Civic statistical literacy for democratic education

Joachim Engel
Ludwigsburg University of Education, Germany
engel@ph-ludwigsburg.de

Democracy depends on public reasoning grounded in evidence. For democratic societies to thrive, citizens must be able to understand socially relevant data, assess the credibility of sources, and participate in informed public debate and decision-making. In the contemporary information environment, these capacities are increasingly challenged by misinformation, selective availability of data, and unequal access to information. This paper argues that civic statistical literacy—understood as statistical literacy oriented toward democratic participation—requires more than technical skills. It highlights critical evaluation of data quality, source credibility, and contextual interpretation as core competencies. Beyond an individual perspective, the paper examines how structural conditions—such as access to data, data ownership, and the organization of information ecosystems—shape democratic culture and constrain or enable civic participation. We propose a conceptual framing of civic statistical literacy that connects individual competencies with societal and institutional dimensions of democracy, and discuss implications for democratic education.

STATISTICAL LITERACY AS A CIVIC COMPETENCE

Over the past three decades, statistical literacy has been viewed mainly as an everyday skill for interpreting and critically evaluating statistical arguments, graphs, and numerical summaries (Wallman, 1993; Gal, 2002). More recent perspectives expand this view, situating statistical literacy within broader agendas of critical thinking, social context, and civic responsibility (e.g., Lesser, 2007; Weiland, 2017; Louie, 2022; Gal et al., 2022). From this perspective, statistical literacy is not merely a technical skill but a civic resource—a prerequisite for informed participation in democratic life. Democracies depend on citizens' capacity to reason with evidence; statistical literacy thus becomes a foundational competence for democratic participation and civic empowerment (Weber-Stein et al., in press).

Contemporary political discourse and public decision-making are deeply shaped by data. Pandemic models inform public-health measures (Jahn et al., 2022), climate projections guide environmental policy (Lemos & Rood, 2010), and economic indicators influence fiscal planning (IMF, 2015). Meaningful engagement with such issues requires more than passive exposure to numbers. Citizens must be able to interpret statistical claims, assess their credibility, and evaluate uncertainty and limitations. Without these capacities, civic participation risks remaining superficial and vulnerable to misinformation, rhetorical manipulation, and unfounded claims.

This paper examines the role of statistical literacy in strengthening democratic societies and argues that it is a central component of democratic education in the digital age. Many political and societal issues—such as unemployment, crime, vaccination, economic growth, or climate change—are framed quantitatively. When citizens lack the ability to critically assess numerical information, decisions are easily driven by anecdotes, slogans, or selective evidence rather than by sound reasoning.

Statistics are frequently mobilized by governments, political parties, media outlets, and interest groups to legitimize policies or advance particular agendas. Statistically literate citizens are better equipped to identify cherry-picked data, misleading visualizations, percentages presented without context, or spurious correlations. In this sense, statistical literacy functions as a form of civic protection: it reduces susceptibility to manipulation, conspiracy narratives, and strategic misinformation. At the same time, it enables participation in democratic deliberation by allowing citizens to engage with evidence rather than retreat into opinion alone.

Beyond individual decision-making, statistics play a crucial role in diagnosing and addressing social problems. Issues such as income inequality, educational opportunity, and access to healthcare are rendered visible through quantitative indicators. Citizens who understand how such measures are constructed can recognize structural injustices, assess policy interventions, and argue for change. Moreover, democratic governance relies on public trust in science—particularly in areas such as public

In: Birk, L., Loth, G., Jotzo, L., Binder, K., & Frischemeier, D. (Eds.) (2026). *Statistics and Data Science Education in STEAM. Proceedings of the Satellite Conference of the International Association for Statistical Education (IASE), September/October 2025, Münster, Germany*.

health or climate policy. Statistical literacy helps bridge the gap between expert knowledge and public understanding, fostering informed trust rather than blind acceptance or categorical rejection.

Seen from this perspective, statistical literacy is not simply an individual cognitive achievement but a civic competence. It empowers citizens to navigate complexity, resist manipulation, deliberate responsibly, and ground democratic decisions in evidence.

CONTEMPORARY CHALLENGES FOR DEMOCRACY

Today, democratic societies face mounting pressures, including political polarization, erosion of trust, and the rapid spread of misinformation (Van Beek, 2022). Addressing this entire landscape is beyond the scope of this paper. Instead, we focus on two interrelated challenges where statistical literacy can make a substantial contribution to democratic resilience: (1) the spread of misinformation, disinformation, and fake news in digital media, and (2) declining trust in science.

A common metaphor for understanding these challenges is that of the information ecosystem (Ridgway & Ridgway, 2022). While this ecosystem contains abundant high-quality information, it is also polluted by misleading, distorted, or strategically fabricated content. Two important survival strategies in polluted ecosystems are: (1) limiting the production and dissemination of misinformation, and (2) strengthening the resilience of citizens navigating this environment. From an educational perspective, the latter—building cognitive and statistical resilience—is of particular importance.

Empirical studies reveal substantial deficits in citizens' ability to evaluate online information. Research in the United States shows that many high-school students struggle to assess the credibility of digital sources (McGrew et al., 2017). A recent supplement to the German PISA-D study found that fewer than half of 15-year-olds feel capable of judging the quality of online information (Kastorff et al., 2025). Adults are not immune: they, too, show vulnerability to misinformation and reduced resistance to misleading content (Brashier & Schacter, 2020).

Trust in science adds another layer of complexity. Statistical literacy helps bridge the gap between expert knowledge and public understanding, fostering informed trust rather than blind faith or rejection. Large-scale international surveys suggest that overall trust in science remains moderately high, yet it is notably fragile in domains where scientific findings intersect with political values and policy decisions—such as health, climate change, or the social sciences. In these areas, public acceptance of scientific evidence often correlates with political ideology, and scientific credibility becomes contested, especially in polarized contexts.

Climate change illustrates these dynamics particularly clearly. Vast amounts of high-quality data are publicly available, climate science is widely covered in mainstream media, and data-based explorations are increasingly accessible even at school level (e.g. through tools such as CODAP). Yet despite broad scientific consensus and international agreements, political action is often stalled by short-term economic interests and organized campaigns aimed at undermining trust in climate science. Precisely because climate research implies far-reaching societal change, it has become one of the most politically contested scientific domains.

CIVIC STATISTICS AND CRITICAL STATISTICAL LITERACY

These challenges are not new, but their urgency has increased. Against this background, the ProCivicStat initiative was launched a decade ago with the goal of empowering future citizens to understand and critically evaluate data related to key social issues (Engel et al., 2016). The central concept of Civic Statistics refers to data-based messages and statistics about major social, economic, and political trends that shape public life.

In Civic Statistics, statistical techniques are not ends in themselves but means for understanding context and informing civic engagement (Ridgway, 2022). Authentic data drawn from real societal issues are therefore essential. Methods and models are introduced not for procedural mastery alone, but for the purpose of making sense of complex social phenomena. A key educational goal is to foster positive dispositions toward quantitative evidence and to support learners in engaging critically with the world.

Critical statistical thinking in civic contexts includes attention to data provenance, data collection, operationalization of variables, and measurement choices. It requires reflecting on problem formulation and model adequacy rather than mechanically applying standard techniques. Importantly,

In: Birk, L., Loth, G., Jotzo, L., Binder, K., & Frischemeier, D. (Eds.) (2026). *Statistics and Data Science Education in STEAM. Proceedings of the Satellite Conference of the International Association for Statistical Education (IASE), September/October 2025, Münster, Germany*. © ISI/IASE.

civic contexts rarely permit a single definitive statistical description. Citizens must therefore learn to adopt a questioning stance—asking what questions different data sources can and cannot answer, and recognizing the limitations and assumptions underlying statistical claims.

In recent years, aspects of socio-political reflection and critical civic education have become increasingly prominent. Lesser (2007) characterizes statistics as the grammar of social justice and discusses ways of teaching various statistical concepts in relation to social justice issues. Weiland (2017) situates statistical literacy within debates on critical literacy, which extend beyond functional skills toward socio-cultural awareness and empowerment. This perspective resonates strongly with the work of Paulo Freire (1970), whose conception of literacy as learning to "read the word and the world" highlights the transformative potential of education. Applied to statistics, this implies a form of civic statistical literacy that enables citizens not only to interpret data, but also to question dominant narratives and, ultimately, to participate in shaping a more just society. This approach to statistical literacy has attracted attention in recent years, especially in Latin America (Souza et al, 2020; Ubilla et al., 2024; Zapata-Cardona, 2018).

WHAT IS DEMOCRATIC EDUCATION?

Since the publication of "Democracy and Education" by John Dewey (1916), democratic education has been understood as intrinsically linked to the functioning of democratic societies. Dewey conceptualized democracy not merely as a form of government, but as a regulative ideal grounded in participation, social justice, and shared responsibility for the common good. Education, in this view, is inseparable from democracy: it must cultivate the dispositions, competencies, and habits of mind required for active and reflective citizenship (van der Ploeg, 2016).

Central to Dewey's conception is the idea that individual development always takes place within a social context. Self-determination cannot be achieved in isolation; it emerges through interaction, communication, and collective problem-solving. Democratic education therefore aims to foster critical reflection, deliberative judgment, and an orientation toward the consequences of one's actions for others. Moral and political decisions, Dewey argued, require informed consideration of evidence and anticipation of their effects on the community. From this perspective, democratic education seeks to empower individuals to become informed, engaged, and responsible participants in democratic life.

Dewey further emphasized the role of schools as "miniature communities" in which democratic principles are not only taught but enacted. Schools should provide opportunities for participation, shared responsibility, and reasoned deliberation, enabling students to experience democracy as a lived practice rather than an abstract ideal. Democratic education thus involves both *learning about democracy*—its institutions, processes, and values—and *learning through democracy*, by participating in decision-making and collective inquiry. Dewey insisted that education must be democratic in both content and form.

Contemporary discussions of democratic education reflect a wide range of theoretical perspectives—liberal, deliberative, participatory, multicultural, or agonistic—each emphasizing different civic competencies and political aims (Sant, 2019). Despite these differences, a common thread is the emphasis on citizens' capacity to engage critically with societal issues, to deliberate across differences, and to contribute to collective decision-making. Democratic education therefore encompasses not only knowledge about political systems, but also action-oriented skills, attitudes, and dispositions that support democratic participation.

CONNECTING DEMOCRATIC EDUCATION AND STATISTICAL LITERACY

Within this framework, data literacy—and more specifically civic statistical literacy—plays a crucial role. Democratic participation increasingly requires citizens to engage with quantitative evidence: weighing alternatives, considering competing claims, and making reasoned judgments based on data. Critical thinking and data-based reasoning enable individuals to move beyond opinion or intuition and to participate meaningfully in democratic deliberation.

Statistical literacy promotes democratic competence by encouraging citizens to question sources, scrutinize methodologies, assess uncertainty, and interpret data within its social and political context. These practices are essential for healthy democratic discourse, particularly in an era in which numerical claims are routinely mobilized to justify policies and political agendas. As Ole Skovsmose

(1994) argued, mathematics and statistics play a key role in shaping democratic, participatory, and socially just structures, because they influence how social realities are described, legitimized, and contested. For democracy to function, citizens must be able to understand and critically evaluate quantitative evidence related to social, economic, and health-related well-being, as well as to the realization of civil rights. Questions of equity and fairness—such as disparities in wages, educational opportunities, health outcomes, or political representation—are largely addressed through statistical indicators. Assessing whether women, minorities, or people with disabilities are systematically disadvantaged requires statistical reasoning and the ability to interrogate how such data are produced and interpreted.

This connection between democracy and statistical literacy has also been articulated forcefully by Gerd Gigerenzer, who has pointed out that the traditional enemies of statistical literacy have been authoritarian governance, secrecy of data, and lack of public education. Democratic societies, by contrast, depend on open data, transparency, and citizens who are capable of reasoning with evidence rather than deferring blindly to authority or rejecting expertise outright (Gigerenzer, quoted in Ridgway, 2022).

In sum, democratic education requires more than procedural knowledge about political systems. It demands the cultivation of citizens who can engage critically with evidence, deliberate responsibly, and challenge unjust structures using data-informed arguments. Civic statistical literacy thus constitutes a key bridge between democratic ideals and educational practice—linking critical inquiry, social participation, and evidence-based decision-making in contemporary democracies.

STATISTICAL LITERACY AS INDIVIDUAL COMPETENCE IN DEMOCRATIC SOCIETIES

The information landscape has changed dramatically in the digital age. Vast amounts of information are now instantly accessible through the internet, digital platforms, and increasingly powerful data-analysis tools. This transformation has profound implications at both the societal and the individual level. At the micro level, it raises a fundamental question: What skills do individuals need in order for democracy to function well in conditions of data overload and information diversity? At the macro level, it prompts questions about how information is used in society—whether it serves the common good or undermines it. In this section, we focus on the individual level.

A defining challenge of contemporary democracies is the widespread dissemination of false, misleading, or biased information. Disinformation, fake news, conspiracy narratives, and so-called "alternative facts" are increasingly used to manipulate public opinion or to advance specific political or economic interests. While often shielded by freedom-of-expression protections, such practices can pose serious threats to democratic deliberation and trust. Accordingly, the ability to assess the credibility of information and its sources has become a core civic competence.

Recent risk assessments underscore the severity of this challenge. The World Economic Forum's Global Risks Report 2024 identifies misinformation and disinformation as the most severe global risk in the short term—ranking above extreme weather events, social polarization, and armed conflict. From an educational perspective, this diagnosis reinforces the urgency of fostering citizens' resilience against manipulation. In order to increase the resilience of our students to misinformation, manipulation and fake news, we must design our teaching in a way that supports critical argumentation informed by data and statistical information.

Data, Evidence, and Critical Judgment

Data constitute the empirical basis of evidence-informed decision-making and knowledge creation. They are generally preferable to anecdotes, superstition, prejudice, or ideology. However, data are neither synonymous with facts nor equivalent to truth. Rather, they can be understood as constructed representations of reality—models shaped by theoretical assumptions, methodological choices, and practical constraints (Podworny & Frischemeier, 2024).

Data are generated through deliberate decisions: what to measure, how to operationalize concepts, which populations to include or exclude, and which research designs to adopt. They often measure manifest variables that are subsequently used to construct latent constructs within specific modeling frameworks. At a deeper level, it is legitimate—and necessary—to ask why particular indicators were chosen, by whom, and for what purposes. Measurement is always theory-laden. The

historical dominance of GDP per capita as an indicator of societal well-being, later challenged by Amartya Sen and complemented by broader measures such as the Human Development Index, illustrates how data choices reflect normative assumptions about what counts as progress.

Collecting data is labor-intensive, costly, and purposeful. Data are rarely neutral; they serve particular interests and agendas. A key component of individual statistical literacy, therefore, is the ability to question whose interests are reflected in a dataset—and whose perspectives are absent. Asking *why* data were collected and *whose story* they tell (and do not tell) is as important as analyzing the numbers themselves.

Critical engagement with data includes asking reflective questions such as:

- Are the measures clearly defined, robust, and appropriate for their intended purpose?
- Are metadata available, including information about variable definitions and sample characteristics?
- Were sampling procedures adequate, and who is systematically missing from the data (e.g., non-users of digital platforms when social media data are analyzed)?

Beyond Technical Skills: Interpreting Claims and Causal Narratives

Many social science and policy-relevant studies address questions of causality—an area fraught with philosophical and methodological challenges. While slogans such as "correlation does not imply causation" are widely known, they are insufficient for evaluating real-world claims. When evidence is based on observational studies, surveys, or administrative data rather than controlled experiments, identifying causal mechanisms becomes particularly complex.

Individual statistical literacy therefore extends beyond technical knowledge of data generation. It includes the capacity to assess the credibility, plausibility, and coherence of statistical claims, even when they originate from seemingly authoritative sources such as official statistics agencies or reputable media outlets. Citizens must be able to scrutinize interpretations and narratives built on data, for example by asking:

- How strong is the evidence supporting a policy claim or media assertion?
- Are the statistical models and assumptions underlying projections reasonable (e.g., in climate or pandemic modeling)?
- Are relationships assumed to be linear, and is this assumption justified?
- If causal claims are implied, are alternative explanations, confounders, or intervening variables considered?
- Are conclusions consistent with the broader body of available evidence?

Such questions are essential when evaluating proposals for social policy, where problem definitions, indicator choices, and selective evidence can strongly influence political outcomes. It is important to educate students to be sceptic, not cynical. Rather, criticism is about adopting the attitude of a fair sceptic who is ready to accept an account, but has to be convinced by evidence.

Heuristics, Fact-Checking, and Fair Skepticism

Fact-checking organizations can support citizens in evaluating data-related claims in the public sphere. For example, the UK-based organization Full Fact (https://fullfact.org) provides practical heuristics for identifying misleading information. These include asking where a claim originates, what information might be missing, and how emotional responses are being triggered. Such heuristics are valuable, but they cannot substitute for deeper forms of statistical reasoning.

What democratic societies require is not generalized distrust, but a stance of fair skepticism: a willingness to accept claims that are well supported by evidence, combined with the readiness to question those that are not. Criticism in this sense is constructive rather than cynical. When data are misleadingly presented, citizens should be able to re-express them more appropriately; when data are dubious or fabricated, they should be encouraged to seek out more reliable sources.

In this context, Osborne and Pimentel propose a set of *fast and frugal heuristics* (Figure 1) designed to help "competent outsiders" evaluate scientific claims (Osborne & Pimentel, 2019). Their model, which combines a small number of effective filters, illustrates how citizens can make informed judgments without being experts—an approach that aligns well with the goals of civic statistical literacy.

According to the authors, evaluating a scientific claim should not begin with scrutinizing evidence, but with assessing the credibility of the source: Is the source transparent, impartial, and free from conflicts of interest? Are sources of information clearly acknowledged? To support this step, they recommend *lateral reading*—using external sources to investigate who is making the claim, how they are regarded, and what others say about it.

If a source is credible and has relevant expertise, the decisive next question is whether there is a scientific consensus on the issue. For topics such as climate change, evolution, or the origin of the universe, this consensus is well established. Where no consensus exists, further inquiry is needed—but claims expressed with absolute certainty by isolated voices should be treated with strong skepticism.

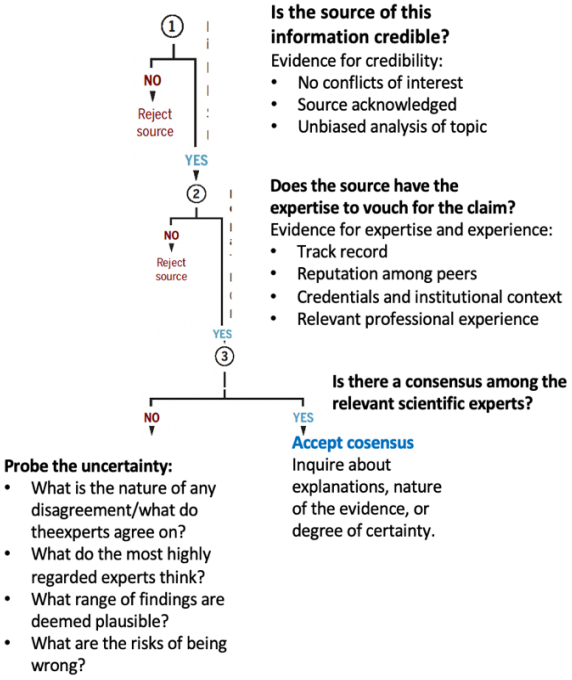

Figure 1. Fast and frugal decision tree to evaluate the credibility of scientific claims (from Osborne & Pimentel, 2019).

To summarize, statistical literacy as an individual competence encompasses far more than computational proficiency. It involves critical judgment, contextual understanding, and ethical reflection. These capacities enable citizens to engage responsibly with evidence, resist manipulation, and participate meaningfully in democratic deliberation—thereby linking individual competence directly to the health and resilience of democratic societies.

DEMOCRATIZING THE INFORMATION ECOSYSTEM

As educators, our primary focus lies at the micro level: preparing individuals with the competencies required for critical citizenship and informed participation in democratic societies in the information age. In the language of Civic Statistical Literacy, this means enabling citizens to interpret, evaluate, and use statistical information in socially and politically relevant contexts. Yet these individual competencies unfold within a broader macro-level information ecosystem, shaped by access to data, institutional arrangements, ownership of data and norms of data governance. Democratic culture depends not only on what citizens know, but also on the conditions under which information is produced, circulated, and controlled.

Potentials of an effective information ecosystem

A democratic data ecosystem requires, first and foremost, meaningful access to data and information. From a civic statistical literacy perspective, access is not limited to technical availability; it also involves making data understandable, interpretable, and usable by a wide public. Open data

policies play a central role here. Governments can strengthen democratic participation by making public-sector data freely available, while private companies can contribute by sharing non-sensitive data in ways that support transparency, accountability, and social innovation.

However, openness alone is insufficient. Civic statistical literacy can only be exercised if data are embedded in accessible platforms that support exploration and sense-making. Public repositories must therefore be complemented by user-friendly interfaces that allow non-experts to search, visualize, and download data without advanced technical skills. Otherwise, data access remains restricted to a small group of specialists, reinforcing rather than reducing informational asymmetries.

A further institutional pillar of a democratic data ecosystem is the existence of independent national statistical offices. Their independence from political pressure is essential to ensure the quality, integrity, and credibility of official statistics. For civic statistical literacy, such institutions serve as trusted reference points, enabling citizens, journalists, and educators to engage in evidence-based public discourse grounded in reliable data.

Access to data must also be accompanied by data and statistical literacy education. Even the most open and well-designed data infrastructures fall short if citizens lack the competencies to critically interpret statistical information, question assumptions, recognize uncertainty, and evaluate competing claims. Civic statistical literacy thus forms the connective tissue between individual capabilities and societal data structures: it enables citizens to actively participate in democratic processes that are increasingly shaped by data.

Finally, democratizing the data ecosystem requires careful attention to privacy and ethical considerations. Robust anonymization techniques and clear ethical guidelines for data sharing and data use are essential to protect individual rights and to sustain public trust. From a civic perspective, ethical data practices are not merely technical safeguards, but expressions of democratic values such as dignity, autonomy, and fairness.

Taken together, these elements highlight the democratic potential of the data ecosystem: when access, institutional integrity, literacy, and ethical safeguards align, data can function as a civic resource—supporting informed decision-making, public accountability, and collective problem-solving.

Threats of an information ecosystem misused by powerful interests

Yet the very features that give the contemporary information ecosystem its democratic potential also make it vulnerable to misuse. Open access to information can be exploited strategically, data can be framed selectively or even withheld, and digital infrastructures can be leveraged to steer behavior at scale. Without effective safeguards, asymmetries in data ownership, algorithmic control, and economic incentives risk undermining democratic discourse and civic agency rather than strengthening them. This section therefore turns to structural threats of the information ecosystem—focusing less on misinformation itself and more on the power that accrues to those who own and control mass data**.**

A central concept for understanding these threats is *surveillance capitalism*, an economic system centered on the large-scale extraction, commodification, and monetization of personal data. Popularized by Shoshana Zuboffs book *The Age of Surveillance Capitalism* (Zuboff, 2019), the term describes a shift in which human experience itself becomes raw material for profit-making. Digital platforms collect vast amounts of behavioral data, often without meaningful user consent or control, in order to predict—and increasingly shape—individual behavior.

Initially driven by targeted advertising, surveillance capitalism extends far beyond commercial marketing. Behavioral data are used to nudge choices, influence preferences, and steer actions in domains such as political communication, consumption, and social interaction. Those who control large-scale data infrastructures thus gain disproportionate influence over public opinion, social norms, and individual decision-making processes. Importantly, this influence does not rely on persuasion in the traditional sense, but on the capacity to intervene in environments in ways that make certain behaviors more likely than others.

Surveillance capitalism relies on digital technologies such as algorithms, sensors, and machine intelligence, operating through what Zuboff describes as *economies of scale* (collecting ever larger volumes of data), *economies of scope* (combining diverse data sources), and *economies of action* (modifying behavior to ensure predictable outcomes). The result is a form of power Zuboff terms *instrumentarian power*—a mode of control focused not on ideology or coercion, but on the continuous

optimization of behavior. Individuals are reduced to measurable patterns of action, while meaning, intention, and autonomy become secondary.

From a democratic perspective, this development raises profound ethical, legal, and societal concerns. Ownership of mass data creates deep asymmetries of knowledge and power between corporations and citizens. Much of the data collection and behavioral modification occurs invisibly, bypassing awareness and deliberation. As a result, individuals may formally retain freedom of choice, while the conditions under which choices are made are systematically shaped by opaque systems beyond public scrutiny. This poses a direct challenge to civic statistical literacy. Even highly data-literate citizens face structural limits when critical information about data collection, algorithmic processing, and behavioral targeting remains inaccessible or proprietary. Civic statistical literacy depends not only on individual competencies, but also on institutional transparency and democratic control over data infrastructures. When data ownership is concentrated and decision-making processes are hidden, the capacity for informed public reasoning and collective self-determination is weakened.

Zuboff describes this situation as a "Faustian pact": individuals become increasingly dependent on digital platforms for communication, work, and social participation, while simultaneously surrendering control over their data. This dependency undermines possibilities for collective action and democratic accountability, replacing reciprocal relationships between citizens and institutions with unilateral extraction and control.

In sum, the misuse of the information ecosystem through surveillance capitalism threatens democratic societies not by distorting facts alone, but by reshaping the conditions of agency itself. By eroding autonomy, concentrating power, and rendering behavioral influence opaque, it challenges the foundations of democratic participation and calls for renewed forms of regulation, education, and collective resistance.

CONCLUSIONS

Democracies do not defend themselves automatically. They depend on citizens who are able to think critically, argue based on evidence, and hold decision-makers accountable. In a time when facts are contested, numbers are selectively framed, and public discourse is increasingly polarized, statistical literacy is no longer a technical add-on—it is a democratic necessity**.** Throughout this article, we have argued that civic statistical literacy operates at the intersection of individual competence and societal structures. On the micro level, citizens need the skills to assess credibility, interpret data, recognize uncertainty, and question claims. On the macro level, these competencies unfold within an information ecosystem shaped by data access, institutional integrity, platform design, and power asymmetries in data ownership. Strengthening democracy therefore requires attention to both: empowering individuals *and* shaping the conditions under which data and statistics are produced, circulated, and used.

This places a particular responsibility on statisticians and statistics educators. We are more than technical experts or method instructors. We are custodians of ways of reasoning that enable societies to make sense of complexity, uncertainty, and change. Statistical methods provide tools to distinguish evidence from opinion, signal from noise, and trustworthy information from manipulation. Used responsibly, they support public deliberation rather than domination, understanding rather than control.

Embracing this responsibility means recognizing that statistical education is inherently civic. It involves making uncertainty discussable, exposing assumptions, revealing limitations, and fostering a culture in which data can be questioned without being dismissed. It also means engaging with ethical issues, power structures, and the societal consequences of data-driven decision-making.

The challenges are substantial—but so are the opportunities. A democratic data ecosystem, combined with strong civic statistical literacy, can enable citizens to participate meaningfully in debates about climate change, public health, social inequality, and technological governance. It can support collective reasoning in the face of complexity and disagreement.

Let us embrace this responsibility. Let us help build a culture where data is not feared or ignored, but used to deliberate, to question, and to decide—together. I invite you to see your work not only as advancing statistical knowledge, but as strengthening the very fabric of democracy. By fostering civic statistical literacy, we empower people to participate meaningfully in democratic decision-making. That is both our challenge and our contribution.

**** Fostering civic statistical literacy means strengthening democracy ****

ACKNOWLEDGMENT

I am grateful to Florian Weber-Stein for many valuable discussions and insightful comments that helped sharpen this paper.

REFERENCES

Brashier, N. M. & Schacter, D. L. (2020). Aging in an era of fake news. *Current Directions in Psychological Science, 29*(3), 316–323. https://doi.org/10.1177/0963721420915872

Dewey, J. (1980). Democracy and Education. In J. A. Boydston (Ed.), *John Dewey. The Middle Works, 1899–1922* (Vol. 9: 1916, pp. 1–370). Southern Illinois University Press. (Original work published 1916)

Engel, J. (2024). Some Reflections on the Role of Data and Models in a Changing Information ecosystem. In S. Podworny, D. Frischemeier, M. Dvir, & D. Ben-Zvi. (Eds.), *Reasoning with data models and modeling in the big data era*. Minerva School 2022. https://doi.org/10.17619/UNIPB/1-1815

Engel, J., Gal, I., & Ridgway, J. (2016). *Mathematical literacy and citizen engagement: The role of Civic Statistics*. Paper presented at the 13th International Congress on Mathematical Education (ICME-13). Hamburg, Germany.

Freire, P. (1970). *Pedagogy of the Oppressed*. New York: Continuum Books.

Gal, I. (2002). Adults' statistical literacy: Meanings, components, responsibilities. *International Statistical Review, 70*(1), 1–25. https://doi.org/10.1111/j.1751-5823.2002.tb00336.x

Gal, I., Nicholson, J., & Ridgway, J. (2022). A Conceptual Framework for Civic Statistics and Its Educational Applications. In J. Ridgway (Ed.), *Statistics for empowerment and social engagement* (pp. 37–66). Springer.

International Monetary Fund (2015). *Fiscal policy and long-term growth* (IMF Policy Paper). https://www.imf.org/external/np/pp/eng/2015/042015.pdf

Jahn, B., Friedrich, S., Behnke, J., Engel, J., Garczarek, U., Münnich, R., Pauly, M., Wilhelm, A., Wolkenhauer, O., Zwick, M., Siebert, U., & Friede, T. (2022). On the role of data, statistics and decisions in a pandemic. *AStA Advances in Statistical Analysis*, *106*, 349–382. https://doi.org/10.1007/s10182-022-00439-7

Kastorff, T., Müller, M., Selva, C., Greiff, S., & Moser, S. (2025). *Fake News oder Fakten? Wie Jugendliche ihre digitale Informationskompetenz einschätzen und welche Rolle Schulen und Lehrkräfte dabei spielen: Erkenntnisse aus PISA 2022*. Münster: Waxmann. https://doi.org/10.25656/01:33288

Lemos, M. C., & Rood, R. B (2010). Climate projections and their impact on policy and practice. *Wiley interdisciplinary reviews: Climate Change, 1*(5), 670–682. https://doi.org/10.1002/wcc.71

Lesser, L. M. (2007). Critical values and transforming data: Teaching statistics with social justice. *Journal of Statistics Education*, *15*(1), 1–21. https://doi.org/10.1080/10691898.2007.11889454

Louie, J. (2022). *Critical data literacy: Creating a more just world with data*. Paper prepared for the National Academy of Sciences' workshop on Foundations of Data Science for Students in Grades K–12, September 13–14, 2022.

McGrew, S, Ortega, T., Breakstone, J., & Wineburg, S. (2017). The challenge that's bigger than fake news. Civic reasoning in a social media environment, *American Educator*, *41*(3), 4–9.

Osborne, J. & Pimentel, D. (2019). Science, misinformation, and the role of education. *Science*, *378*(6617), 246–248. https://doi.org/10.1126/science.abq8093

Podworny, S. & Frischemeier, D. (2024). Young learners' perspectives on the concept of data as a model: what are data and what are they used for? In S. Podworny, D. Frischemeier, M. Dvir, & D. Ben-Zvi. (Eds.), *Reasoning with data models and modeling in the big data era*. Minerva School 2022. https://doi.org/10.17619/UNIPB/1-1815

Ridgway, J. (Ed.) (2022). *Statistics for empowerment and social engagement: Teaching civic statistics to develop informed citizens.* Springer. https://doi.org/10.1007/978-3-031-20748-8

Ridgway, J., & Ridgway, R. (2022). Civic Statistics in context: mapping the global evidence ecosystem. In J. Ridgway, (Ed.), *Statistics for empowerment and social engagement: Teaching Civic Statistics to develop informed citizens* (pp. 581–607). Springer. https://doi.org/10.1007/978-3-031-20748-8_23

Sant, E. (2019). Democratic Education: A Theoretical Review (2006–2017). *Review of Educational Research*, *89*(5), 655–696. https://doi.org/10.3102/0034654319862493

Skovsmose, O. (1994). Towards a critical mathematics education. *Educational Studies in Mathematics, 27*(1), 35–57. https://doi.org/10.1007/BF01284527

Souza, L., Lopes, C., & Fitzallen, N. (2020). Creative insubordination in statistics teaching: Possibilities to go beyond statistical literacy. *Statistics Education Research Journal, 19*(1), 73–91. https://doi.org/10.52041/serj.v19i1.120

Ubilla, F., Giaconi, V., Vergara, C., Saravia, A., & Ruz, F. (2024). *Educación estadística cívica: una oportunidad para la articulación curricular entre ciencias para la ciudadanía y matemáticas.* Escuela de Educación de la Universidad de O'Higgins. https://www.educacionestadistica.cl/ensenanza/estadistica_civica/

Van Beek, U. (Ed.) (2022). *Democracies under pressure. Resilience or Retreat?* Springer International Publishing.

Van der Ploeg, P. (2016). Dewey versus 'Dewey' on democracy and education. *Education, Citizenship and Social Justice*, *11*(2), 1 –15. https://doi.org/10.1177/1746197916648283

Wallman, K. K. (1993). Enhancing statistical literacy: Enriching our society. *Journal of the American Statistical Association, 88*(421), 1–8.

Weber-Stein, F., Awe, O. O. & Engel, J. (in press). Civic statistics and youth empowerment: Bridging data, education, and democracy. In S. Barsch, E. B. Claravall, & F. Rein (Eds.), *International Handbook of Digital Civic Engagement and Youth Empowerment: Toward Achieving Inclusive Society.* Oxford University Press.

Weiland, T. (2017). Problematizing statistical literacy: An intersection of critical and statistical literacies. *Educational Studies in Mathematics*, *96*(1), 33–47.

Zapata-Cardona, L. (2018). Students' construction and use of statistical models: A socio-critical perspective. *ZDM Mathematics Education*, *50*(7), 1213–1222. https://doi.org/10.1007/s11858-018-0967-8

Zuboff, S. (2019). *The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power*. PublicAffairs.