dimensions, that support proposals of both theoretical and methodological frameworks (Dogruel, et al., 2021; DeVito, 2021; Silva et al., 2022; Oeldorf-Hirsch & Neubaum, 2021).

Among these approaches, one prevalent perspective conceives algorithmic literacy as a multidimensional construct. This construct typically encompasses three core levels: awareness, knowledge, and skills, which collectively serve to operationalize and measure the concept.

According to Swart (2021a, 2021b) algorithmic experiences are featured by three dimensions (cognitive, affective, and behavioral), connected to three forms of interactions with algorithms (understanding, sensing, engaging). Thus, algorithmic literacy and experience overlap and mutually nurture themselves, including the heuristic understanding of the technical and social processes by which algorithms are generated, distributed, and consumed, and the knowledge that allows users' control over these processes (Shin, 2021; Dogruel, et al., 2021). In this sense, algorithmic literacy crosses with concepts of *algorithmic imaginaries* and *folk theories* since it includes users' understanding of the way algorithms convey meaning and structure social interactions, with people and cultural contents (Bucher, 2012; DeVito, 2021). Research focuses on different levels of understanding, experiences and practices found in different segment of population, correlating the variance and factors as socio-economical, educational, professional, assiduity of usage or the specificities of the analysed algorithmically-drive platforms (Hargittai & Hinnant, 2008; Diakopoulos, 2019).

Despite the affirmation of algorithmic literacy as a flourishing research field, few studies seek to assess the algorithmic literacy of journalists (Beckett, 2019; Deuze & Beckett, 2022).

Investigating algorithmic literacy among journalists is relevant due to the critical role and the specificity of their profession within democratic societies, scrutinizing public and private issues in favor of public interest and accountability. Journalism produces verified information and aims to reach its publics, who are increasingly less interested, avoiding news contents and accessing them via social media and third-party sources (Cardoso, Paisana & Pinto-Martinho, 2022).

Newsroom and media owners struggle to test and find new models to distribute and monetize their contents reaching the audience, while trying to fight against disinformation, disseminating and enhancing trustful online contents.

Given the escalating significance of algorithmic systems in modern society, the necessity and responsibility for journalists to comprehend and navigate these technologies are intensifying. This is particularly crucial given that journalists not only employ these systems in their professional duties but also serve as reporters elucidating the public about these technologies.

Particularly about the Portuguese context and media ecosystem, to the extent of our knowledge, there is a research gap in this area. The need for better understanding how and to what extent journalists in Portugal

are aware and recognize the role of algorithms in their journalistic work and practices, reinforces the urgence and the ambition of answering to our main research question:

R.Q.1. How can algorithmic literacy, encompassing cognitive, attitudinal and behavioural dimensions, be effectively assessed among professional journalists?

This exploratory research aims to–navigate the theoretical and methodological challenges identified by scholars, particularly the difficulty in accurately assessing journalists' comprehension of opaque and ever-evolving algorithms. These issues are significant as they impact our ability to determine the alignment between journalists' understanding and the actual functionalities of specific algorithms in their professional practices.

This paper unveils preliminary results from our research, illustrating the proposed approach to overcome these challenges. We have developed and validated a methodological tool specifically designed to measure algorithmic literacy levels and to assess their experiences among journalists. This tool is tailored to the focal target group, characterized by their professional roles and expertise within the Portuguese journalistic landscape.

To address the research objectives, we applied an online pretest questionnaire (Bryman & Beel, 2016) to an initial sample of journalists working in Portugal. We first discuss the strengths and limitations of our methodological instrument, offering new perspectives on the adopted variables. Then the responses collected through the exploratory sample are analyzed using univariate descriptive statistics, adhering to our multi-dimensional analytical framework. This framework is structured to explore the cognitive, affective, and behavioral dimensions of journalists' interactions with algorithms.

The findings offer insights into the levels of algorithmic literacy and experience among Portuguese journalists, serving as indicators of emerging trends from the empirical data. Our contributions not only provide a foundational understanding of the current state of algorithmic literacy in the field but also enhance the methodological framework with a sophisticated data collection tool, intending to guide the direction for subsequent future research.

Literature review

Algorithmic systems

Automated decision-making processes (ADM) and algorithms can be considered as socio-technical artifacts (Elish and Boyd, 2018) that do not function in isolation, being embedded in specific societal, institutional, and organizational structures, featured by their own mechanisms, incentives, power relationships, and roles in society (Araujo et al., 2020).

Almost all digital tools and hardware use some type of algorithms to perform their functions, and people use them, delegating to them options, calculation, choices, and tasks' accomplishment with different levels of concerns and criticism. Complexity and pervasiveness of algorithms increased, until the designation of ours as "algorithmic society" (Pasquale, 2017), where algorithmic systems are defined as collections of algorithms working in concert (Silva et al., 2022).

The definition of algorithm encompasses the set of instructions followed and executed by a computer according to steps defined by its designer and is operationalized in many forms and typologies of algorithms, with different complexity levels, purposes and functions across various contexts and organizations (Downey,

2015 in Silva et al, 2022). The computer science approach tends to oversimplify the social, ethical, economic, and political complexities embedded in algorithmic design, since programming an algorithm requires a multitude of sources and choices, each of those have the potential to shape the consequences of algorithmic implementation.

Some algorithms lead only basic operations (classifying and filtering data, or storing and retrieving information), while more complex systems are adopted to implement functionalities such as personalization, data analysis, task-automation, and prediction (Saghiri et al., 2019). The latter are the infrastructures of very popular digital tools, such as social media, weather forecasting platforms or generative Artificial Intelligence (AI).

The most critical and common point on these tools is that the internal functioning criteria are mainly not public nor open (Gillespie, 2019; Pasquale, 2015). Scholars also raise issues about accountability reporting, trust, ethics and credibility, which are gaining increasing importance in the generative AI context, considering that algorithms are also optimized to meet the goals of the organizations that design and control them (Zuboff, 2019; 2023).

The influence of the algorithms on communication processes has been extensively investigated. Research analysis moves from social media platforms and dynamics to other sectors such as cultural production, audience formation and the entire ramifications of the platform society (van Dijck, 2021).

Communication scholars for example seek to identify transformations in news organizations and journalistic work (Küng, 2016; Beckett, 2019), how new technologies intervene within the public-media relationship through algorithmic gatekeeping (Napoli, 2015; Manninen et al., 2022) shaping new declinations of media literacy (Frau-Meigs, 2022), and why we can consider Artificial Intelligence as a social actor that participates and influences in multiple ways the disinformation phenomenon and its stakeholders (Cardoso, 2023).

A strong strand of research focuses on algorithms' functioning and their influence on online social networks and users' experience. Focusing on social media platforms, the newsfeed algorithms shape user experiences by curating the "flow of content, ideas, and sociability" (Rieder et al., 2018, p. 51) using algorithms that determine what posts are presented to users.

Since the first development of Facebook EdgeRank in 2007 (Bucher, 2012) this mechanisms of control of visibility and priority turn into huge phenomenon spread across global platforms, such as the GAFAM (Google, Apple, Facebook, Amazon e Microsoft), and consequently affecting the entire sectors of media, journalism, creative industries and further beyond (van Dijck, 2021; Niebog & Poell, 2018). Since algorithms are often platform specific, scholars' efforts support the understanding of specific digital tools functions.

Another focus of research is on users' understanding and perceptions of these algorithmic systems. In 2015 Facebook users were mostly unaware of filtering mechanisms, and when they discovered them people were surprised or even angry, moreover the lack of "feedback mechanism for users to understand the effects of their own actions on the system made difficult to assess the influence of either algorithm knowledge or ignorance" (Eslami et al., 2015, p. 153). Nowadays, online news consumers realize that often the contents offered to them are filtered, but still have a limited understanding of the criteria used (Powers, 2017; Swart, 2021b). Given the limited available knowledge about how algorithms work, users, from their personal interaction with these systems develop algorithmic imaginaries, defined as "way in which people imagine, perceive and experience algorithms and what these imaginations make possible" (Bucher, 2017, p. 31).

From such repeated experiences, people create "folk theories" as "intuitive, informal theories that individuals develop to explain the outcomes, effects, or consequences of technological systems, which guide reactions

to and behaviour towards said systems" (DeVito et al., 2017, p. 3165), being a sort of adaptable constructions, malleable to accommodate algorithmic changes on the platforms (DeVito, 2021). For example, folk theories built about Facebook mostly depend on *endogenous information* (people own experiences within the platform such as patterns of what contents and users appear in their feeds) but also *exogenous information* (from other media or discussions with friends) was used (DeVito et al., 2018).

Scholars inquire standard users, target-groups or professional content creators on platforms such YouTube, Instagram, Etsy and TikTok to analyse awareness and strategies to lead with processes of "algorithmic curatorship", "algorithmic labor", "visibility game" (Ma & Kou, 2021; Siles & Meléndez-Moran, 2021; Cotter, 2019; Alvarado et al., 2020) or, even worse, gender or race discriminatory bias.

All these approaches point to and are condensed by the multidimensional concept of algorithmic literacy, operationalized through the heuristic prism (Shin, 2021).

Algorithmic literacy

The notion of algorithmic literacy derives from the umbrella definition of media literacy (Livingstone, 2004; Frau-Meigs, 2022) concerning users' skills to find, consume, evaluate, and produce information through media, and its evolution in parallel with technological innovations and the consequent transformation of "people's cognitive, technical, motoric and emotional abilities required for effectively using newly emerging information and communication technologies" (Oeldorf-Hirsch & Neubaum, 2021, p.8). Media literacy is key leverage in the construction of more equitable, democratic, free, and inclusive societies, as well as is essential to effectively embrace the fight against disinformation and misinformation (Hobbs, 2016; Frau-Meigs, 2022; Tomé & De Abreu, 2019).

Thus algorithmic literacy refers to a recent strand of research focusing "specifically on whether and how people make sense of algorithms filtering information that is processed and displayed through new technologies" and has been defined in multiple ways, revealing both a "range of concepts that are being addressed" and "terminological inconsistencies" (Oeldorf-Hirsch & Neubaum, 2021, pp. 9-10).

For example, DeVito conceptualizes it as the fact of being aware of the presence and the impact of algorithm-based systems and knowing how to use this understanding and calls for the capacity to be aware of "both the presence and impact of algorithmically-driven systems on self or collaboratively-identified goals" and highlights the ability to "crystallize this understanding into a strategic use of these systems to achieve those goals." (2021, p.3).

Dogruel explains algorithmic literacy as "being aware of the use of algorithms in online applications, platforms, and services, knowing how algorithms work, being able to critically evaluate algorithmic decision-making as well as having the skills to cope with or even influence algorithmic operations" (2022, p. 4).

Algorithmic experiences: levels and dimensions

As illustrated by above examples, algorithmic literacy has undergone a progressive evolution since its inception (Hargittai et al., 2020).

Firstly, it was centered around algorithm *awareness* as a fundamental concern, primarily revolving around the recognition of the presence or absence of algorithms. Subsequently, algorithmic literacy began incorporating *knowledge*, emphasizing an understanding of the underlying workings of algorithms. More

recently, the field has shifted its focus towards the affective aspect, recognizing that individuals' *attitudes* towards algorithms significantly influence their usage and engagement.

The last dimension pertains to the development of *skills and competences*, enabling individuals to effectively leverage algorithms to their advantage.

In a broader context, Swart (2021a) posits that algorithmic experiences' analysis can be characterized by three distinct dimensions: cognitive, affective, and behavioral.

Understanding algorithms represents the cognitive comprehension of their existence and functioning; sensing algorithms represents the affective influences that algorithms have over users; engaging with algorithms represents the behavioural dimension of interactions with algorithms.

The multidimensional conceptual framework suggested by Swart (2021a) aligns with the model of Lomborg and Kapsch (2020) based on a communication perspective, which emphasizes the knowing, feeling, and doing aspects of algorithmic engagement. These authors adapt the communication theory of decoding to develop an understanding of algorithms with the purpose of highlighting the knowledge gaps that must be interpreted to ensure meaningful communication, in this case about and with algorithms. According to Lomborg and Kapsch, once algorithms cannot be directly decoded, users attempt to decode them through communication processes of knowing, feeling, and doing. These three stages of decoding algorithms synthesize the existing research on awareness of algorithms (knowing), and attitudes about algorithms (feeling), and points to necessary future work on assessing the effects of algorithmic literacy on behaviours (doing).

Deuze and Beckett propose a similar approach to define Artificial Intelligence literacy, moving from the knowledge level beyond, to "understanding and appreciating its normative dimension, as much as it is linked to impact and action: being able to identify ways to apply AI responsibly, creatively and efficiently"(2023, p.1915). Very similarly, AI literacy is featured by three key components: knowledge (understanding AI in the world as a subject of critical journalism); ability to recognize instances (for example particular workflow processes, stories, and packages where AI might be usefully and creatively applied or when it should be avoided); skills (to help, coach or teach others when strategically understanding, imagining, developing, and implementing AI) (idem).

Thus, algorithmic literacy can be conceptualized through three primary elements: cognitive, encompassing awareness and knowledge; affective, capturing attitudes towards algorithms; and behavioral, reflecting the practical application of algorithmic skills. This comprehensive framework enables a nuanced examination of algorithmic literacy, accommodating increasingly complex stages of understanding and utilization (Oeldorf-Hirsch & Neubaum, 2021).

The multi-faceted feature of algorithmic literacy brings methodological challenges and scholars have been converging on the need to identify key dimensions of analysis that allow for a holistic framework to study the phenomenon in its multidimensionality (Silva et al., 2022). This type of research usually focuses on social media usage and presents challenges since the inner workings mechanisms of the algorithms are mostly undisclosed, vary widely by platform, and are always changing (Andersen, 2020; Kitchin, 2017). Hargittai, et al. (2020) set out guidelines for what may or may not work for assessing these "black box" measures. For instance, directly asking social media users to report their level of literacy is unlikely to be useful, but instead more in-depth discussions of their experiences with algorithms may uncover what they really know. Most empirical efforts to uniformize the measurement of algorithmic literacy focus on cognitive dimensions lying on experimental studies about awareness and knowledge (Cotter & Reisdorf, 2020; Gran et al., 2021;

Zarouali et al., 2021). Awareness is more explicitly defined as "knowing that a dynamic system is in place that can personalize and customize the information that a user sees or hears" (Hargittai et al., 2020, p. 771).

Zarouali et al. (2021) provide the most developed quantitative measure of awareness with their validated 13-item Algorithmic Media Content Awareness (AMCA) scale. This standardized scale allows us to gain insights into people's ability to make proper sense of algorithms in digital platforms and measures the level of awareness of four constructs of algorithmic media platforms: content filtering, automated decision-making, human-algorithm interplay, and ethical considerations. One drawback of this scale is that it relies on users to assess their awareness of each construct for a specific platform, rather than generally.

Cotter and Reisdorf (2020) intend that "basic awareness provides a foundation on which to build an understanding of the criteria by which algorithms rank content (…) more advanced algorithmic knowledge includes insight about the principles and methods of software development that underlie algorithms and/or the social and political effects of algorithms" (p. 747). They conceptualize users' understanding and literacy with respect to the impact of algorithm-driven media.

Other quantitative studies adopt online surveys to analyse levels of awareness, directly inquiring internet users (Gran, Booth & Bucher, 2021), or algorithmic knowledge gap observing the usage of search engines (Cotter & Residorf, 2020).

DeVito's definition (2017) applies two dimensions of algorithmic literacy (awareness and practical use), Dogruel and colleagues (2021) expand it into four steps, by distinguishing awareness from knowledge, adding the ability to critique algorithms, and the skills to influence them. Dogruel, et al. (2021) categorize *awareness* and *knowledge* as cognitive dimensions of understanding algorithms. While representing distinct levels of understanding, neither necessarily extends to affective or behavioural aspects.

We also consider that knowledge levels about the existence of algorithms (that is, algorithmic awareness) is generally increasing (Klawitter & Hargittai, 2018), however expanding the gap between those who lack this literacy level and may be disadvantaged (Rainie & Anderson, 2017). In this sense algorithmic literacy has been pointed as the next digital divide (Gran et al., 2021; Zarouali, 2021), on both levels of algorithmic awareness and data inequalities (Lythreatis et al., 2022) following the principles rooting the framework of digital inequality (Reisdorf & Blank, 2021).

The *affective dimension* relates to emotional understanding and has been developed in the literature of attitudes toward algorithms, focusing on how individuals feel about them, and how these affective components also imply at least awareness, and potentially some component of skill.

Araujo and colleagues (2020) provide definitions of algorithmic appreciation/aversion and algorithmic perceptions, considering that experiencing algorithms users inevitably encounter FATE issues, as essentially related to people's understanding. The heuristic dimension of FATE is highlighted in experiences with AI or chatbot news services (Shin, 2021).

Analysing algorithm appreciation and heuristics, Logg and colleagues (2019) focus on attitudes such as how users perceive algorithmic features, how algorithmic trust and satisfaction are created toward these systems. Silva and colleagues posit that algorithmic literacy does not necessarily relate to trust in algorithmic systems, and their qualitative study shows how people make sense of algorithms and their role in society through affective processes.

Considering the behaviour-related dimensions of algorithmic literacy, two sub-dimensions are included to account for users' behaviours in terms of algorithmic curation: namely coping behaviours, creation and design.

Cotter (2022) tap into the behavioural dimension by proposing the practical knowledge of algorithms, "to capture knowledge located at the intersection of practice and discourse" (p. 2), thus knowing extends beyond knowing the factual basis for knowing *that* an algorithm exists, to make sense of *how* it is used in practice. This borders on the use of *skills*, though the ambiguity of algorithms offers no concrete proof of how skilled a user is in using them, highlighting a boundary condition of behavioural understanding.

We conceive algorithmic skill as referring to "users' knowledge about algorithms and their role in making online content visible, as well as users' ability to figure out how particular algorithms work, and then leverage that knowledge when producing and sharing content" (Klawitter & Hargittai, 2018. p. 3492). Scholars point to the relevance of distinguishing algorithmic literacy from concepts such as code literacy and programming capabilities, since the former goes beyond basic digital capacity and includes the heuristic understanding of the technical and social processes (Shin, 2021).

Journalism, algorithms and AI: professionals, work practices and training

The relationship between journalism, Artificial Intelligence (AI) and algorithms can be approached from two fundamental perspectives.

On one hand such innovative technologies, digital tools and socio-economic powers are part of the contents of journalistic work. Journalists must cover this area as part of their professional practice, reporting about it in the public interest, not only, neither necessarily, from a technical perspective but having some specialized and updated knowledge to report about it.

On the other hand, journalists must cope with their use as relevant tools for their work.

In both cases, such professionals need to understand how these algorithmic systems work, how they are used by different people and how they can influence or aid their specific work.

Regarding the first perspective, the academic research dedicated to journalistic reporting about AI and algorithms is scarce although this a very important area of study, hence the journalistic approach and work on this field could contribute to understand how information and framing of this field are made by journalists, influencing their audiences in their interpretation of what is happening in this area, also offering important clues and about journalist's literacy.

Barn (2020) mapped the public debate on ethical concerns showing how algorithms were approached in mainstream media and found that there is a tendency for what he calls *deification* and concludes that the "ethical concerns discussed are limited in scope and suggests that it is not clear what concerns dominate the debate" (2020, p.38).

In a society where algorithms are more and more used to make key decisions that impact everyday lives and when a big part of those algorithms are real black boxes that contribute to inequality and threaten democracy (O'Neil, 2016), it is important to engage news organizations on a closer look to how these systems work and their impact.

Thus, understanding how algorithms work, and knowing how to put them under scrutiny are nowadays essential skills for journalists and media professionals.

Considering the second perspective, the number of newsrooms working using algorithm and AI driven tools is growing and the importance of this area for journalism is highlighted by several authors (Beckett, 2019; Kotenidis, 2021; Diakopoulos, 2020; Newman et al., 2023). One of the first reports about AI implementation in the newsrooms, concludes that newsrooms are using AI and algorithms in three main areas: newsgathering; news production and news distribution (Beckett, 2019).

About newsgathering, Haan and colleagues (2022), studied the use of algorithmic tools by journalists for information gathering and showed that most of the tools used for these tasks are not specifically designed for it, so journalists mainly use search engines and social media for this process. Both tools are driven by algorithms "playing a major role when it comes to the search, selection, and verification of sources and information" (p. 1775). This research also found that journalists were not aware of the presence of algorithms as "facilitators" of the search process, stressing out that "they profess specific notions regarding the use of algorithmic-driven tools in the form of folk theories, which are predominantly negative regarding the influence of AI on journalism", and pointing also to a sense of professional authority among journalists that highlights their ability to work autonomously "of any kind of influence, including algorithms" (*idem*).

The report *Journalism, media, and technology trends and predictions* (Newmann et al., 2023) offers a more specific view on algorithm and AI driven projects, highlighting that media companies are integrating AI into their products with a special emphasis on personalization. "New applications such as ChatGPT and DALL-E 2 also illustrate opportunities for production efficiency and the creation of new types of semi-automated content" (2023, p.5). According to the authors, 28% of the interviewed newsrooms say AI is now a regular component of their tasks' accomplishment, with 39% affirming that they have been conducting experiments in the area.

Algorithms are also used to analyse big data and have an important role in debunking disinformation (Thomson et al, 2022; Giansiracusa, 2021), gathering and helping the analysis of contents from social media, often used as a source of information (Fletcher et al., 2020).

Algorithms related to automated news production, in some cases called robot journalism (Schapals & Porlezza 2020), are also making their way into the newsrooms, even if they are not new, having been used for more than a decade now, especially in areas such sports, finance and economy, by several news organizations, although they raise some issues about authorship (Newsreel 2 report, 2022).

The project points out that most of the time these kinds of tools are developed by an interdisciplinary team, combining IT and journalism professionals, among others (idem), which bring the issue of skills and training under the spotlight.

News distribution is another of the most relevant three areas in which newsrooms are adopting algorithmic systems. It is widely recognized that social media platforms are a key element for news distribution (Meese and Hurcombe, 2021). Digital News Report shows that people are getting more prone to consume news that comes from social media (Newmann et al., 2023). Consequently, to this growing importance of a group of global platforms, understanding and leading the process of news distribution and its pitfalls is a key issue for newsrooms, that use social media to get to broader audiences (Karlsen and Aalberg, 2023), aiming to sustain their business (Deuze & Beckett, 2022) and fighting disinformation spread (Khan et al., 2019)

In fact, newsrooms are using and analysing data from social media to measure engagement, page views, and time on page which can help inform content strategy, as well as leads generation and marketing strategies (Nieborg & Poell,2018; Morais & Jeronimo, 2023; Nielsen & Fletcher, 2023). The phenomenon of

platformization of news is expanding and a growing number of newsrooms also reported to use personalization strategies with AI technologies to improve user experience (Beckett, 2019).

Literature shows how and to what extent in very recent times professional roles and daily practices of journalists are continuously and dynamically changing (Deuze, 2023), particularly in smaller and younger newsroom functioning according to a sort of start-up logic, project oriented, with multiple tasks and objectives running at same time relying on reduced-size team and alternative business models (Crespo et al., 2020).

To face challenges and grab opportunities, professional training and formation are often pointed out as sensitive and urgent issues, by research focused on diverse regions and topics (Deuze, 2023; Kung, 2016; Castro-Moreno et al., 2023).

The report coordinated by Beckett (2019) finds that most of the interviewees from the 71 news organizations, stressed out the importance of training journalists in innovation and AI field, with some of them highlighting the role of literacy. Also, according to the Newsreel 2 project report (Newsreel, 2021), a significant part of the journalists that work with algorithms and AI, in general, are self-taught. The report mentions the lack of more specific courses, specially aimed at the use of algorithm and AI driven tools in journalism but doesn't explore the need for algorithmic literacy.

This leaves us with questions regarding the use of algorithms and Artificial Intelligence for journalistic work, that encompasses reporting on and using them as work tools. Moreover, these questions point out the need to engage with high levels of algorithmic literacy among journalists, hence their work in this area is of major importance.

Methodology

The primary aim of this study is to contribute to the growing body of research on algorithmic literacy, shedding light on the understanding perceptions, and capabilities of Portuguese journalists regarding their professional practice within algorithmically curated digital environments.

Specifically, this exploratory research is designed to address questions related to how algorithmic literacy, with its cognitive, attitudinal and behavioural dimensions can effectively be assessed among professional journalists in Portugal.

Considering scholars' achievement in defining and operationalizing measurement for algorithmic literacy,-we define two research objectives:

O1. To design, construct, and validate a specialized methodological instrument aimed at quantifying and assessing the algorithmic literacy and related experiences among professionals within the national journalism sector, characterized by specific criteria of professional expertise and specialization.

O2. To initiate a preliminary inquiry into the algorithmic literacy and experiences of journalists in Portugal, serving as an exploratory foundation for subsequent, more comprehensive investigations.

We employ a multi-dimensional approach to algorithmic literacy, relying on frameworks and methods established in existing research.

Firstly, we designed and tested an online questionnaire oriented to investigate the dimensions of algorithmic literacy of journalists, working in Portuguese news media organizations, with diverse business and production characteristics.

The design of this tool follows the theoretical framework of Swart (2021a; 2021b), that serves as basis to structure the analytical dimensions for the characterization of algorithmic literacy, distinguishing three main dimensions of algorithmic experiences (cognitive, affective, and behavioural[1]) and highlighting actions and behaviours undertaken by individuals in response to algorithmic processes.

Then we operationalized these dimensions in articulation with three algorithmic literacy levels, as methodological choice resulting from a ponderation between constructing a bulk questionnaire versus a segmented tool.

However, the ambition to create a comprehensive yet accessible questionnaire that encapsulates all dimensions in a single iteration presents its own set of challenges. The decision to opt for a more segmented approach versus a unified questionnaire involves trade-offs. While the former can provide depth, the latter offers a holistic view of the subject matter. Ultimately, strategic decisions must be made to balance these considerations, ensuring that the questionnaire is both thorough and pragmatic.

Doing this we recognize that the algorithmic literacy scale (Dogruel, et al.,2021) is currently considered the most comprehensive measuring attempt (Silva et al., 2022), capturing the levels of algorithmic awareness and knowledge, as sub-dimensions of the cognitive one. As shown on Table 1., additionally, we adopted indicators and metrics inspired by Gran and colleagues' research (2021) on attitudes, while skills are assessed based on literature about journalistic practices and algorithmic engagement, encompassing the behavioural dimension (Beckett, 2019).

Findings support further critical discussion about these three dimensions, their construction and empirical evidence.

Pre-test: sampling, data collection and analysis techniques

The primary objective of conducting a pre-test is to evaluate the clarity, relevance, and effectiveness of the methodological instrument, namely the questionnaire items (Lenth, 2001). This phase is crucial for ensuring that the questions are comprehensively understood and appropriately targeted to capture the multidimensional nature of algorithmic literacy.

The pre-test was initially conducted with a handful of journalists, who were asked to complete the questionnaire and provide feedback on various aspects, such as the wording of questions, the structure of the survey, and the time required to complete it. This feedback was critical to identify any issues or ambiguities in the questionnaire and amend them.

These methodological improvements and considerations are crucial for developing a research tool that is not only robust but also sensitive to the contextual realities of journalism. The choices we make in the design and structure of our questionnaire will significantly influence our ability to deepen our understanding of algorithmic literacy in the field of journalism.

The refined version results in a data collection instrument, applied to be tested through an online questionnaire structured on Qualtrics software and disseminated through professional networks and social

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[1] According to Swart (2021a) terms of cognitive comprehension, individuals strive to understand the existence and functioning of algorithms, thereby acquiring knowledge about their fundamental principles. The affective dimension, referred to as "sensing algorithms," acknowledges the emotional and psychological influences that algorithms exert on users, recognizing that individuals' attitudes and perceptions play a crucial role in their engagement with algorithmic systems. Lastly, the behavioural dimension, denoted as "engaging with algorithms," encompasses the practical aspect of interacting with algorithms.

media (using researchers' profiles on X, LinkedIn, Instagram and Facebook chosen to be the most frequently used by Portuguese journalists).

During the first month of surveying in 2023, we collected 32 answers and validated 28, according to two validation criteria: 1) respondent's self-description as journalist, 2) fully answered the three blocks of questions related to the three dimensions of algorithmic experience.

This sample provided a snapshot of algorithmic literacy within this cohort, however its admittedly modest size is a significant factor that deserves consideration. The acknowledgment of the limitations imposed by the sample's size underscores the exploratory nature of this study and its focus on the development and test of an adequate methodological instrument.

While the responses obtained have yielded valuable initial insights, it is important to acknowledge the constraints they place to the generalizability of our findings, that may not fully capture the wide array of experiences, viewpoints, and levels of understanding that exist within the broader journalistic community in Portugal. This limitation is particularly relevant when considering the diversity inherent in journalism, which includes variations in elements such as media platforms formats, geographical locations, specialization, educational backgrounds, and years of professional experience (Castro-Moreno et al., 2022).

Thus, it is worth noting that small samples can be useful in the preliminary stages of research for capturing initial patterns and trends, generate hypotheses, and lay the groundwork for more extensive, follow-up research (Guest, Bunce, & Johnson, 2006). In this context, our study serves as an initial investigation, providing a foundation upon which subsequent research can build, with larger and more diverse samples to validate, refine, and expand upon our initial findings.

Furthermore, as posited by Bryman and Beel (2016, p.163), "even when a sample is selected using probability sampling, any findings can be generalized only to the population from which the sample was taken". This statement underscores the notion that generalizability is not solely a function of sample size. In a similar vein, Lenth elucidates that "sample size is not always the main issue; it is only one aspect of the quality of a study design" (2001, p.10).

Besides the size of the sample, the inherently dynamic nature of algorithmic literacy as it interacts with evolving technology poses challenges to the external validity of the findings, once the results are inherently time-sensitive and susceptible to ongoing discourses about pressing technological issues (Bryman & Beel, 2016). Thus, the issue of sample size should not overshadow other crucial methodological considerations and operations during the exploratory phase of research.

The analysis of the 28 valid responses moves beyond mere representativeness to focus more intently on the distribution of values within the data. This perspective is crucial as it allows us to identify relevant leads or signs of potential trends emerging from the empirical field. These insights are invaluable in informing and guiding the direction of future research.

The analytical process employed univariate descriptive statistics (Bryman & Beel, 2016), adopting procedures to provide an explanatory frame of the sample and to organize the answers according to These descriptive statistics allow us to characterize the sample of journalists and shed light on initial insights about their algorithmic literacy.

Findings

The results of our study provide a valuable opportunity to critically examine the design and adequateness of the methodological instrument, as well as to glean meaningful insights from the data regarding the understanding and perceptions of sampled journalists in the context of algorithmic literacy. The analysis allows to present a combined discussion of empirical evidences and methodological reflexions, which is crucial, considering the pivotal role that algorithmic literacy plays in enhancing the quality of journalistic work and in equipping journalists to effectively combat disinformation in today's digital landscape, and the challenges posed by the development of effective research tools (Dogruel, 2021).

Questionnaire design

This combination of methodological and theoretical frameworks allowed us to probe deeply into journalists' engagement with algorithms, providing insightful understanding of their experiences. In the next session we critically deepen each dimension and its operationalization.

The design of the questionnaire is based on the multidimensional aspects of algorithmic literacy, encompassing cognitive, affective, and behavioural dimensions.

As shown on Table 1. the measurement of the level of algorithmic knowledge firstly considers the ability to correctly identify the definition of algorithm through a multiple-choice question. Secondly, according to Dogruel's measurement (Online Supplement, 2021) we posit a sequence of (false and true) assumptions and multiple-choice queries designed to test and ascertain the depth of respondent's comprehension of algorithmic functionalities and nuanced aspects.

To measure the level of algorithmic awareness we quantitatively assessed it using binary statements about whether a variety of 10 digital tools communication technologies embed algorithms to function. This formulation allows us to assess that the awareness level is higher the bigger is the number of digital tools selected by respondents, showing to what extent journalists recognize the transversality of algorithms' usage in working instruments frequently adopted (Beckett, 2019).

Turning to the affective dimension, the metric of attitudes is employed drawing upon the Likert scale instrument formulated by Gran and colleagues (2021). However, to accommodate the specificities inherent to the journalistic profession, attitudes are gauged on a Likert scale (from 1 to 5) referred to questions meticulously tailored to capture nuanced attitudes and satisfaction.

Lastly, the behavioural dimension is encapsulated through the variable of skills (Beckett, 2019; Deuze & Beckett, 2022).

Given the methodological limitations associated with capturing behavioural attributes in the absence of controlled experimental setups (Hargittai et al., 2020), skills are proxied through self-reported assessments. In this phase of research, we ask participants to indicate their training experiences and perception of proficiency in algorithm-related tasks.

Table 1. Questionnaire design chart

Algorithmic experience's dimensions	Algorithmic literacy's levels	Question	Variables	References
Cognitive	Knowledge	1. Select the correct definition of algorithm	a) a programming language used for web development b) a set of defined steps that computationally process input to produce a desired output c) a mathematical axiom used as the basis of equations d) a program used to copy data to an external hard disk for protection against data theft e) I don't know	Dogruel et al., 2022; Downey, 2015; Silva et al., 2020
Cognitive	Awareness	2. Which of the following digital tools have algorithm-based functionalities?	a) Wordpress (content management system) b) Adobe Premiere (video editor) c) Excel (spreadsheet) d) Mailchimp (email marketing) e) Canva (image editor) f) Chartbeat (online news performance monitoring) g) Google (search engine) h) Twitter (social media) i) Audacity (audio editor) j) Word (text editor)	Adapted from Dogruel et al., 2022
Affective	Attitudes	3. Rate your overall satisfaction with the use of these digital tools in your journalistic work:	Very Dissatisfied Dissatisfied Neither satisfied nor unsatisfied Satisfied Very Satisfied	Adapted from Gran et al., 2021
Behavioural	Skills	4. Have you acquired any skills or knowledge to understand and use these digital tools for journalistic purposes?	Yes No	
Behavioural	Skills	5. How did you acquire these skills or knowledge?	Self-taught Workplace training Self-initiated training	
Behavioural	Skills	6. Please specify the skills or knowledge you acquired?	Open answer	

Behavioural	Skills	7. When carrying out your journalistic work, what level of competence do you have in using social media platforms? (Facebook, Twitter-X, LinkedIn, TikTok, and/or others)	Very high High Medium Low Very low	
Behavioural	Skills	8. When performing your journalistic work, what level of competence do you have in the use of generative artificial intelligence tools? (ChatGPT, Bard, Bing, Midjourney, DALL-E, and/or others)	Very high High Medium Low Very low	
Cognitive	Knowledge	9. Next, we will present some claims about algorithms. Tick true or false according to your perception.	I can influence algorithms with my Internet usage behavior	Dogruel et al., 2022
			The database used by an algorithm is not decisive in determining its quality	
			The results of algorithms are always very different from the decisions humans would make	
			Algorithms can only run predefined processes	
			It is easy to identify whether algorithms discriminate against certain people	
			The use of algorithms that classify people based on certain criteria can lead to systematic discrimination against some people	
			What people do on the internet influences the databases used in an algorithm and can change its function in the future	
			Algorithms, in the form of bots (robots), can be used to automatically distribute opinions and information on online social networks	
			The use of algorithms that deliver personalized content can mean that the content you find is mostly consistent with your pre-existing opinions	
			The results of an algorithm can be skewed due to the input of incorrect data	
Affective	Attitudes	10. Next, we will present some statements about the role of algorithms in online social media platforms. On a scale of 1 to 5 (where 1 corresponds to completely disagree and 5 to completely agree), rate your opinion.	Algorithms in social media have a positive impact on the discovery and content reach	Adapted from Gran et al., 2021
			Algorithms in social media reduce exposure to different ideas and opinions, creating information bubbles (filter bubbles)	
			Algorithms in social media provide an opportunity for users to engage and interact with content that is most useful to them	
			Algorithms in social media put user's privacy and data protection at risk	
Affective	Attitudes	11. Next, we will present some statements on the use of algorithms in generative artificial intelligence tools such as GPT Chat,	Algorithms in generative artificial intelligence tools increase efficiency and productivity in journalistic tasks	Adapted from
			Algorithms in artificial intelligence tools always produce biased results	

		Bing, Bard and/or others. On a scale of 1 to 5 (where 1 corresponds to completely disagree and 5 to completely agree), rate your opinion.	Algorithms in artificial intelligence tools can generate quality journalistic work	Gran et al., 2021
			The use of algorithms in artificial intelligence tools to produce journalistic work should always be mentioned	
Socio-demographic characterisation	Individual	Gender	Male Female Non-binary/other gender	
		Age	18-24 25-29 30-34 35-39 40-44 45-49 50-54 55-59 60-64 65+	
		Education	No schooling Basic education Secondary education Bachelor's degree Master's degree Doctorate	
	Professional	Scientific area of training and/or specialization:	Open question	
		Professional position	Open question	
		11.2 Media organization	Press Radio Television Online	
		11.3 Geographic coverage of the media organization where you work	National Regional Hyper-Local	
		11.4 Years of experience as a journalist	Open question	

Source: own elaboration

Questionnaire results

The application of the questionnaire, conducted during a brief period in the 2023 summer-break season, received positive engagement from journalists in Portugal, with a total of 32 journalists participating. Out of these, a significant portion of responses, amounting to 28, were validated and considered for analysis. The positive participation and high response validation rate, achieved even during a typically less active period for professional engagement, indicate that algorithmic experiences are not only a critical aspect of journalists' professional lives but also resonate with their personal interests and concerns.

To critically analyse the results of the answers to the questionnaire, it is crucial to situate our sample of 28 journalists within the larger context of the Portuguese journalism landscape, which includes over five thousand active professionals as of 2023. While our sample offers valuable insights, it does not fully encapsulate the diverse range of experiences and perspectives present in the field. Therefore, the findings from this preliminary study should be interpreted as indicative rather than definitive.

The following section presents a critical exploration of findings and examines the efficacy of the dimensions used to assess journalists' algorithmic literacy. By scrutinizing the responses given by journalists, the aim is to evaluate the comprehensiveness and relevance of our methodological approach in capturing the multifaceted nature of algorithmic literacy among these professionals of information.

Sociodemographic Characterization

The sample of 28 journalists comprises an equitable gender distribution (n=14 female and n=14 male), which aligns with recent studies that indicate an increasing trend towards gender parity in journalism (Weaver, Willnat, & Wilhoit, 2019).

The age of the respondents varies, albeit skewed towards mid-senior career individuals and seasoned professionals, as 12 out 28 respondents fell between the age group of 40-49, and 10 are 50 or more years old. This demographic weighting hints at an experienced workforce, might influence their attitudes towards algorithmic technologies, but it also highlights a lack of representation from younger journalists who are likely more native to digital transformations.

Educationally, the majority of the respondents (12 out of 28) held university degrees, predominantly postgraduate. The high educational attainment, particularly in Communication/Journalism, could suggest increased technological aptitude and familiarity with digital tools (Hargittai & Hinnant, 2008). However, this may not necessarily translate into advanced algorithmic literacy or critical understanding of algorithmic impacts, which requires specific training and awareness.

In terms of professional background, most participants (21 out of 28) worked at the national level, with 6 at regional and one at the hyperlocal level. The diversity of media levels offers a broad perspective, yet the dominance of national-level journalists could skew the findings towards experiences and challenges more prevalent in larger, possibly more digitally advanced settings. The roles within journalism were varied, with the largest group self-identifying as journalists (15), followed by various other roles like freelancers (3), reporters and producers (3), and editors-in-chief (2). This diversity is crucial for understanding algorithmic literacy across different journalistic functions, but it also raises questions about how these different roles uniquely interact with and perceive algorithms.

Cognitive dimension

The cognitive dimension of algorithmic experience encompasses both knowledge and awareness as algorithmic literacy levels. In particular the level of knowledge was approached through a two-fold strategy. Initially, we assessed journalists' basic understanding of algorithms through a direct question (question 1), which served as a gateway to gauge foundational knowledge.
Focusing attention on the algorithmic knowledge, the fact that a substantial portion of the sample (20 out of 28) could accurately define an algorithm (as "a set of defined steps that computationally process an input to produce a desired output") suggests a good foundational understanding of algorithmic principles.
This aligns with the necessity for journalists to comprehend the technical basis of algorithms for effective navigation of today's digitized media landscape and also to be able to better exercise their scrutiny on platforms and their algorithms.
However, it's equally salient to consider that 8 journalists fail to answer that fundamental question about what an algorithm is, pointing to risks of potential vulnerability to misunderstandings or misinterpretations in their professional practices. A similar proportion of wrongs responses appears when asked to tell if is true or false that the "algorithms can only execute predefined processes," which reveals a lack of professionals' knowledge about the scholarly understanding that algorithms operate under pre-established rules and frameworks and cannot inherently possess the cognitive faculties to initiate actions or decisions autonomously (Diakopoulos, 2019).
To capture deeper layers of understanding, the questionnaire included more complex scenarios and applications of algorithms (question 9), not only regarding their technical aspects but also their broader implications in society.
Significantly we notice that half of ten (true-false) questions regarding knowledge dimension were correctly answered by almost all journalists within the sample. This suggests that some core principles of algorithmic functionality and its socio-technical implications are well-understood by

these professionals, but also that it is important to move beyond the basic definition and measure these nuanced understandings of algorithms.

In particular, the co-constitutive relationship between users' behaviour and algorithmic systems is recognized, as the online human activities influence algorithmic databases, thereby altering their future functionalities (Rieder et al, 2018). Similarly, the sample's acknowledgment that algorithms, shaped in the form of bots, can disseminate opinions, mis- and dis-information, aligns with current literature on disinformation spreading (Wardle & Derakhshan, 2017). Additionally, the recorded high level of agreement about the fact that algorithmic curation can create echo chambers, where users predominantly encounter content that aligns with their pre-existing opinions, adds empirical consistency to experts' concerns about the "filter bubble" phenomenon (Hargittai, 2020). Moreover, the affirmed notion that introducing incorrect data can distort algorithmic outcomes reflects the understanding of the "data quality problem" as pervasive in algorithmic systems (Diakopoulos, 2019).

Consistently with the results obtained about the conceptual definition, consequent gaps in nuanced comprehension emerge in certain areas. The two true-false questions that yielded the poorest performance are particularly enlightening.

Only 19 journalists correctly disagreed with the statement that "the database used by an algorithm is not decisive for its quality," reflecting perhaps a gap in understanding the importance of data quality in algorithmic systems (Diakopoulos, 2019), that paradoxically contradicts the overall excellent performance on the question about the effects of introduction of incorrect data. It suggests the need for more targeted questions that can unravel these contradictions and provide clearer insights into journalists' understanding. Even fewer, only 12 journalists, correctly identified the complexity involved in discerning algorithmic discrimination, a growing concern in recent years (O'Neil, 2016). Maybe adding more specific work-related scenarios, posting algorithmic discrimination as it applies to their day-to-day professional experiences, would give more insights into the wrong perspective that "It is easy to identify whether algorithms discriminate against certain people".

Regarding the assessment of levels of awareness (question 2), another part of the cognitive dimension, and surveyed journalists also have a relatively strong understanding of which digital tools in their workflow are algorithmically driven.

The results reveal a mean accuracy of 7.53 out of 10 possible points in assessing algorithmic awareness, with a standard deviation of 2.03. This score distribution largely concentrates between 8 and 9 correct answers. This resonates with existing literature which contends that journalists, as mediators of public discourse, must possess algorithmic literacy to navigate the complex digital media ecosystem (Diakopoulos, 2019).

Nonetheless, the data also suggests variability in awareness, as evidenced by a standard deviation of 2.03, indicating some disparity in the level of awareness. This indicates a need for a

complementary methodology that can capture this range more effectively. For instance, incorporating a tiered or graduated set of questions in the survey could help differentiate between basic, intermediate, and advanced levels of algorithmic awareness.

Affective dimension

The affective dimension explores the satisfaction levels of journalists towards digital tools (question 3) as well as their perceptions of algorithms in specific applications like online social media (question 10) and generative Artificial Intelligence systems (question 11). This strategy intends to be comprehensive in covering a range of tools and contexts, which is pointed as an essential approach to inquire the affective dimension of algorithmic literacy (Silva et al., 2022).

The data analysis presents a nuanced understanding of journalists' attitudes and perceptions towards such a variety of algorithmically driven tools, from digital services adopted in their workflow to the more specialized categories of algorithms embedded in social media platforms and generative AI.

Most of the small sample of journalists express high levels of satisfaction in using digital tools for their work, with a mean satisfaction level of 4.03 (on a scale from 1 – Very Dissatisfied to 5 – Very Satisfied) and a standard error of 0.74. Most of the respondents (18 out 28) reported being "Satisfied," followed by 8 who were "Very Satisfied." Only one was "Dissatisfied," and none reported being "Very Dissatisfied".

Such data aligns with previous research, suggesting that the adoption of digital tools enhances job satisfaction, due to increased efficiency and broader reach (Reinardy, 2011). However, this high satisfaction level in using digital tools for journalistic work, hides several nuanced aspects that might imply instances of technological barriers, skill deficits, or even ethical concerns that deter seamless adoption and favourable perspectives towards algorithms.

For example, the expressed attitudes towards social media algorithms manifest a dialectic tension: on one hand, there is an overwhelmingly positive evaluation of the algorithms' functional attributes, while on the other, ethical and socio-political concerns cloud this optimism.

Firstly, we observe a largely favourable stance towards the functional advantages offered by algorithms on social media platforms. Specifically, 19 out of 28 respondents either 'Partially Agreed' or 'Strongly Agreed' that algorithms substantially augment content discovery and reach. This suggests an acknowledgment of the instrumental role played by algorithms in distributing journalistic contents to a potential wider audience (Beckett, 2019). Similarly, most of the journalists, that is 17 out of 28, affirmed that algorithms enhance the users' engagement with contents perceived as relevant. However, this functional approval is juxtaposed with ethical reservations.

Notably, the survey's results indicate that journalists are critically aware of the darker facets of algorithmic sorting and filtering. Except only one, all journalists agree, either partially or strongly, that algorithms could lead to the creation of information bubbles, thus restricting the plurality of public discourse. This finding corroborates prior literature that has critiqued the narrowing effect of algorithms on the information landscape (Deuze & Beckett, 2022). Moreover, data reveal bifurcated viewpoints and concerns regarding the risk algorithms pose to users' privacy and data protection: 10 respondents 'Partially Agreed' and 10 more 'Strongly Agreed,' reflecting an overall awareness of the potential misuse of personal data in algorithmic systems.

In terms of attitudes towards generative AI algorithms in the journalistic field, data manifest a complex interplay between optimism, skepticism, and ethical considerations among sampled Portuguese journalists.

The most striking observation relates to the perception of efficiency and productivity gains attributed to generative AI algorithms.

A total of 22 out of 28 respondents, either 'Partially' or 'Strongly Agreed' that these algorithms could enhance operational efficiency in journalistic tasks. This result corroborates previous findings that suggest the adoption of AI-powered tools can result in optimized workflows and increased productivity in newsrooms (Beckett, 2019).

On the issue of algorithmic bias, the perspectives among respondents are decidedly mixed. 10 respondents 'Partially Disagreed,' while an equal number 'Partially Agreed' on the contention that generative AI algorithms inevitably produce biased results (Diakopoulos, 2019).

This divergence might be indicative of the changes occurring in journalists' perceptions of generative AI tools, that become less polarized to extreme judgment, while they increasingly multiply and penetrate in daily life of society, during work and leisure times. That is, they probably experiment and test them more and tune their attitudes (Araujo et al., 2020).

When asked about the impact on the quality of journalistic work, again the data revealed a divided stance. While 14 respondents were optimistic, affirming either 'Partial' or 'Strong Agreement,' eight were less so, offering a 'Partial' or 'Strong Disagreement'.

This suggests that despite general enthusiasm for the potential of AI in journalism, there remains caution, if not skepticism, regarding its ability to maintain or elevate the quality of journalistic output.

Perhaps most noteworthy is the near-unanimous advocacy for transparency in algorithmic applications within journalism. A striking 22 respondents 'Strongly Agreed' that any algorithmic intervention in journalism should be transparently communicated. This mirrors growing discourse within the academic community and the industry, emphasizing the ethical necessity for transparent algorithmic processes in journalism (Diakopoulos, 2019).

The data reveals a nuanced landscape where journalists exhibit both positive evaluations of the functional attributes of algorithms and concerns over their ethical implications. This suggests that

the questionnaire is successful in capturing the complex and often contradictory nature of journalists' attitudes towards algorithms. Additionally, the mixed responses regarding generative AI tools reflect the evolving nature of journalistic perceptions toward these technologies. This diversity in viewpoints is a strength of the methodologic instrument, as it allows for capturing a broad spectrum of opinions. However, it may benefit from deeper probing into the reasons and underlying factors influencing these seeming contradictions and diverse perspectives to gain more detailed insights.

Behavioural dimension

In evaluating the behavioural dimension, it is evident that the methodological approach sheds light on various aspects of journalists' practical engagement with algorithms, revealing insights into their skills (question 4) and training (question 5). Additionally, an open question (question 7) was included to determine the specific range of skills journalists have acquired.

Firstly, regarding the acquisition of competencies to understand and use digital tools in journalism, 13 of the 28 respondents affirmed having acquired some skills, while 15 did not. This nearly even distribution suggests that, while there is a segment of journalists engaged in continuous learning about digital tools, there remains a substantial portion that lack updated and better preparation for further digital transitions in journalism. This disparity raises questions about the uneven distribution of digital skills within the journalism profession, as it may have significant implications for the quality of reporting and the ability to combat disinformation effectively (Wardle & Derakhshan, 2017).

The findings offer valuable insights on behavioural experiences with and about algorithms, particularly related to professional digital tools, social media platforms, and AI.

The specificity of competencies acquired was confined mainly to informatics, social media management, and text editing. These foundational skills are essential but may not encompass the full range of capabilities required for adept handling of algorithmic and data-driven tools (Newsreel 2 report, 2022). This suggests a need for more detailed investigation into the range of algorithmic skills journalists are acquiring.

In terms of skills related to social media platforms' usage for professional work, most journalists (20) rated their skills as medium, while 9 rated theirs as high, and 3 as very high. No respondents reported low or very low competencies. This suggests a generally great level of expertise in using social media platforms, which are increasingly integral for news dissemination and audience engagement (Meese & Hurcombe, 2021). This is an important clue to be further explored qualitatively, asking about specific platforms, tasks accomplishment, or even if there is also high perception of competences in social media management.

However, when asked about tools powered by generative Artificial Intelligence (AI) - like ChatGPT, Bard, Bing, DALL-E and Midjourney - the results are markedly different. The majority (11) rated their skills' level as low, followed by 8 who reported very low competencies. Only 2 considered themselves very highly skilled, and 4 as highly skilled. This indicates a lag in the adoption and understanding of more advanced, AI-driven tools among journalists, a critical shortcoming given the accelerating AI advancements in the field (Deuze & Beckett, 2022). This discrepancy highlights a need for the methodology to probe deeper into the barriers and facilitators for journalists in acquiring advanced digital skills, particularly in AI.

Asked about the source of competences' acquisition a most significant number (11) reported being self-taught, followed by 9 who obtained training on their own initiative, and 6 through workplace training. This suggests that the ongoing training and professional development are less supported by formal institutional education or workplace HR policies, leaving individual professional alone in their research and effort to be better prepared, which could be detrimental for the preparation on algorithmic literacy, especially in terms of the collective professional category homogeneity and equal access to information and tools. Our findings recall the report *Impact of Disinformation on the Media Industry in Spain and Portugal* (Moreno-Castro et al., 2022), that inquires journalists editors-in-chief, to identify how their newsrooms deal with disinformation results, and alert for the abundant informal practices among journalists, and the generalized lack of specialised training in 70% of the observed news media organisations.

Results discussion and conclusions

This exploratory study aims to address the noticeable gap in understanding the algorithmic literacy among journalists by constructing an appropriate methodological tool and validating it to research about algorithmic experience and literacy of journalists in Portugal.

The focus of this paper was pivotal in setting the groundwork for this exploratory journey. It entailed the careful design, validation and discussion of a methodological instrument, crafted within a multi-dimensional analytical framework, to effectively gauge the algorithmic literacy in this specific journalistic context.

The preliminary findings from the pre-testing and testing phases offer invaluable insights into Portuguese journalists' understanding, perceptions, and competencies regarding these systems.

The discussion of the results, considering that the sociodemographic characterization of a small Portuguese journalists' sample, provides valuable context to the subsequent findings on algorithmic literacy. Our sample predominantly comprises educated, mid-career professionals specialized in journalism, working in diverse roles primarily at the national level. These sociodemographic features are not merely descriptive but have substantive implications for the

understanding of algorithmic literacy. For instance, the predominance of senior and mid-career professionals could suggest a certain level of comfort or familiarity with technological innovations due to their years of experience in the field. However, it could also imply potential resistance or skepticism towards newer algorithmic technologies that are disrupting traditional journalistic practices. Similarly, the high level of education observed may correlate with a better understanding or adoption of algorithmic tools, but this remains an assumption that needs to be rigorously tested.

Findings allow to identify to what extent journalists understand the transversality and pervasiveness of algorithms and their relevance on the tools used to work, highlighting their attitudinal approach and self-evaluated level of practical competences within the framework of algorithmic literacy.

The results of the cognitive dimension indicate a reasonably high level of algorithmic awareness but expose certain gaps in nuanced algorithmic knowledge among journalists. Areas such as the significance of databases in determining algorithmic quality, the subtleties of algorithmic discrimination, and the evolving nature of algorithms themselves appear to be less understood. Given the importance of these facets in the era of digital journalism marked by disinformation challenges (Wardle & Derakhshan, 2017; Moreno-Castro et al., 2023), these gaps signify crucial avenues for further training and research.

Attitudes towards algorithms reveals a nuanced perspective among Portuguese journalists. Generally, their attitudes towards digital tools in their work are optimistic, resonating with the narrative that views technology as an enabler for journalism. This is particularly evident in attitudes towards algorithms' impact on content discovery, reach, and even work efficiency—key aspects that align with more positive general attitudes towards technology (Beckett, 2019). However, this positive outlook is tempered by concerns surrounding the 'filter bubble' effect, privacy risks, bias, and transparency. This dualism perhaps indicates a maturing algorithmic literacy among journalists, wherein the positive general attitude towards digital tools and algorithms does not lead to an uncritical acceptance but is balanced by a nuanced understanding of the algorithms' limitations and risks (Diakopoulos, 2019).

On the behavioural dimension the data showcase a journalistic workforce in flux, negotiating varying degrees of comfort and proficiency with algorithmic tools. While there are areas of relative strength, such as social media utilization, conspicuous gaps in comprehensive algorithmic literacy are evident, most notably in the realm of artificial intelligence. These findings suggest an urgent need for targeted, perhaps even bespoke, educational interventions to level the playing field, especially given the pivotal role of algorithmic literacy in combating disinformation and upholding journalistic standards.

While our research does face certain limitations, particularly a relatively small sample size of 28 valid responses, this serves the exploratory phase of our study, which offers preliminary insights

and identifies trends within the scope of our sample. However, these findings should be interpreted with caution and cannot be generalized. They represent a starting point rather than a comprehensive overview of algorithmic literacy across the entire field of journalism in Portugal. The results, therefore, may not be fully indicative of the broader population of journalists, limiting our ability to make definitive conclusions about the state of algorithmic literacy at a national level. We deem it important to emphasize the inherently dynamic landscape of algorithmic literacy, shaped by rapid technological changes. Such a volatile context naturally introduces questions about the external validity and replicability of findings in this area, as they are subject to temporal limitations and influenced by concurrent media dialogues on critical technological issues (Bryman & Beel, 2016). Importantly, these considerations should be distinguished from limitations related to sample size. Drawing on existing literature, most notably Lenth (2001), we argue that the potential for generalizing findings is a composite result of multiple factors, including the design and context of the study. Consequently, this exploratory phase serves as an initial milestone to prosecute with wider multi-methods research towards a more comprehensive understanding of algorithmic literacy in journalism.

This research highlights the importance of a well-developed, multi-faceted research instrument in capturing the complexities of this field. The instrument's development was underpinned by the recognition of algorithmic literacy as a complex construct, demanding a comprehensive and nuanced approach to gather meaningful information. Ensuring the tool's robustness and representativeness was paramount, as algorithmic systems are intricate and multifaceted.

Overall, the multidimensional approach of this instrument successfully captured essential aspects of algorithmic literacy among journalists. However, the questionnaire's design and test also illuminate the existence of aspects of possible enhancement that should be critically addressed.

For instance, about the cognitive dimension measurement, the testing phase and preliminary results bring us to consider that measuring the level of awareness through a single question about 10 professional tools presents risks. This approach may not adequately capture the diverse spectrum of awareness levels among journalists raise the need to complement data collection with more varied set of questions, tailored to be context-specific and directly relevant to journalistic practices, ideally posed through interviews or focus group, which are methods that allow to an in-depth and more personal discussion, practical example and open-end answers.

The findings related to the affective dimension of algorithmic literacy suggest that the questionnaire is successful in capturing the complex and often contradictory nature of journalists' attitudes towards algorithms. Additionally, the mixed responses regarding generative AI tools reflect the evolving nature of journalistic perceptions toward these technologies. This diversity in viewpoints is a strength of the methodologic instrument, as it allows for capturing a broad spectrum of opinions. However, it may benefit from deeper probing into the reasons and

underlying factors influencing these seeming contradictions and diverse perspectives to gain more detailed insights.

To enhance the methodology, more emphasis could be placed on exploring how personal experiences, professional roles, and the specific media environment influence journalists' affective responses to algorithms. This could involve more personalized questions or segmenting respondents based on their work environment (e.g., digital-native newsrooms vs traditional media).

Referring to the results about the behavioural dimension we acknowledge that the reliance on self-reported data may introduce biases in the skill assessment, in particular an under or over estimation of competencies (Swart, 2021a). More context specific questions that inquire directly about the day-to-day professional use of algorithms could contribute to more objective measures and validation of the reported skills. The findings on the behavioural dimension underscore the necessity for tailored professional development programs that address the specific needs of journalists in the digital age. Another set of questions could be implemented to investigate what types of training and support journalists find most valuable and feasible, and to directly link journalists' digital skills to their practices in reporting and addressing disinformation.

Possible strategies of enhancement of our methodological choices are: expanding the analytical dimensions, the scope and depth of our questionnaire's questions; complementing and combining the instrument with other techniques, following the scientific exploration that suggest the adoption of in-depth interviews or focus-groups as a further integration of the professional contexts and perspectives, aiming to achieve a more detailed understanding of how journalists interact with, comprehend, and are impacted by the complex, algorithm-driven landscape of modern journalism. A notable consideration in refining the methodological approach is the balance between comprehensiveness and respondent engagement. While an extensive questionnaire can provide a wealth of data, it also raises the risk of increased non-responses and may pose challenges in maintaining a complete and multidimensional survey. To address this, one strategy could be to segment the study into three distinct parts, each focusing on one dimension of algorithmic literacy. This separation would allow for more in-depth exploration within each dimension without overwhelming the respondents.

Future study can replicate and improve our methodological framework and adopt the elaborated tool, extending the period, size and geographic focus of data collection. Moreover, scholars can add value including new technological developments and more sophisticated analysis of tools, used for specific job's tasks, and eventually extend to areas collateral to distribution and access to news, such digital marketing and social media management.

To gain a comprehensive understanding of how sociodemographic factors impact algorithmic literacy, future research must engage in cross-variable analyses. For instance, it would be insightful to investigate if journalists with higher educational qualifications are indeed more adept

at integrating algorithmic tools into their practice. Similarly, it would be helpful to grasp if the number of years in the profession correlates with a more nuanced understanding—or perhaps skepticism—of algorithmic technologies.

Another valuable inquiry could examine if the type of media outlet (online, print, etc.) influences algorithmic literacy, as platforms can do (Silva et al., 2022). The national versus regional focus of the journalists may also present divergent views on the role and trustworthiness of algorithms in news dissemination. Such analyses could employ statistical methods like multiple regression to determine the strength and direction of these relationships. Specifically, the need for sophisticated cross-variable analyses stands out as a crucial next step in understanding the complex interplay between sociodemographic factors and algorithmic literacy in journalism. It would also be beneficial to include qualitative methods, such as interviews or focus groups, to capture the nuanced perspectives that quantitative data may not fully reveal.

Further research can add more in-depth and qualitative perspective exploring levels and experiences of literacy in each of the three phases of journalism practice algorithmically supported, as pointed by Beckett (2019), approaching them from the generative AI adoption perspective (Deuze and Beckett, 2023), new tools for debunking, extracting or generating information or to personalize news as well as including the formation of new AI-driven algorithmic imaginaries (Bucher, 2012).

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