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Artificial intelligence and the dawn of an algorithmic divide

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Emerging technologies like artificial intelligence (AI) and algorithms reshape news curation and consumption. Against this background, previous research has been focused on divides between groups regarding access to such digital technologies. Disparities in awareness and knowledge of AI across socio-demographic groups seem to persist, potentially leading to an algorithmic divide. Despite this situation, there is still limited research into such an emerging inequality. Building on the framework of algorithmic literacy, this study aims to contribute to this gap with findings from a national representative study in Germany ($N = 1{,}090$) in January 2022, considering socio-demographic factors such as age, gender, and education. Findings shed important light on the extent to which news audiences are knowledgeable about the use of AI and algorithms in news selection and recommendation, as well as in society. The results of our analysis imply that newsrooms should increase their knowledge about the potential divides created by applying AI across sectors to various socio-demographic groups and stay vigilant about the level of transparency of their AI use.

KEYWORDS

algorithmic divide, artificial intelligence, journalism, literacy, Germany

1 Introduction

Within the past decades, news media in Germany and elsewhere have experienced high disruption due to the digital transformation of journalism. Emerging technologies, such as artificial intelligence (AI) and algorithms, have also reshaped how news is curated, accessed, and consumed by the audience. Especially digital intermediaries such as search engines and social media platforms play a pivotal role in the context of the growing influence of AI and algorithms on citizens' information access and knowledge production (Flensburg and Lomborg, 2023; Oeldorf-Hirsch and Neubaum, 2023b). At the same time, there is a lack of (digital) media literacy education in Germany (Tulodziecki and Grafe, 2019), which also applies to the use of digital technologies like AI or understanding algorithms. In fact, media literacy initiatives at a federal level mainly focus on the safe use of the internet and social media or education of parents regarding television broadcasting rather than technologies (Petranová et al., 2017, p. 62).

In turn, the current developments and subsequent heightened awareness of AI-powered technologies have prompted academia to explore the framework of algorithmic literacy, encompassing the understanding of and engaging with algorithms and related implications (Swart, 2021). At its core, algorithmic literacy involves understanding how algorithms function and critically evaluating their impact on decision-making processes and information dissemination (Dogruel et al., 2022a). As literacy is thought to strengthen the audience's critical thinking abilities, thus enabling them to distinguish more accurately between what is true and false and what is trustworthy or not (for an overview, see Dogruel, 2021), algorithmic

literacy should help them in navigating the emerging ecosystem of AI in journalism (Sjøvaag, 2024).

Despite the ubiquitousness of AI and algorithms in everyday lives (i.e., social media, search engines, and chatbots), disparities in awareness and knowledge about them across different socio-demographic groups have emerged, which could lead to a so-called algorithmic divide. At the same time, this emergent form of inequality has yet to attract much policy and scholarly attention. While Lythreatis et al. (2022, p. 7) assert that "there is a massive opportunity to explore algorithmic awareness and data inequalities" (see also Lutz, 2019, p. 142; Yu, 2020, pp. 334, 335), journalism scholarship has so far paid scarce attention to how this divide may increase the gap between journalism and its audiences. Journalism's core mission is not only to inform people but also to hold powerful elites accountable. Journalism should also enable people to act politically and make informed decisions (Meier, 2018, p. 16). Moreover, journalists should contribute to decreasing rather than increasing differences in society. As AI and algorithms can be seen to shift power relations in society (Jungherr, 2023), journalists are responsible for keeping audiences informed about developments in this technological domain and decreasing the gap between the information-rich and the information-poor in this regard.

Drawing from previous research, this study follows the call by Oeldorf-Hirsch and Neubaum (2023b) to explore the previously identified varying knowledge about AI and algorithms as well as the associations between age, gender, and education across different user groups in other national contexts outside the US. This is useful to journalism as it can help newsrooms target user groups that fall behind in technological development, strengthening journalism's democratic mission.

We aim to contribute to the research state of the art by analyzing the cognitive dimension of the audience's algorithmic literacy against the background of a possible algorithmic divide in Germany. The country is a relevant case to explore in this context because the population still struggles to recognize the relevance of algorithms in their everyday lives. At the same time, there is a growing acceptance of (partially) automated decision-making in specific applications with a strong potential for social harm (i.e., credit scoring procedures, preselection of job candidates, and facial recognition technology in public spaces) (Overdiek and Petersen, 2022).

2 Literature review

Emerging technologies such as AI and algorithms have led to a shift in the media environment with their many application areas (i.e., personalizing content, data management and analytics, dynamic pricing, and programmatic advertising). Nowadays, not only is it important to have algorithm skills to efficiently use such technologies (Gruber and Hargittai, 2023), but also to think about potential inequalities in knowledge about them. In this context, AI can be described as "a label for currently dominant computational techniques and technologies that extract statistical correlations (designated as patterns) from large datasets, based on the adjustment of relevant parameters according to either internally or externally generated feedback" (Suchman, 2023). Algorithms mainly refer to "a finite series of precisely described rules or processes to solve a problem. It is a sequence of stages that transform input through specified computational procedures (throughput) into output (Latzer et al., 2016, p. 397).

2.1 Algorithmic literacy and related concepts

The critical role that algorithms and AI play in how people get their information from internet services (e.g., Netflix or Spotify), search engines like Google, and social media platforms (e.g., Facebook, TikTok, or *X*)[1] can be interpreted—besides other reasons—as a driving force that has led to increasing awareness of such technologies by the public.

Well-developed algorithmic literacy is linked to critical thinking about AI technologies and their impact on society. Given the possibility of personalized advanced AI assistants acting on behalf of individuals (Milano and Nyholm, 2024), the critical evaluation of interacting with technology has become central. Moreover, algorithmic literacy is of importance when it comes to news media specifically. On the one hand, journalists need to be aware of the algorithm's influence on their gatekeeping role within the newsgathering process (Cools et al., 2021) and that generative AI can produce false information (Ji et al., 2023). On the other hand, the public needs to critically reflect upon the content they consume, as AI-generated content could soon be indistinguishable from human-generated content (Groh et al., 2024). Moreover, the gradual integration of AI into various aspects of journalistic distribution processes has changed how news content is selected and recommended for the audience and how content management can be automated (e.g., Thurman and Schifferes, 2012; Møller, 2022; Raza and Ding, 2022). Finally, as AI-generated information is based on data, often extracted from unknown sources, the potential bias of generative AI can have an impact on knowledge production itself. Particularly as data is fed back into the world, reproducing taken-for-granted assumptions about the world (Van Dijck, 2014) that can exaggerate, enhance, and augment social inequalities, influencing principles of inclusion, diversity, and universality (Kennedy et al., 2021).

Various terms have been used to examine the understanding of how algorithms work, their implications, and the ethical considerations they entail (for an overview, see Oeldorf-Hirsch and Neubaum, 2023b). Against this background, Swart (2021) has proposed a framework for algorithmic literacy, categorizing the many ways of understanding and engaging with algorithms into three dimensions: cognitive, affective, and behavioral. By combining the cognitive and behavioral dimensions, Dogruel et al. (2022b, p. 118) thus describe the concept 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" (emphasis in original). Linked to this concept is AI literacy, commonly defined as "the ability to understand, use, monitor, and critically reflect on AI applications without necessarily being able to develop AI models themselves" (Laupichler et al., 2022, p. 1) and AI competence, which refers to both literacy, with prerequisite factual

1 Formerly known as Twitter.

knowledge and practical skills to recognize and interact with AI, and general attitudes toward AI (Wang et al., 2024). The cognitive dimension—which will be the main focus of this paper—relates to two interconnected but separate concepts (Petrovčič et al., 2024). The first one is algorithm awareness, a condition to form a cognitive understanding of algorithms (Martens et al., 2023, p. 208). The concept can be described as the (often self-reported) ability to perceive or know if 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). The second one, algorithmic knowledge, defined as "a practice that leverages meaning making within local assemblages of people, algorithms, practices, and settings," which "entails knowing how to accomplish X, Y, or Z within algorithmically mediated spaces (practice) as guided by the discursive features of one's social world (discourse)" (Cotter, 2024, p. 2137; see also Cotter and Reisdorf, 2020). Furthermore, Lomborg and Kapsch (2019, pp. 750–752) propose a differentiation between professional (i.e., learning during education), experience-based (i.e., learning by interaction), and third-party knowledge (i.e., learning through news media) about algorithms.

As shown, the extent of terms associated with algorithmic processes is a significant theoretical challenge to define the cognitive dimension of algorithmic or AI literacy. In the present study, we adapt the operationalization by Oeldorf-Hirsch and Neubaum (2023a). Thereby, algorithmic literacy is a form of knowledge and awareness of how and where algorithms and AI work (e.g., content filtering and automated decision-making). Moreover, several studies indicate that the awareness (and perception) of algorithms and AI is context-and platform-dependent, with a distinction between algorithm awareness and understanding (see, e.g., Gruber and Hargittai, 2023).

Owsley and Greenwood (2024) have shown that self-reported awareness of AI is not only generally low but even declines when individuals are asked about specific applications of AI. However, awareness of AI in journalism and broadcast news was notably lower, with only 29% of the participants aware of AI in use for journalism and only 19% aware of AI used in broadcast news. Moreover, Monzer et al. (2020) have shown that German online news readers have a basic understanding of algorithmic news personalization but fail to distinguish it from commercial targeting.

Kozyreva et al. (2021) conducted a representative online survey on public awareness of AI technologies online in Germany, Great Britain, and the United States. Most were familiar with artificial intelligence and aware of AI's presence in smart assistants, search engine results, and social media advertising. However, they were less aware of areas like curating social media news feeds. Doing 26 semi-structured in-depth interviews, Martens et al. (2023) concluded that there is a certain awareness of an algorithmic system.

These results echo (Sehl and Eder (2023)). The findings from their study about the audience perspective on news personalization show that three-quarters of the respondents in Germany and the UK have heard of indirect personalization of news content through algorithms and also have noticed it in their usage (e.g., of news websites or-apps, social media platforms, search engines, ads).

In their cross-European country study ($N = 10{,}960$), Grzymek and Puntschuh (2019) found a lack of knowledge about algorithms among the respondents, with 48% showing no or little familiarity with what an algorithm is. Additionally, one-fifth of them are unaware of algorithms' application across various domains, like areas impacting social inclusion such as lending, job selection, and medical diagnostics. However, men and individuals with higher formal education levels are more familiar with algorithms than women and individuals with lower education levels. At the same time, the older the respondents were, the lower the proportion who had never heard of algorithms.

2.2 Algorithmic divide

The (first-level) digital divide, traditionally understood as the gap between those who have access to digital technologies and those who do not (Van Deursen and Van Dijk, 2019; Van Dijk, 2020), has been a focal point of research for decades (for an overview, see Lythreatis et al., 2022).

The concept originates from unequal access to and use of information and communication technologies (ICT) as well as "the ways in which longstanding social inequalities shape beliefs and expectations regarding ICT and its impact on life chances" (Kvasny, 2006, p. 160). Initially framed around access to physical infrastructures such as computers and internet connectivity, recent research has described a second-level digital divide with a gap in technological knowledge and skills and a third-level digital divide with unequal participation in technology use (e.g., Scheerder et al., 2017; Gran et al., 2021).

With the proliferation of digital platforms and the rise of algorithmic decision-making systems (e.g., Kaun et al., 2024), inequality in the digital age is significantly shifting. However, as technological advancements continue to shape society, a new form of disparity emerges —the algorithmic divide.[2] Such a divide has a strong resemblance to the structure of digital divides, which means a split in terms of socio-demographic backgrounds (see, e.g., Lutz, 2019; Cotter and Reisdorf, 2020; Ragnedda, 2020, pp. 61–83; Gran et al., 2021; Zarouali et al., 2021; Oeldorf-Hirsch and Neubaum, 2023b; Cotter, 2024). As rightfully stated by Gran et al., (2021), p. 1791: "Being aware of and navigating consciously on the Internet infrastructure could be seen as a new and reinforced level of digital divide."

According to Yu (2020), the algorithmic divide refers to disparities in (1) awareness about the impact of machine-learning algorithms and intelligent machines on everyday life and knowledge of how algorithms actually operate, (2) access to algorithm-enhanced products and services, (3) affordability to a type of product and service, (4) availability as a specific type of product or service might not exist, and (5) adaptability of new technologies to individuals specific needs.

Previous research on algorithmic awareness and knowledge indicates a divide between different socio-demographic factors and other variables. For instance, initial research by Cotter and Reisdorf (2020) indicates that algorithmic knowledge building depends on age and educational background.

Findings by Gran et al. (2021) indicate a significant lack of awareness of algorithms among the Norwegian population, with most participants reporting low or no awareness. There is also a divide between men and women–with the latter perceiving lower levels of algorithm awareness–age and education. Younger age groups and the

2 Carter et al. (2020) have coined the term "AI divide," which relates to a divide in access, capability, or outcome.

most educated cohort indicate high and very high levels of awareness. These findings echo research by Kennedy et al. (2023) about the awareness of AI among US adults. They also found a divide along income, with lower income groups showing lower levels than those from upper income.

Powers (2017) and Swart (2021) have shown context-dependent limited awareness of news personalization algorithms among younger age groups. Those who use multiple online platforms (e.g., Google or Facebook) and spend more time on them are more likely to understand how algorithms reflect specific values and interests and how personalized news might impact their ability to stay informed.

In a study about public attitudes toward the use of AI in journalism across 28 countries, Ross Arguedas (2024) shows gaps in AI awareness across socio-demographic groups. On average, younger and higher-educated individuals are more aware of AI than older and less educated. Moreover, men are more likely than women to have heard or read about AI.

Using data from a panel wave study in the Netherlands, Zarouali et al. (2021) have shown a general lack of knowledge, manifesting in misconceptions about algorithms. Older and less educated respondents have consistently shown more misconceptions than their younger and more educated counterparts. Moreover, a higher proportion of women than men have given incorrect answers, especially about whether algorithms can solve every societal problem. Moreover, Wang et al. (2024) identified several groups according to their AI competence. Mainly older people and those with lower levels of education and privacy protection skills, who have shown the lowest levels of AI knowledge and AI skills.

3 Research questions

Against the background of the possible dawn of a new digital divide (Gran et al., 2021), this study aims to analyze the varying algorithmic knowledge among different groups in relation to key socio-demographic variables (i.e., age, gender, and education). While they are well-researched in communication sciences, Oeldorf-Hirsch and Neubaum (2023a) remark: "When considering the general population, there is a [*sic*] still a need to assess this basic awareness, particularly as an outcome of various demographic variables." Therefore, the study investigates the following research questions:

> RQ1: What is the relationship between socio-demographic variables and awareness and knowledge about algorithms and AI?
>
> RQ2: What is the relationship between socio-demographic variables and knowledge about algorithmic or AI-driven news selection and recommendations?

4 Methods

This study takes a quantitative research approach based on a survey conducted on behalf of the Bertelsmann Foundation in Germany. Secondary data analysis of such open-access data sets with a large sample of respondents "are more representative of the target population and allow for greater validity and more generalizable findings" (Johnston, 2014, p. 624).

To go beyond the initial analysis of the parent study, a more in-depth analysis of variables that were not sufficiently focused on will be conducted. To secure the appropriateness and data quality in advance, we follow the evaluative steps for secondary data analysis by Stewart and Kamins (1993).

The initial study explored "what the German public knows about algorithms and artificial intelligence as well as how it perceives digital technologies and their impact on society" (Overdiek and Petersen, 2022, p. 11). The Allensbach Institute (Institut für Demoskopie Allensbach), a renowned research organization in Germany, was responsible for the data collection.

In total, 1,090 respondents over the age of 16 were questioned face-to-face in January 2022. The respondents were selected using representative quotas, meaning the survey results can be generalized to the German population as a whole. The sample has 48.6% female respondents ($n = 530$) (51.4% male, $n = 560$). Age ranged from 16 to 98 years ($M = 50.85$, $SD = 18.632$). A total of 28.6% have no educational degree or lower education (39.2% moderate, 32.3% higher) (Table 1).

The study is based on various variables, dealing with knowledge about the functions and use of algorithms and the acceptance of algorithms. The definitions of AI and algorithms applied in this survey were derived from a previous study at the Bertelsmann Foundation (Fischer and Petersen, 2018). The respondents were divided into two groups with slightly different questions. In this context, the survey used the German term *Bekanntheit*, situated between knowledge and awareness in English. The first group ($n = 545$) was asked about algorithms, which were described as rules according to which computer programs proceed to solve tasks automatically, give recommendations, or make decisions. The second group ($n = 545$) was asked about artificial intelligence, described as computer programs that can be used to automatically solve tasks, give recommendations, or make decisions that would be generally done by humans.

The selected variables for this study are as follows:

Awareness of algorithms and AI: Following the framework by Swart (2021), the findings relate to the cognitive dimension of algorithmic literacy. As such, knowledge and awareness about algorithms (group A) or AI (group B) were measured with two statements ("Have you heard the term algorithm before this interview, or is this the first time you have heard it?" and "And would you say you know a lot, something, or hardly anything about how algorithms work?"). The awareness was measured explicitly by asking the

TABLE 1 Distribution of age groups by gender (in percent).

	Male	Female	Total
Under 18	2.8	2.0	2.4
18–24	8.1	7.5	7.8
25–34	14.3	12.3	13.3
35–44	14.0	14.4	14.2
45–54	16.0	14.8	15.4
55–64	20.4	21.6	21.0
65–74	14.9	13.4	14.1
Over 75	9.4	14.1	11.8

$N = 1,090$ (weighted); the sum of the percentages deviates from 100% due to rounding.

respondents to rate the perceived influence of algorithms or AI on their everyday life today on a four-point scale (1 = very strong to 4 = not at all).

The respondents were also given a list of 17 areas where they would decide if computer programs made decisions or recommendations with the help of algorithms or artificial intelligence. We focus on the awareness of (online) news and current news selection and recommendation as AI and algorithms shape information flows in the news and, therefore, have a structural impact on the public arena (Jungherr and Schroeder, 2023).

In this context, we need to trust respondents' potentially overestimated subjective statements on awareness and knowledge, as stated by Timmermans and Cleeremans (2015, p. 40): "We do not and cannot have direct access to people's subjective experience, and hence have to rely instead on potentially biased reports."

Socio-demographics: Identifying the respondents' gender followed the common practice of binary gender measurement with two categories: Female (woman) and male (man). Such an approach is justified as the research focuses on "how individuals identify or express themselves from a social perspective" (Lindqvist et al., 2021, p. 341).

Respondents indicated their age in an open-ended format, which was grouped for the analysis (16–98 years in 5-year groups, e.g., 18–24 years) (Table 1). For education, the respondents were asked to specify their highest educational degree, which was collapsed into three categories: lower education,[3] moderate education,[4] and higher education.[5]

5 Findings

Beginning with a general overview, the results indicate that most of the surveyed individuals in both groups have at least heard about algorithms (80.8%, $n = 440$) and artificial intelligence (88.0%, $n = 479$).

A total 43.8% of the respondents stated that they only had some knowledge about how algorithms operate, while 49.7% made such a statement for AI. Conversely, 39.9% of the respondents stated they have little to no knowledge about algorithms, a sentiment echoed by approximately one-third of respondents (35.1%) regarding AI.

Moreover, perceptions of the influence exerted by algorithms vary among respondents, with 29.2% reporting a strong or very strong impact on their lives. In comparison, 42.8% perceive their influence as less strong or hardly any. This perception is less pronounced in the other group of respondents, where only 13.9% state such levels of influence for AI.

The robustness of these findings is supported by a statistically significant association between algorithmic or AI knowledge and perceived influence [X^2_{Algo} (16, $n = 545$) = 232.336, $p < 0.001$, $V = 0.326$; X^2_{AI} (16, $n = 545$) = 146.390, $p < 0.001$, $V = 0.258$]. Most respondents who state they possess a quite precise understanding of algorithms also report a strong influence of algorithms on their lives (31.5%, $n = 41$). Similarly, about one-third of individuals with a lot of knowledge about AI perceive a significant impact on their lives (33.3%, $n = 23$).

Regarding the relationship between socio-demographic variables and awareness and knowledge about algorithms and AI (RQ1), we observed the following results:

Education is a pivotal factor influencing individuals' abilities to engage with new technologies, thereby contributing to the dynamics of digital divides (Van Deursen and Van Dijk, 2014). The findings underscore this significant association between education levels and knowledge about algorithms and AI.

Most of the respondents with higher levels of education state at least some knowledge about algorithms (56.8%) and AI (53.9%), with one-quarter of them stating to know a lot about these terms (26.8% for algorithms; 26.3% for AI). Conversely, respondents with lower levels of education tend to express limited knowledge about both terms, with a notable majority stating that they have hardly any or no knowledge, particularly about algorithms (45.9%; 25.6% for AI). Looking at the group with a moderate level of education reveals that most respondents have some knowledge about algorithms (44.6%) and AI (55.4%). Again, the differences between knowledge about algorithms or AI in the context of education are statistically significant [X^2_{Algo} (8, $n = 545$) = 142.602, $p < 0.001$, $V = 0.362$; X^2_{AI} (8, $n = 545$) = 90.472, $p < 0.001$, $V = 0.408$] (Table 2).

In addition to education, age is a significant demographic factor in the digital divide. Regarding the distribution of algorithmic knowledge across different age groups, older respondents, particularly those over 65 years old, tend to exhibit the lowest levels of knowledge. In contrast, younger age cohorts demonstrate the highest levels of knowledge. Notably, individuals between 18 and 24 years of age emerge as the most knowledgeable group, with 31.6% reporting they know a lot about algorithms.

Similar patterns emerge concerning knowledge of AI, with younger age groups displaying greater precision in their knowledge, particularly among those under 18. Some knowledge about AI seems to be relatively evenly spread across age groups. Approximately 50% of respondents fall into this category, excluding those over 75 years old.

At the same time, a quarter of respondents in the over 75 age group (25.4%) and one-fifth in the 65–74 age group (20.8%) state to have never heard of the term AI. Furthermore, 15.4% of respondents under 18 also report no knowledge about AI whatsoever. Age and knowledge about algorithms and AI are shown to have a significant and robust association [X^2_{Algo} (28, $n = 545$) = 103.140, $p < 0.001$, $V = 0.217$; X^2_{AI} (28, $n = 545$) = 79.516, $p < 0.001$, $V = 0.191$] (Table 3).

Gender is another significant factor influencing individuals' knowledge about algorithms and AI, with notable differences observed between male and female respondents.

Male respondents tend to state higher levels of knowledge with both terms than their female counterparts. Nearly half of the female respondents stated that they know hardly anything or nothing at all about algorithms (47.9%), a proportion notably higher than the 31.3% of the males. Conversely, a greater percentage of male respondents claim to possess a lot of knowledge about algorithms (23.0%), contrasting with only 8.9% of females.

Similarly, regarding AI knowledge, most participants of both genders indicated that they had some knowledge about the term (51.5% of males and 48.2% of females). However, a significant

3 Ohne Abschluss, Hauptschulabschluss/Volksschulabschluss bzw. Realschulabschluss, polytechnische Oberschule.

4 Realschulabschluss, Mittlere Reife, Abschluss der 10-klassigen polytechnischen Oberschule, Fachhochschulreife.

5 Allgemeine oder fachgebundene Hochschulreife, abgeschlossenes Studium an einer Universität, Fachhochschule oder Pädagogischen Hochschule.

TABLE 2 Distribution of algorithm and AI knowledge by education (in percent).

	Algorithms			Artificial Intelligence		
	Lower	Moderate	High	Lower	Moderate	High
A lot	1.4	16.4	26.8	4.3	8.9	26.3
Something	26.4	44.6	56.8	38.4	55.4	53.9
Hardly anything	25.7	24.4	12.6	30.5	24.9	13.2
I do not know the term	45.9	14.1	3.3	25.6	8	4.2
Do not know	0.7	0.5	0.5	1.2	2.8	2.4
n (weighted)	148,04	213,23	183,76	163,58	213,57	167,83

$n_{Algo} = 545$; $n_{AI} = 545$ (weighted).

TABLE 3 Distribution of algorithm and AI knowledge by age groups (in percent).

	Algorithms							
	Under 18	18–24	25–34	35–44	45–54	55–64	65–74	Over 75
A lot	14.3	31.6	26	19.7	17.6	10.7	11.1	4.2
Something	57.1	44.7	46.8	53.9	47.1	52.4	33.3	20.8
Hardly anything	28.6	15.8	14.3	7.9	23.5	24.3	28.4	25
I do not know the term.	–	7.9	13	18.4	11.8	10.7	27.2	48.6
Do not know	–	–	–	–	–	1.9	–	1.4
n (weighted)	13,84	38,67	75,90	77,16	84,91	102,37	81,01	71,17

	Artificial intelligence							
	Under 18	18–24	25–34	35–44	45–54	55–64	65–74	Over 75
A lot	30.8	17.4	23.5	14.1	19	7.9	5.6	3.4
Something	46.2	43.5	50	59	53.6	51.6	50	32.2
Hardly anything	–	34.8	10.3	19.2	17.9	31	22.2	32.2
I do not know the term	15.4	4.3	16.2	6.4	7.1	6.3	20.8	25.4
Do not know	7.7	–	–	1.3	2.4	3.2	1.4	6.8
A lot	30.8	17.4	23.5	14.1	19	7.9	5.6	3.4
n (weighted)	12,54	46,37	68,7	77,93	82,38	126,03	72,66	58,37

$n_{Algo} = 545$; $n_{AI} = 545$ (weighted).

proportion of male respondents (27.6%) report having hardly any or no knowledge about AI, while 42.1% of the female respondents do so. Gender and knowledge about algorithms and AI are also shown to have a significant and robust association [X^2_{Algo} (4, $n = 545$) = 29.707, $p < 0.001$, $V = 0.233$; X^2_{AI} (4, $n = 545$) = 22.318, $p < 0.001$, $V = 0.203$] (Table 4).

Regarding the respondents' knowledge of using algorithms or AI for news selection and recommendation, it becomes evident that most respondents acknowledge knowledge of this specific application area (63.0%, $N = 1,090$).

When examining the relationship between socio-demographic variables and the knowledge of news selection and recommendation facilitated by algorithms and AI (RQ2), consistent patterns identified in the analyses mentioned above emerge.

Regarding gender, a slight majority of male respondents (51.7%) report knowledge of such an application area, in stark contrast to female respondents. Many of them perceive a lack of knowledge (56.6%). Gender and knowledge of news selection and recommendation by algorithms and AI are shown to have a significant but negligible association [X^2 (1, $N = 1,090$) = 6,920, $p = 0.009$, $V = 0.080$].

TABLE 4 Distribution of algorithm and AI knowledge by gender (in percent).

	Algorithms		Artificial Intelligence	
	Male	Female	Male	Female
A lot	23	8.9	18.6	7.5
Something	45.7	42.1	51.5	48.2
Hardly anything	16.2	25	19.3	26.4
I do not know the term	15.1	22.9	8.3	15.7
Do not know	–	11.1	2.3	2.1
n (weighted)	264,77	280,26	264,80	280,18

$n_{Algo} = 545$; $n_{AI} = 545$ (weighted).

When looking at age as a demographic factor, it is notable that most respondents across various age groups claim knowledge of news selection and recommendation by algorithms and AI. Specifically, respondents in the age group of 55–64 exhibit the highest self-reported knowledge (22.3%), followed by those in the 45–54 age group (17.3%) and the 35–44 age group (16.2). The association between age and knowledge is statistically significant [X^2 (7, $N = 1{,}090$) = 62,940, $p < 0.001$, $V = 0.240$] (Table 5).

Similar patterns emerge when examining the relationship between educational levels and knowledge of news selection and recommendation through algorithms and AI. Respondents with lower education especially express a lack of knowledge regarding this topic. Conversely, the discrepancy regarding the level of knowledge between the moderate and higher education groups is relatively minimal, with 40.4% of respondents with moderate education and 39.1% of those with higher education reporting to know about algorithms and AI being used for news selection and recommendation. Notably, higher-educated respondents exhibit the lowest proportion of individuals claiming no knowledge. Again, the differences are statistically significant with a medium association [X^2 (2, $N = 1{,}090$) = 69,108, $p < 0.001$, $V = 0.252$] (Table 6).

6 Discussion

AI and algorithms have become increasingly influential in the media environment as they shape the cognitive process of how and which information is accessed and consumed by the audience. This change has the potential to be disruptive as well as empowering (Shanmugasundaram and Tamilarasu, 2023). Against this background, it is essential that people have the skills to efficiently use and understand the basic inner workings of such digital technologies (Gruber and Hargittai, 2023).

The intensive developments of new technologies—with OpenAI's ChatGPT being one of the most prominent examples—in the past years has led to initial experience with and perception of AI and algorithms in many application areas all over the world (see, e.g., Fletcher and Nielsen, 2024; Strippel et al., 2024, pp. 13–16). At the same time, disparities in attitudes toward them and literacy across various socio-demographic variables prevail.

Building on previous research findings, this study explored the possible emergence of an algorithmic divide among a nationally representative sample of 1,090 respondents in Germany through secondary data analysis.

The findings show that, in general, most respondents have at least heard about AI and algorithms while only having a vague understanding of how such technologies operate. Moreover, there is no feeling of a strong or very strong impact of AI or algorithms on their lives, if hardly any. At the same time, disparities in knowledge about AI and algorithms among different socio-demographic groups are also present in Germany, which hints toward the dawn of an algorithmic divide. These findings can be attributed to several factors rooted in societal, educational, and technological contexts.

The study reveals a distinct pattern whereby older age groups show lower algorithmic knowledge levels than their younger counterparts. This observation aligns with broader societal trends reflecting the digital divide, wherein younger generations often display higher levels of digital proficiency (Van Dijk, 2020). The age-related differences in algorithmic knowledge can be attributed to several factors, including differences in exposure to and familiarity with digital technologies (Kebede et al., 2022), as well as varying levels of receptivity to learning new digital skills among different age groups (Livingstone and Helsper, 2007). Furthermore, the rapid pace of technological advancements may contribute to a generational gap in algorithmic literacy, as older individuals may encounter challenges due to beliefs about capabilities and physical and cognitive capabilities in keeping pace with evolving digital technologies (Kebede et al., 2022).

Gender is another dimension of the algorithmic divide. The findings reveal that male respondents tend to state higher levels of algorithmic knowledge than their female counterparts. This gendered pattern reflects broader gender inequalities related to algorithm awareness (Gran et al., 2021). However, Cotter and Reisdorf (2020) concluded that gender does not predict algorithmic knowledge. Societal stereotypes and gender norms may influence individuals' perceptions of their technological aptitude (Hargittai and Shafer, 2006), exacerbating gender differentials in algorithmic literacy. Moreover, the findings echo Beyer and Bowden (1997) (see also Reilly et al., 2022), who concluded in their study about gender differences in the accuracy of self-perception that women tend to under-evaluate their own performance.

TABLE 5 Distribution of knowledge of algorithms and AI for news selection and distribution by age (in percent).

		Under 18	18–24	25–34	35–44	45–54	55–64	65–74	Over 75
Individual selection of news and current news that are shown to me as an internet user	Yes ($n_{weighted}$ = 686,61)	1.7	9.3	14.1	16.2	17.3	22.3	12.1	7.0
	No ($n_{weighted}$ = 403,40)	3.5	5.2	11.7	10.9	12.2	18.9	17.6	20.1

$N = 1{,}090$ (weighted); Question: In which of these areas did you know that computer programs make decisions or recommendations with the help of algorithms or artificial intelligence?

TABLE 6 Distribution of knowledge of algorithms and AI for news selection and distribution by education (in percent).

		Lower education	Moderate education	Higher education
Individual selection of news and current news that are shown to me as an internet user	Yes ($n_{weighted}$ = 686,61)	20.6	40.4	39.1
	No ($n_{weighted}$ = 403,40)	42.2	37.2	20.6

$N = 1{,}090$ (weighted); the sum of the percentages deviates from 100% due to rounding. Question: In which of these areas did you know that computer programs make decisions or recommendations with the help of algorithms or artificial intelligence?

Education can also be described as a determinant of algorithmic literacy, with disparities observed across educational levels. Overall, the findings indicate that individuals with higher levels of education tend to state greater knowledge compared to those with lower levels of education. This disparity may stem from access to educational resources and opportunities, wherein individuals with higher levels of education are more likely to possess the cognitive skills to engage with new technologies efficiently (Van Deursen and Van Dijk, 2014; Tsiplakides, 2018). Furthermore, formal education is crucial for transmitting digital literacy skills and fostering critical thinking abilities necessary for navigating algorithmic systems (Warschauer, 2003).

The findings address the ongoing discussion about the knowledge of algorithms and AI in journalistic practice and academia (e.g., Deuze and Beckett, 2022). Comparing our findings with previous findings from other European countries (e.g., Gran et al., 2021; Zarouali et al., 2021), the US (Kennedy et al., 2023) or multi-country (Ross Arguedas, 2024), similar patterns emerge. While in recent years, more and more Germans have at least heard about algorithms and artificial intelligence and seem to be generally aware of such technologies being used for various tasks (Overdiek and Petersen, 2022), an algorithmic divide remains visible in terms of knowledge among different groups about key socio-demographic variables. Moreover, the knowledge of news selection and recommendation facilitated by algorithms and AI is also congruent with patterns identified in the analyses mentioned above.

In general, our findings indicate a persistence of the digital divide in the age of AI. While most people nowadays have at least heard of algorithms and AI and their manifold application areas (i.e., for news and content recommendation), there is an alienation of specific groups such as women, older people, and less educated people. A possible reason could be that "experiences with existing digital technology, whether positive or negative, are likely to impact perceptions, experiences, and attitudes toward new digital applications such as AI" (Bentley et al., 2024).

News media has been a target of critical approaches to knowledge divides in society for decades (Lind and Boomgaarden, 2019), and the emerging algorithmic divide is no exception. What we take from these insights is that news organizations should remain vigilant as to the levels of technical knowledge that their audiences possess. For legacy media, particularly for public service media, the divide between low income, education, gender, and age should help ensure their public service remit to reach all audiences. Also, for newspapers, these results should alert news editors and managers as to the growing knowledge divide between the readers they seek (typically younger audiences) and the readers they have (typically older audiences) (Wang et al., 2024). Future research should thus also explore additional factors such as socioeconomic status, cultural background, and geographic location to understand digital inequality in the AI age better. As AI has the potential to influence the cognitive foundations of knowledge production itself (see Van Dijck, 2014), either by strengthening assumptions about the world or exacerbating socio-cultural differences (Kennedy et al., 2021), journalism also needs to stay vigilant in their own use of AI, as Generative AI also feeds information back to society.

Our study also has some limitations. While our findings from Germany identified a significant influence of gender on algorithm and AI knowledge, there is a possibility of overconfidence by male respondents. At the same time, there are no conclusive findings about such overconfidence in the self-reporting of knowledge (Moore and Dev, 2017). Another limitation is that the study only provides a snapshot of the algorithmic divide in Germany in January 2022. Given the swift evolvement of AI and the complexities of digital transformation with its manifold application areas, the algorithmic divide could be even further widened in a comparatively short period of time (see, e.g., Hendawy, 2024).

7 Conclusion

The present study provided new insights into awareness and knowledge of AI and algorithms, which align with broader trends observed in other country contexts, suggesting a persistent digital divide in the era of AI. While the findings have shown that a significant portion of the population in Germany has heard about AI and algorithms, this is not the case equally across all sociodemographic groups. The impact of AI and algorithms emphasizes the necessity of enhancing public information and educational outreach to promote technology literacy. These efforts should focus on enhancing algorithmic literacy across society more broadly, particularly among older demographic groups and individuals with lower educational levels, to ensure equitable access to the benefits of AI and mitigate the risks of exclusion.

In addition, there is a need to foster a deeper understanding of how these technologies function and their potential impacts on the selection and recommendation of news. There is a need for a broader discourse about informing the parts of the population that are unable to assess the risks and consequences that are a part of these technologies, like fragmentations of the public sphere (Magin et al., 2022), or levels of inclusion and diversity in news representation (Kennedy et al., 2021).

There are further opportunities for research as well. First, longitudinal studies on algorithmic literacy could examine how algorithmic literacy evolves across different demographic groups. This would help identify trends and possible factors influencing shifts in knowledge. Second, expanding the research scope to other countries could provide a more comprehensive understanding of how different cultural, educational, and policy contexts impact algorithmic literacy. Comparing findings across diverse settings could uncover universal patterns. Third, an evaluation of specific educational programs' effectiveness in improving algorithmic literacy could provide valuable insights into best practices for increasing knowledge and understanding of AI.

Data availability statement

Publicly available datasets were analyzed in this study. This data can be found at: https://www.bertelsmann-stiftung.de/umfrage-algorithmen2022.

Author contributions

ME: Conceptualization, Data curation, Formal analysis, Methodology, Project administration, Visualization, Writing – original draft, Writing – review & editing. HS: Conceptualization,

Formal analysis, Funding acquisition, Supervision, Validation, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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