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An Innovative Model of Media Literacy Education Effective in Tackling Disinformation

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ABSTRACT

This doctoral dissertation examines how educational systems can respond to disinformation in post-medial societies and proposes "remediated prebunking" as an innovative pedagogical methodology for media literacy education.

The dissertation is presented as a *compilation thesis* comprising three peer-reviewed publications. *Paper 1* provides a conceptual synthesis of disinformation as a socio-technical phenomenon, analyzing its historical precedents, psychological and social drivers, and countermeasures. *Paper 2* presents a baseline assessment of Italian secondary school teachers' media literacy competencies (N=243), revealing that only 25% achieve sufficient proficiency levels, with visual literacy emerging as the most critical gap. *Paper 3* evaluates a 12-hour blended learning intervention based on remediated prebunking (N=115), demonstrating significant improvements across all competency domains.

The theoretical framework integrates Eugeni's post-mediality theory, Phillips and Milner's ecological approach to information pollution, and Rivoltella's three-pillar model of media education. The research reconceptualizes prebunking for educational contexts through inquiry-based investigation.

The findings establish two principal contributions. First, they document a substantial gap between policy expectations and teacher readiness, identifying four distinct teacher profiles requiring differentiated professional development. Second, they demonstrate that targeted intervention can effectively close these gaps, with improvements rooted in enhanced argumentative reasoning.

The dissertation argues that effective responses to disinformation require ecological and preventive strategies. The remediated prebunking methodology provides a scalable, evidence-based model for building educational capacity, beginning with teacher professional development and extending toward curriculum integration.

The work comprises three parts: Part 1 (Chapters 1–3) establishes the theoretical and methodological framework; Part 2 presents the three papers in their original published form; and Part 3 offers a synthesis discussing implications for policy, practice, and future research.

Keywords: disinformation, media literacy, prebunking, post-mediality, teacher education, visual literacy

PART 1 – INTRODUCTION

Chapter 1
Disinformation in the post-media era

1.1 The Post-medial Condition

Disinformation has emerged as one of the defining challenges of contemporary society, with profound political, social, and educational consequences, particularly among younger populations (Pérez-Escolar et al., 2023). In response to the information crisis, policy and educational interventions to counter disinformation have proliferated (Kozyreva et al., 2024; UNESCO, 2025). Yet these efforts require a foundational understanding of the media environment in which disinformation circulates, a setting that can no longer be adequately described through the traditional frameworks developed for the mass media era.

The concept of post-mediality captures precisely this transformation. It describes a condition in which media have become so pervasive that they no longer appear as distinct objects, dissolving instead into the structure of everyday social life. Eugeni (2015) describes the post-media condition as a state in which media seem to have disappeared, yet their presence returns from within the artifacts and tools that populate everyday life. This apparent paradox is characterized by three distinctive features (P. C. Rivoltella, 2021).

First, the disappearance of distinctions between different devices: the computer, as a meta-medium, absorbs functions that previously belonged to separate media, becoming multimedia or hypermedia.

Second, the relocation of traditional devices: cinema, for instance, can now be experienced on airplanes, smartphones, or subway stations.

Third, media devices become indistinguishable from social apparatuses: home automation, remote surveillance, and photo albums shared on Facebook or Instagram blur the boundaries between media technologies and everyday social practices. The result is the difficulty of recognising what counts as media and what does not: "Media are everywhere. We are

the media. And this is why the media no longer exist" (Eugeni, 2015, p. 28).

The origins of the “post-media” conceptual shift reach back to debates in the field of art theory with Rosalind Krauss and media political philosophy with Felix Guattari. Krauss refers to the “post-media era” in relation to the debate on the boundaries of artistic media (Krauss, 2000). Post-mediality challenges the idea that unique, intrinsic features define each form of media. Instead, it highlights the blending and convergence of media, where content moves across devices and platforms that support images, text, or sound. W.J.T. Mitchell also echoes this idea, asserting that there is no pure media and that all media are inherently mixed (Mitchell, 1994). Eugeni (2015) clarifies that scholars like P. Weibel (2006) and Casetti (2011) have pursued the same path as Krauss.

In the field of political philosophy, the thinker Felix Guattari (1986, 1996) also spoke of a “post-media era,” referring to the end of the hegemonic role of the mass media in favor of new forms of production and distribution of knowledge.

Yet recognizing this transformation requires epistemological caution. As Moriggi (2023) warns, it is easy to deploy the prefix "post" as a convenient shorthand for archiving an entire historical and cultural period (that of traditional media) while looking ahead, with enthusiasm or fear, to the technological and cultural novelty awaiting us. The challenge is that we are part of the history we want to tell; we can't watch it unfold from a safe distance.

This integration is what makes educational responses both necessary and difficult. As P. C. Rivoltella (2023) argues, Post-Media Education emerges as a new evolutionary stage in the continuous adaptation of media literacy and media education to the ever-changing media landscape. It operates within a communication ecosystem characterized by mediatization, platformization, and the growing protagonism of data and algorithms. These conditions have profoundly altered the dynamics of the information ecosystem we live in, as the following section will explore.

1.2 Beyond Fake News: Understanding Disinformation

Our current conversations about disinformation were born out of what many have called a “moral panic” (Jungherr & Schroeder, 2021). After the Brexit referendum and the 2016 U.S. presidential election, the phrase "fake news" seemed to be everywhere: in media coverage, in policy discussions, and in public debates. When Oxford Dictionaries named "post-truth" the word of the year in 2016 (Oxford Dictionaries, 2016), they captured the spirit of the time: a world where facts seemed to matter less than appeals to emotion and personal beliefs.

However, as UNESCO already argued in 2017, "solving "fake news" starts with avoiding the term" (UNESCO, 2017). The European Union's High-Level Group on Fake News and Online Disinformation similarly recommended abandoning the phrase in favor of more analytically precise vocabulary (European Commission, 2018). The term proves problematic for several interconnected reasons.

First, the label "fake news" groups together very different situations that actually require different ways of understanding and responding. Deliberate hoaxes meant to deceive are not the same as honest mistakes, misunderstood satire, or accurate information that is presented in a misleading way. When we use one term for all these cases, we risk oversimplifying a much more nuanced reality.

Second, "fake news" has become a political weapon. Politicians and groups from all sides have used the phrase to discredit reporting they dislike, attack the credibility of journalists, or cast doubt on their opponents. In trying to name the problem, the term itself has become part of the problem in the ongoing battle over information.

Third, thinking of news as either "real" or "fake" misses the complexities of the information we encounter today. Many problematic stories are not outright fabrications but rather involve cherry-picking facts, presenting things out of context, or amplifying real but unusual events in misleading ways.

The most influential alternative framework emerged from Claire Wardle and Hossein Derakhshan's 2017 Council of Europe report, Information

Disorder: Toward an Interdisciplinary Framework for Research and Policy Making (Wardle & Derakhshan, 2017). Their tripartite taxonomy distinguishes three categories based on intent and accuracy.

Disinformation means spreading false or misleading information on purpose, with the goal of deceiving people or causing harm. What sets it apart is that someone is knowingly creating or sharing untrue content to achieve a specific aim.

Misinformation, on the other hand, is when people share false or misleading information without realizing it's wrong. They genuinely believe what they are sharing is true, or they simply don't notice that it's problematic. Sometimes, disinformation can turn into misinformation when others who don't know it's false begin to pass it along.

Malinformation is different: it's true information, but it's shared or used in a way that causes harm or misleads people. For example, someone might leak private details to damage someone's reputation, or take real facts out of context to convey a false impression, or deliberately spread genuine content just to manipulate people.

However, as recent philosophical debates have shown, it's actually very difficult to tell what someone's intentions were when they spread false information. Hayward (2025) dives into this challenge: Did the person sharing a misleading claim know it was false? Did they care about getting it right? Were they trying to cause harm, or just trying to entertain, fit in with a group, or issue what they thought was a genuine warning? Figuring these questions out is tough, especially when so much content moves so quickly online.

These challenges suggest that disinformation involves more than just people lacking the right facts or believing things can be corrected with better information. It grows from the complex interactions between how our minds work, how we relate to each other in society, and the technologies that shape our communication (World Economic Forum, 2025).

Recognizing this complexity requires confronting what has been warned as a dangerous trap: treating facts as if they are sacred and believing that

objectivity is always possible (Bruno & Moriggi, 2023a). Sometimes, efforts to fight disinformation act as if the truth is simple to determine and lies are obvious, just a matter of comparing claims to reality. This is not to suggest that truth doesn't exist or that everything is relative. Rather, it is an acknowledgment that connecting what is claimed to what is real is complicated. As Umberto Eco (2024) showed in his discussion of the Braibanti case, even statements of fact can be used to mislead if they're taken out of context or framed in a certain way.

Eco's insight points to a deeper issue. A crucial part of understanding the post-media era is acknowledging, as Balbi & Ortoleva (2023) argue, that communication is inherently "imperfect." They suggest that "what are considered marginal imperfections by most are inside communication, located at its center and not at its sides." In other words, elements like noise, distortion, manipulation, and misunderstanding are not just occasional problems: they are built into the structure of how we communicate.

As Phillips & Milner (2021) argue, this perspective complicates the usual stories we tell about disinformation. It is not a rare problem or an outside force that makes communication less clear; it is a normal part of all communication processes. Precisely in order to combat the "recentism" of "fake news" crusades that often lead to "technophobic" positions (Gallese et al., 2025), in Paper 1 we have reconstructed a reasoned history of disinformation and "information disorder" across centuries and cultures (Darnton, 2017; Pretalli & Zagni, 2025).

Events such as Brexit and the 2016 U.S. presidential election, which sparked public anxiety about "post-truth" and led Oxford Dictionaries to designate it as their word of the year, serve as a prime example. This framing, which suggests that facts have lost out to emotions and personal beliefs, risks missing the deeper, structural problems. As Phillips & Milner (2021) argue, the real crisis was not simply a matter of truth but also reflects new structural features in the digital environment that have fundamentally altered how information functions.

Taking an ecological approach means recognizing that responsibility for the health of our information environment is distributed among many actors across social, technological, economic, and policy domains (Strate, 2017). This stands in contrast to simplistic stories that pit "bad" producers of fake news against "good" citizens or journalists (Bruno & Moriggi, 2023a). For education, the implication is clear: instead of just teaching students to spot "fake news," media literacy must foster the skills needed to navigate a world where communication is always, to some extent, imperfect and confused (Watzlawick, 1977).

1.3 A Multi-dimensional Approach

A lot of research from different fields explores why people often believe things that aren't true, spread them to others, and sometimes refuse to change their minds even when shown the facts. In Paper 1 we suggest that to really understand this, we have to look at several connected factors, including cognitive, emotional, social, narrative, and technological drivers.

First, how our minds work plays a big part. For example, if we hear something over and over, we're more likely to believe it, even if it's false (this is called the *illusory truth effect*). Disinformation can also stick in our memory and keep influencing us, even after we've been corrected (*continued influence effect*). We're also more likely to trust information that's easy to understand or looks familiar, and we tend to accept ideas that fit with what we already believe, while questioning those that don't.

Our emotions have a strong impact on how we process and share information. Language that triggers strong feelings (especially moral outrage or anger) grabs our attention and makes us more likely to pass it along. Content that stirs up fear, anxiety, or a sense of belonging to a group spreads faster than neutral facts, even if it's not true. When something makes us feel righteous or part of a team, we find it much harder to question its reliability, even if we suspect it may be misleading.

The people around us also shape what we believe and share. We naturally tend to connect with others who are like us, which means we often hear the same stories and views repeated in our circles. It can feel

risky to challenge what our group believes, so we might go along rather than speak up. Occasionally, we end up in 'echo chambers' where only certain perspectives are heard. We're also more likely to trust information from people we see as part of our community, even if they're not actual experts.

Stories are especially powerful. As Gottschall (2021) puts it, humans are "storytelling animals." We make sense of the world through narratives, not just facts. Disinformation often works because it comes in the form of a gripping story, with clear heroes and villains, secret plots, and patterns that make the world feel more understandable. Conspiracy theories, for example, are appealing partly because they offer satisfying stories to explain confusing or frightening events.

Technology also plays a big role in what we see and how we react. Social media platforms are built to keep us engaged, which often means showing us content that triggers strong emotions. The more we interact with a certain type of post, the more similar content we're shown, creating feedback loops that reinforce our views. It's easy to share things instantly, so we don't always pause to think. And because platforms make money by keeping our attention, they may end up promoting content that divides or excites us, even if it's not accurate.

Forgetting history makes things even harder. As we point out in Bruno and Moriggi (2023), one big problem in studying disinformation is that we don't look back far enough. People often act as if disinformation is new and caused only by social media, but there's a long history of propaganda, manipulation, and deception stretching back centuries (Darnton, 2017; Pretalli & Zagni, 2025). When we ignore this history, we risk thinking today's problems are brand new and missing out on the lessons and tools that past generations developed, like critical thinking and media literacy.

1.4 From Debunking to Prebunking

After the 'fake news panic' of 2016, the main response was fact-checking and debunking, trying to correct false information after people had already seen it. Fact-checking organizations grew quickly, platforms added

warning labels, and journalists spent more time verifying stories. These steps do help, but it's become clear that they have important limits.

Fact-checking works, but only to a certain extent and not always for everyone. Research indicates that it can assist individuals in determining the facts; however, the effect is typically minimal or moderate, contingent upon the subject matter, the presentation of the information, and the audience. Sometimes, fact-checks even backfire, making people hold onto their false beliefs even more strongly (Walter et al., 2019, 2021).

There are some big reasons why simply correcting false information isn't enough (Van Der Linden, 2023). People are less likely to accept corrections if the truth challenges their personal identity or group beliefs. Even when misinformation is corrected, it can linger in our memory and shape how we think. There is also an excessive amount of content for fact-checkers to monitor effectively: any individual can publish information at any time, and the sheer volume is overwhelming. Furthermore, factual corrections often can't compete with the emotional pull or storytelling power of false information.

That doesn't mean we should give up on fact-checking, but these limits show we also need other strategies, especially ones that help people build resistance to disinformation before they even see it.

Psychological research on inoculation theory points to a different strategy: instead of waiting to correct false beliefs after they've taken hold, we can help people build resistance by exposing them to mild versions of misinformation techniques ahead of time. It's like how vaccines work: by exposing our bodies to harmless forms of a virus, we learn to fight it off. In the same way, 'psychological inoculation' prepares our minds to spot and resist manipulative tactics before they have a chance to fool us (Roozenbeek et al., 2022).

This method is now often called "prebunking." It means warning people in advance about the tricks and tactics used in misinformation and sometimes even letting them practice spotting these tactics in safe, simulated situations. As Traberg et al. (2022) explain, effective inoculation involves two steps: first, clearly warning people that a threat is coming;

second, showing them how to challenge or refute the misleading argument before it takes hold.

There's growing evidence that that approach works. Large-scale studies indicate that short prebunking videos focused on specific misinformation tactics help people recognize manipulation and make them less likely to fall for misleading content (Roozenbeek et al., 2022). These effects aren't huge, but they're significant, and importantly, they can reach many people at once, something that fact-checking every single claim can't do.

However, most research on psychological inoculation looks at quick, one-off interventions, with effects measured over just a short time. To use these ideas in education, we need to adapt them: that means longer and more meaningful lessons, connecting with bigger learning goals, making sure activities fit students' ages, and figuring out how teachers can realistically use these methods in real classrooms.

1.5 Toward an Ecological and Educational Response

The realities of post-mediality require us to fundamentally rethink how media education works. P. C. Rivoltella (2020) argues that effective media literacy today means building not just critical thinking skills but also ethical and aesthetic capacities, the three pillars of robust media education. This framework acknowledges that successfully navigating post-medial environments involves much more than just fact-checking.

Critical competencies are about analyzing, evaluating, and questioning media messages, as well as the systems that produce them. This means understanding how digital platforms work, how algorithms affect what we see, how economic incentives can shape content, and how to judge the reliability of sources. Nevertheless, critical analysis by itself is often not enough, especially when manipulation works through emotions, storytelling, or visual design.

Ethical competencies concern understanding our responsibilities, values, and the consequences of our actions in media spaces. In today's world, where anyone can be both a consumer and a producer of information (and both a victim and a carrier of misinformation), ethical

awareness is crucial. We must ask: What are the responsibilities when sharing something unverified? How do our individual choices shape the broader information ecosystem? And what values should guide us when we engage with controversial or emotionally charged content?

Aesthetic competencies relate to engaging with the expressive and creative aspects of media. This includes knowing how visual rhetoric works, how design choices influence interpretation, and how aesthetic features can make messages more persuasive (Fuller & Ṿeytsman, 2021). In a media world filled with images, videos, and multimedia, these skills are especially important. Manipulated or decontextualized visuals (and even synthetic media) make the need for aesthetic literacy more urgent than ever, yet traditional, text-centered education often overlooks this area.

Without developing what could be called "informational immunity," it becomes extremely challenging to navigate the post-media world with awareness and intention. The move from mass media to post-media, as Rivoltella puts it, takes us beyond the old idea that certain types of messages belong to certain media. Today, communication happens in ecosystems shaped by mediatization, platformization, and, above all, the central role of data and algorithms. This new landscape calls for new literacies and teaching strategies that address the challenges of algorithmic influence, data practices, and how platforms operate.

Phillips & Milner (2021) employ an ecological metaphor to elucidate contemporary information environments. Just as environmental pollution comes from many sources, both big and small, information pollution arises from complex interactions among platforms, content creators, and everyday users. In this context, everyone has a role to play in either sustaining or harming the overall health of our information ecosystem.

This ecological perspective carries significant implications. It means that any of us might become both victims and spreaders of disinformation, not because of personal failings, but because of our place within a polluted information system. Even a journalist trying to correct falsehoods can end

up spreading them further, and a worried citizen sharing urgent updates might unintentionally help misinformation travel.

This way of thinking suggests that education should respond to disinformation in a systemic way. The ecological approach sees disinformation as a result of how our information systems are built, rather than treating it as an outside threat that we simply need to block. The focus shifts from defending individuals against isolated problems to strengthening our shared ability to foster healthier information environments.

A growing body of research has examined which interventions prove most effective in this endeavor. Kozyreva et al. (2024) identify nine categories of individual-level interventions, ranging from accuracy nudges and friction to media literacy training and prebunking. Meta-analytic evidence suggests that "boosting" approaches—those that build lasting competencies rather than merely correcting specific beliefs—yield the strongest effects. Huang et al. (2024), synthesizing findings from approximately 81,000 participants, found that media literacy interventions produce substantial improvements in resilience to misinformation, discernment between true and false content, and reduced sharing of false information. However, these competence-building strategies should not be viewed in isolation. As the ecological framework suggests, effective responses require integrating multiple approaches: fact-checking and labeling address immediate corrections, nudges and friction slow impulsive sharing, while media literacy and prebunking develop the deeper critical capacities that sustain long-term resilience (Anstead et al., 2025).

Educational responses to disinformation need to go beyond just hoping that technology will save us or simply reacting defensively. In Bruno & Moriggi (2023b we suggest that we should move from just defending against information disorders to taking an active, ecological approach. Instead of telling students to simply 'watch out for fake news and conspiracy theories' (which treats them as passive victims), we should encourage them to see themselves as contributors who can help improve

the information environment for everyone. This approach provides students more agency and reminds us that we all share responsibility for the health of our information ecosystem.

Making this shift means teaching skills on many different levels. Students do need to know how to check sources, verify images, and read laterally (Alsadek, 2024; Martini et al., 2025). But they also need to understand how platforms shape what we see, how social groups influence what is shared, how stories persuade us, and how disinformation is a problem with deep historical roots.

Turning psychological inoculation research into classroom practice requires what we call "remediation," echoing Bolter & Grusin (2002). The educational “remediation” that we propose means adapting techniques that worked in short experiments for use in long-term educational programs. This process means adding new layers: tracing where information comes from, working together to build shared understanding, helping students think about how they judge information, and making sure teachers have the tools they need to put these lessons into action.

To truly understand disinformation, we have to see it as a complicated problem that grows out of the ways people think, how we interact in society, and the technologies we use, not just as a collection of false stories that could be wiped out with better facts.

But this leads to an important practical question: are teachers really ready to deliver this kind of education? Chapter 2 takes up this issue, looking at what policies expect from teachers, what research says about their real skills, and where the gaps are. The answers may be challenging, but they also highlight exactly where professional development can have the largest impact.

Chapter 2
Tackling Disinformation in Educational Contexts

The previous chapter has established the conceptual groundwork for understanding disinformation in post-media environments. This chapter moves from theory to practice, focusing on the important role of teachers in putting media literacy education into action. It also addresses a key question: are educators truly prepared to confront disinformation in their classrooms? This question is crucial, since “information disorders” do not only concern information about current events but also information searches carried out for school activities. Policy frameworks often see teachers as crucial mediators of media literacy, but they may assume that teachers have skills and knowledge that are not actually present. If teachers do not have the ability to evaluate digital sources or handle visual disinformation, even the best-designed curricula will likely not succeed in practice.

In this chapter, I summarize the main conceptual framework and important findings from Paper 2 ("Teachers’ Competencies in Evaluating Digital Sources and Tackling Disinformation: Implications for Media Literacy Education"). I place the empirical research in the wider context of policy developments and introduce the background for the intervention study described in Paper 3.

2.1 Policy Expectations: The Call for Media Literacy in Schools

In the past ten years, international organizations and governments have come to recognize media literacy education as a fundamental element for democratic societies (Bruno & Bellini, 2023). This growing recognition is based on the understanding that people need specific skills to navigate complex post-media information environments.

The UNESCO handbook, "*Journalism, Fake News & Disinformation: A Handbook for Journalism Education and Training"* (UNESCO, 2018), highlights the important role of educators in fighting disinformation.

Although it is mainly directed at journalism education, the handbook presents principles that are useful in many educational settings: the need for verification skills, understanding information systems, and developing critical thinking abilities. UNESCO continued to play an important role in pushing for the integration of media literacy education with a multistakeholder approach, including the educational level (UNESCO, 2025).

The European Commission has played a leading role in creating policy frameworks. Its *Digital Competence Framework for Citizens (DigComp 2.2)* (European Commission, 2022a) lists information and data literacy as a key competence, including the ability to evaluate data, information, and digital content. This framework clearly addresses the problem of disinformation, pointing out that people must be aware that the online world contains many kinds of false, misleading, or biased information, such as disinformation, misinformation, conspiracy theories, or hoaxes. The *Digital Competence Framework for Educators (DigCompEdu)* complements this model by describing the skills teachers need to use digital technologies effectively in their work. It also covers the abilities needed to help students develop information literacy. The most recent update to the *DigComp 3.0* framework puts even more stress on the skills needed to address false and misleading information (European Commission. Joint Research Centre et al., 2025).

Most directly relevant to this research, the European Commission published *Guidelines for Teachers and Educators on Tackling Disinformation and Promoting Digital Literacy Through Education and Training* (European Commission, 2022b). These guidelines provide specific pedagogical recommendations for addressing disinformation across educational levels, recognizing that "teachers and educators are uniquely placed to reach learners across all ages, backgrounds, and circumstances." I have also contributed to the upcoming 2026 publication of a new update to the European Commission's Guidelines. The new guidelines integrate the topic of AI disinformation and promote a preventive approach based on the prebunking model.

These policy documents reveal a common pattern: they view teachers as crucial intermediaries between media literacy frameworks and student learning. The Commission's Expert Group on tackling disinformation points out that teachers are central in the education system and act as role models for their students. Their own digital skills and media literacy will shape how they teach these issues (European Commission, 2018) .

This perspective implicitly assumes that teachers have sufficient skills to meet expectations. Many policy documents suppose that educators can identify disinformation, understand how it works, create effective learning activities, and help students build critical thinking. However, this double expectation (having personal skills and being able to teach them) is often not supported enough by teacher education or professional development programs.

National policy in Italy, the location of this research, is increasingly emphasizing the development of digital skills for teachers. The Ministry of Education's *Scuola Futura* program offers a framework for teacher training in digital skills, which also includes media literacy. The Italian Digital Media Observatory (IDMO), part of the European Digital Media Observatory network, has created teaching resources and training programs for teachers that specifically address disinformation.

The 2023 IDMO report on disinformation in Italy (IDMO, 2023) points out the educational challenge: many people are exposed to false information and do not have strong skills to evaluate it critically. The report says that systematic educational actions should start in schools, and these actions need teachers who are ready to do this work.

2.2 The Research Question: Are Teachers Ready?

International studies have shown that there is a gap between what policies expect and how prepared teachers actually are. Many teachers are proficient at using digital tools for teaching, but they often do not have the right skills to teach students how to think critically or evaluate information properly (Ranieri et al., 2017, 2018).

A paper by McGrew & Byrne (2022) found that many teachers have difficulty with lateral reading strategies, which, according to research, is one of the most relevant skills for information integrity (Caulfield & Wineburg, 2023). This means they do not usually leave a website to check information using other sources but instead judge the site based on things like the 'about' page, author names, or how the site looks. This habit is common among students and the general public, too, while professional fact-checkers use different, more reliable methods.

Research on visual literacy shows certain weaknesses. In a world where images and videos are everywhere, many teachers have not been trained to judge visual content, for example, to spot manipulated images, recognize when an image is taken out of context, or understand how pictures can mislead people even if they are not edited (Moriggi & Bruno, 2025).

Based on the DigComp 2.2 framework and recent studies on how to evaluate sources, this study separates two types of evaluation skills. Following Hebbar & Wolf (2024), we make the following distinction:

- *Assertive provenance* means noticing clear signs of reliability that are shown in the content itself—like verified profiles, website URLs, names of authors, or statements that explain where the information comes from. These signs are called "assertive" because they openly state something about the source and can be seen directly.
- *Inferred context* is about judging reliability by looking beyond the content itself. This includes things like searching for the image elsewhere, checking claims with other sources, or seeing how information is shared online. These skills are called "inferred" because they require extra steps to check the truth, instead of just trusting what is shown in the content. Hebbar and Wolf developed this framework for AI-generated content, but in the context of this research, it was also applied to non-AI-generated content that presents problems of “information noise.”

This difference is important for understanding the gaps in teacher skills. For example, teachers might easily notice a verified badge on social media (assertive provenance) but have trouble checking if a viral image is taken

out of context (inferred context). These two skills may also need different teaching methods.

This doctoral research addresses the competency gap through empirical investigation focused on Italian secondary school teachers. Paper 2 presents the baseline assessment study, organized around two research questions:

Q1: To what extent are educators equipped to identify and evaluate disinformation in its different appearances?

Q2: What behavioral patterns can be identified to propose customized training programs?

These questions help to make clearer the bigger concerns about how ready teachers really are. The first question is whether teachers can actually check information, not just what they think they can do. The second question is about patterns, as teachers are not all the same. Effective professional development must recognize different starting points and needs.

2.3 Evidence from Italian Teachers

Paper 2 presents the complete methodology and findings from the baseline assessment of Italian teachers' media and information literacy competencies. Here, I highlight only those results that directly informed the intervention design presented in Paper 3, reading them through the theoretical lenses established in the preceding chapters.

The baseline assessment revealed a substantial competency gap: only one quarter of teachers demonstrated sufficient media and information literacy skills according to the assessment criteria. This finding established the empirical foundation for the dissertation's central argument: systematic intervention is required before teachers can effectively address disinformation in their classrooms.

Two findings proved particularly consequential for intervention design. First, visual literacy emerged as the most critical weakness, with fewer than 25% of teachers correctly evaluating manipulated or decontextualised images. In post-medial environments where images circulate freely across

platforms and contexts, this deficit represents a significant vulnerability. Second, teachers performed relatively better on recognising surface credibility indicators than on deeper verification requiring lateral reading. This pattern suggests a reliance on evaluative frameworks that prove insufficient in ecosystems where traditional gatekeeping structures no longer guarantee reliability.

These results are also related to the ecological view of false information that was discussed in Chapter 2. Teachers' difficulties cannot be attributed solely to individual skill deficits; they reflect the socio-technical complexity of contemporary information ecosystems. Effective intervention must therefore address not only verification techniques but also the conceptual frameworks teachers use to understand how information circulates, moving from reactive fact-checking toward a preventive, ecological approach.

These considerations motivated the remediated prebunking intervention examined in Paper 3. The complete analysis of teacher competency profiles is presented in Paper 2; the discussion of broader implications for educational policy appears in Chapter 5.

Chapter 3
Research Design and Methodology

This chapter lays out the research design that shapes the empirical core of this dissertation. While Papers 2 and 3 each offer their own detailed methods sections, here I take a step back to provide an integrated overview: how the three papers fit together, why I made certain methodological decisions, and which analytical approaches I used. By clarifying these foundations, I aim to help readers better understand the individual papers and see how their findings connect to the dissertation's main arguments.

3.1 Research Logic

This doctoral project moves deliberately from broad conceptual questions to focused empirical work. Each of the three papers in Part 2 tackles a distinct, yet interconnected, question:

Paper 1 ("Disinformation: History, Drivers, and Countermeasures," Encyclopedia 2025) asks: What is disinformation, why does it spread so effectively, and which countermeasures actually work? This conceptual paper sets the stage by reviewing historical examples, bringing together research on psychological and social factors, and weighing the strengths and limits of different interventions. Notably, it highlights media literacy education as especially promising, while also emphasizing that how it's implemented matters greatly.

Paper 2 ("Teachers' Competencies in Evaluating Digital Sources and Tackling Disinformation: Implications for Media Literacy Education," Je-LKS 2025) then turns to a practical question: Are educational agencies actually ready to deliver media literacy education that addresses disinformation? This baseline study looks closely at what Italian secondary school teachers are able to do—and where there are gaps or patterns that signal a need for support.

Paper 3 ("Remediating Prebunking in Practice: Enhancing Teachers' Competencies for Digital Source Evaluation and Disinformation Detection," Media Education 2025) asks whether targeted professional development can help teachers build these competencies—and how such growth happens. It evaluates a 12-hour blended learning program that uses a remediated prebunking approach.

Taken together, the dissertation tackles a set of interconnected questions, with each paper approaching them from a different perspective:

a) How should educational systems respond to disinformation in today's post-media landscape? Paper 1 argues that preventive, ecosystem-based strategies—especially media literacy education—hold the most promise, while Papers 2 and 3 explore what it takes for these approaches to work well in practice.
b) What skills do teachers actually need—and do they have them? Paper 2 breaks down these competencies using the assertive provenance/inferred context framework and finds significant gaps that need to be addressed.
c) Can a remediated prebunking approach really help teachers build these skills? Paper 3 shows clear improvement after the intervention and takes a close look at how and why those changes happen.

In evaluating teachers' skills in Paper 2 and Paper 3, we put a strong emphasis on open-response (qualitative) assessment, making it 75% of the score, because this approach has real advantages. Traditional media literacy tests often use multiple-choice questions that can be gamed by guessing or spotting patterns (someone might get the right answer without truly grasping how to verify information). By focusing on written explanations, we wanted to see who really understood the strategies, not just who could pick the right answer.

Requiring teachers to explain their answers reveals whether they have a deep, transferable understanding that they can adapt to new situations and teach to others, or whether they just recognize something in a specific

context. It's not enough to get the answer right; the explanation shows the real depth of their thinking. Further research (Moriggi & Bruno, 2025) allowed us to investigate the qualitative responses in greater depth, yielding new insights useful for designing media and visual literacies interventions for teachers.

In the intervention study, this mixed-methods approach helped us tell the difference between real learning and just getting used to the test. If teachers only improved on multiple-choice questions but not on their written explanations, we'd worry they were just getting familiar with the test format. Instead, we saw real gains in argumentation and reasoning, which points to genuine learning.

When we looked at teachers' open responses, we noticed their reasoning changed after the intervention. Before the training, many teachers relied on surface clues (like "the website looks professional"), gut feelings ("something seems off"), or blanket trust ("I trust newspapers"). After the training, their answers more often showed step-by-step evaluation strategies, mentioned verification methods they'd learned, and addressed the specifics of each type of content.

Interestingly, some teachers gave much better explanations after the training even if their final answer didn't change. This suggests that the intervention helped them think more deeply and explain their reasoning more clearly, even when their overall judgment stayed the same.

3.2 Paper 1: Methodology for Conceptual Synthesis

For Paper 1, we used a narrative review and conceptual synthesis approach, which fits its *Encyclopedia* entry format. We drew on research from communication, psychology, political science, history, and education to piece together a broad understanding of disinformation as a social phenomenon.

In terms of methods, we traced how today's disinformation practices connect to their historical roots, showing how certain patterns persist across different media eras, while also highlighting what's unique about our current, post-media environment. We brought together psychological

research to explore why people tend to believe and share false information, looking at cognitive, emotional, social, and narrative factors, and wove these insights into a broader framework. The paper also weighs the evidence for different interventions, drawing a line between reactive strategies (like fact-checking and debunking) and preventive ones (such as prebunking and media literacy education), and considers what each approach can and can't achieve.

This conceptual work lays the groundwork for the studies that follow. In particular, understanding why people fall for disinformation helped us shape the competency domains explored in Paper 2, while the review of intervention strategies became the springboard for the remediated prebunking approach we tested in Paper 3.

One of the key conceptual contributions is the distinction between assertive provenance and inferred context evaluation, a framework we used on the basis of the research paper by Hebbar & Wolf (2024).

3.3 Paper 2: Baseline Assessment

A total of 279 teachers participated in the pre-test assessment, which was carried out as part of different training programs in Italy during 2023–2024. After removing cases with missing data, we ended up with a final sample of 243 teachers. The participants' average age was 51, which is in line with the typical age profile of Italian secondary school teachers.

Data was collected through an online questionnaire (using Computer-Assisted Web Interviewing, or CAWI). The survey had four main sections: demographic information (like age, gender, teaching experience, and subject area); patterns of media consumption and trust (which platforms they use, where they get information, and how much they trust various sources); self-assessed familiarity with digital literacy concepts; and teachers' ability to judge the reliability of digital content in several areas.

The teachers came from training programs across different regions and types of schools in Italy. This diversity helps make the findings more

relevant within the Italian context, though we recognize the sample isn't perfectly representative of the whole country.

Building on the DigComp 2.2 framework and the assertive provenance/inferred context distinction, we focused the assessment on seven specific areas of teacher competency:

- [RELIABLE]: Differentiating reliable from misleading or potentially harmful sources of information
- [TRUSTWORTHY]: Evaluating trustworthy versus deceptive news articles
- [SPONSORED]: Recognizing sponsored content and distinguishing it from editorial content
- [VERIFIED]: Identifying verified profiles on social media platforms
- [SATIRICAL]: Distinguishing satirical material from genuine news reporting
- [DECONTEXTUALIZED]: Detecting images used out of their original context
- [MANIPULATED]: Identifying digitally manipulated photographs

These domains range from tasks that rely on assertive provenance to those requiring inferred context. For example, recognizing verified profiles ([VERIFIED]) is mostly about noticing explicit signals of authenticity, like a verification badge. In contrast, detecting decontextualized images ([DECONTEXTUALIZED]) means digging deeper—checking where an image originally came from and whether it's being used in a misleading way.

This study is distinctive in that it combines qualitative and quantitative evaluation into a single instrument. For each competency area, teachers answered two connected types of questions:

- A closed question (contributing 25% of the domain score) presented a multiple-choice evaluation task. For example, teachers might view two news sources and select the more reliable one or examine an image and indicate whether they believe it has been manipulated.

- An open question (contributing 75% of the domain score) asked, "Can you explain why?" Teachers provided written justifications for their closed-question responses, explaining the reasoning behind their evaluations.

The 75/25 weighting comes from a key insight: qualitative reasoning presents a much deeper picture of real competency than just getting the “right” answer does. For instance, a teacher might guess the correct answer without really understanding it, or they might choose the "wrong" answer but show thoughtful, sophisticated reasoning in their explanation. By reading how teachers explain their choices, I can see whether they truly grasp evaluation strategies, spot what matters in a source, and build clear arguments—all skills they’ll need to teach media literacy effectively.

Two independent coders evaluated the open responses, using a 1–5 scale to judge how well teachers argued their case, spotted what mattered, and showed they could use evaluation strategies. We checked that the coders agreed with each other and then averaged their scores. Each teacher’s domain score came from a mix of their closed and open responses (25% closed, 75% open), giving a final score between 0 and 4.

We set a proficiency threshold at 2.4 out of 4 (that’s 60% of the maximum score) to mark the line between sufficient and insufficient competency. This reflects the idea that teachers need to show more than just the basics if they’re going to teach media literacy skills well.

Descriptive statistics addressed research question Q1, examining competency distribution across the sample. Mean scores, standard deviations, and proficiency rates (percentage achieving the 2.4 threshold) were calculated for each domain and overall. Correlation analysis examined relationships between demographic variables, media habits, trust patterns, and competency scores. Cluster analysis addressed research question Q2, identifying behavioral patterns among teachers.

3.4 Paper 3: Intervention Evaluation

For the intervention study, we used a one-group pretest–posttest design (Ary et al., 2010). This means we measured each teacher's skills before and after the intervention to see what changed as a result of the training.

The one-group pretest-posttest design enables assessment of whether change occurs, while acknowledging limitations in definitively attributing it to the intervention. Potential threats to internal validity include maturation (changes that occur naturally over time), testing effects (improvement due to familiarity with the assessment rather than the intervention), and history (external events that influence outcomes). The discussion of findings addresses these limitations.

Of the 243 teachers who completed the pre-test assessment, 115 completed both the pre-test and post-test assessments, enabling paired comparisons. This represents a 47% retention rate across the training program duration.

We also checked whether teachers who completed the whole study were different from those who dropped out. While the ones who stayed were a bit more engaged at the start, there wasn't enough difference to seriously call the results into question.

For analyses requiring complete data across all domains, 96 teachers had no missing values on any competency measure. Domain-specific analyses used all available data for each domain.

The training program used a 12-hour blended learning model, combining different ways of learning: live online sessions for direct teaching and group practice, self-paced activities for reflection and personal study, and in-person workshops where teachers could discuss, collaborate, and apply what they learned together.

Module 1 (Evaluating Digital Sources) introduced the TAG method based on the validated SIFT methodology (Caulfield & Wineburg, 2023). The first step, "Trova" (Find), means figuring out who created the content, when, and where it was published. Next, "Analizza" (Analyze) is about taking a closer look at what the content actually says—its claims, evidence, and possible biases. The final step, "Guardati intorno" (Look around), encourages teachers to check information by looking for independent

sources outside the original site. This last step is especially important—research shows that expert fact-checkers rely on this kind of lateral reading, while beginners often stick to reading within a single source.

Module 2 (Visual Verification) tackled a key gap found in the initial assessment: visual literacy. Teachers worked with real examples of manipulated and out-of-context images, practiced using reverse image search, and learned how images can be misleading even if they haven't been technically altered. They also developed step-by-step approaches for checking the reliability of visual content.

Both modules followed a four-step prebunking model: first, giving advance warning about manipulation tactics; second, explaining these techniques before teachers encountered them; third, going into detail about how these techniques work; and finally, activating teachers through examples of simulated disinformation.

Throughout the training, the focus was on building strong argumentative reasoning instead of just getting the "right" answer. Teachers practiced explaining why a source was or wasn't trustworthy, building the kind of self-awareness and communication skills they'd need to teach these strategies to students—not just use them themselves.

For the post-test, we used the same mixed-methods assessment as in the pre-test so I could directly compare results. Teachers were assessed on the same areas, with the same balance between multiple-choice and open-response questions, and the same criteria for evaluating their written explanations.

Using the same assessment both times could mean that teachers improve just because they're familiar with the format. However, since so much of the test depends on teachers explaining their reasoning in writing, it's not something they can easily "game" by practicing the test alone. The improvements we saw were also meaningful and went beyond just getting used to the test.

Besides just looking for statistical significance, we tracked how many teachers crossed the 2.4 proficiency line: how many improved and moved

above the threshold, how many stayed above, how many stayed below, and if anyone unexpectedly dropped below. This gave a more practical sense of real change, not just numbers.

3.5 Limitations and Validity Considerations

The absence of control group comparisons represents the main limitation of this dissertation's intervention study. However, it should be noted that during two of the seven training courses, pre- and post-test questionnaires were also administered to a randomized control group. While these data have not yet been analyzed and are therefore not included in this dissertation, they will be examined in future research to provide more robust causal evidence for the intervention's effectiveness.

Still, there are reasons to be confident in the present results. The improvements were large and consistent across different skill areas, which makes it unlikely they just happened by chance. The shift in how teachers reasoned—something that shows in their written explanations—is also hard to explain as just a result of getting used to the test. Plus, since the training and testing happened over a short period (maximum 2 months), it's less likely that outside changes or slow, natural growth explain the findings.

There's also self-selection bias to consider. The teachers who chose to join these professional development programs might be more motivated, more aware of their areas for growth, or more committed to getting better than teachers who didn't sign up. So, the results might not apply to all teachers, especially those less likely to volunteer for this kind of training.

Because this research took place in Italy, its findings might not apply everywhere. Media environments, schools, and teacher preparation can be quite different in other countries. While the overall frameworks and methods should be useful elsewhere, the details—like exactly how competent teachers are or how much an intervention helps—would need to be tested in other settings.

Another challenge is that only 47% of teachers completed the full intervention. If those who didn't benefit as much were more likely to drop

out, the results could look more positive than they really are. I looked into this, but it's hard to completely rule out this kind of bias.

Even though the assessment tool was thoughtfully designed, it only measured certain competencies and only once after the intervention. We don't know if the improvements would last over the long term or if teachers actually put what they learned into practice in their classrooms, since we didn't measure those things directly.

Leaving out the [MANIPULATED] domain because of technical problems also made the visual literacy assessment less complete. The [DECONTEXTUALIZED] domain still covered some key skills, but not being able to test for manipulation detection throughout means we can't say as much about how teachers improved in that area.

We carried out this research according to ethical standards for educational studies. Participation was voluntary, and everyone gave informed consent after learning about the study's purpose and their right to leave at any time without it affecting their professional development.

For analysis, we anonymized the data by removing or coding anything that could identify a participant. The assessment results were used only for research. The training program was created to benefit teachers whether or not they took part in the research.

The next chapter connects these findings to the dissertation's main arguments, explores what they mean for policy and practice, and suggests where future research could go from here.

PART 2 – THE PAPERS

This part of the dissertation includes the three papers that constitute the empirical and theoretical core of the research. The papers are presented in this sequence: Paper 1 establishes the conceptual foundation by examining disinformation as a phenomenon; Paper 2 assesses the baseline competencies of teachers; Paper 3 evaluates the effectiveness of the remediated prebunking intervention.

The table below provides an overview of the three papers, including publication details, research focus, methodology, and author contributions according to the CRediT (Contributor Roles Taxonomy) system.

PAPER 1	
Title	Disinformation: History, Drivers, and Countermeasures
Authors	Nicola Bruno, Stefano Moriggi
Publication	*Encyclopedia*, 2025
Focus	Comprehensive review of disinformation as a phenomenon: historical precedents, psychological and social drivers, and evaluation of countermeasures, including media literacy education.
Methodology	Narrative review and conceptual synthesis drawing on multidisciplinary literature.
Author contributions (CRediT)	**Nicola Bruno:** Conceptualization, Methodology, Writing—Original Draft, Writing—Review & Editing **Stefano Moriggi:** Conceptualization, Supervision, Writing—Review & Editing

PAPER 2	
Title	Teachers' Competencies in Evaluating Digital Sources and Tackling Disinformation: Implications for Media Literacy Education
Authors	Nicola Bruno, Annamaria De Santis, Stefano Moriggi
Publication	*Journal of e-Learning and Knowledge Society (Je-LKS)*, 2025
Focus	Baseline assessment of Italian secondary school teachers' competencies in evaluating digital sources and detecting disinformation. Identification of competency gaps and teacher profiles
Methodology	Mixed-methods assessment (N=243). CAWI questionnaire with closed questions (25%) and open-response justifications (75%). Descriptive statistics and hierarchical cluster analysis
Author contributions (CRediT)	**Nicola Bruno:** Conceptualization, Methodology, Investigation, Project Administration, Supervision, Writing—Original Draft, Writing—Review & Editing **Annamaria De Santis:** Methodology, Formal Analysis, Data Curation, Visualization **Stefano Moriggi:** Conceptualization, Methodology, Investigation, Writing—Review & Editing

PAPER 3	
Title	Remediating Prebunking in Practice: Enhancing Teachers' Competencies for Digital Source Evaluation and Disinformation Detection
Authors	Nicola Bruno, Annamaria De Santis, Stefano Moriggi
Publication	*Media Education*, 2025

Focus	Evaluation of a 12-hour blended learning intervention employing remediated prebunking methodology. Pre-post assessment of teacher competency change
Methodology	One-group pretest-posttest quasi-experimental design (N=115). Mixed-methods assessment. Paired t-tests/Wilcoxon signed-rank tests. Proficiency threshold analysis
Author contributions (CRediT)	**Nicola Bruno:** Conceptualization, Methodology, Investigation, Project Administration, Supervision, Writing—Original Draft, Writing—Review & Editing **Annamaria De Santis:** Methodology, Formal Analysis, Data Curation, Visualization **Stefano Moriggi:** Conceptualization, Methodology, Investigation, Writing—Review & Editing

As first author on all three papers, the doctoral candidate (Nicola Bruno) was responsible for the conceptualization of the research program, the development of the theoretical framework, the design of the research instruments, and the writing of the manuscripts. The candidate also led the project administration and supervision of the data collection process across multiple training programs in Italy.

Annamaria De Santis contributed statistical expertise, conducting the formal analyses (descriptive statistics, cluster analysis, pre-post comparisons) and creating the data visualizations that appear in Papers 2 and 3.

Stefano Moriggi, as co-tutor and doctoral supervisor, contributed to the conceptualization of the research and provided critical review and editing throughout the writing process. His expertise in philosophy of education and post-mediality theory informed the epistemological framework developed across all three papers.

1. Paper 1

Title: Disinformation: History, Drivers, and Countermeasures

Authors: Nicola Bruno, Stefano Moriggi

Publication: *Encyclopedia*, 5(4), 211.

Status: Published on December 10, 2025

Doi: https://doi.org/10.3390/encyclopedia5040211

Definition

Disinformation refers to false or misleading information created with the deliberate intention to deceive and cause individual or societal harm. It is typically distinguished from misinformation, which involves falsehoods shared without deceptive intent, and from malinformation, which uses accurate information in misleading or harmful ways. Terms often used interchangeably in public debate — such as fake news, propaganda, and conspiracy theories — describe related but distinct phenomena with differing aims and methods. The term derives from the Soviet concept of *dezinformatsiya*, originally associated with covert influence operations and strategic deception. Over time, however, its meaning has expanded to encompass a wide range of manipulative practices enacted by both state and non-state actors. Disinformation can take textual, visual, and multimodal forms, including fabricated images and AI-generated content such as deepfakes. Motivations vary and may include political influence, economic gain, ideological mobilisation, or efforts to stigmatise specific groups. Although these practices have long historical precedents, digital and platformised communication environments have amplified their scale, speed, and persuasive potential. This entry provides a narrative overview and conceptual synthesis structured around four dimensions: the history of disinformation, the supply and diffusion mechanisms, the psychological, social, and narrative drivers, and the interventions designed to mitigate its impact.

Keywords: disinformation; misinformation; prebunking; media and information literacy; propaganda

1. Introduction

The literature increasingly regards disinformation as a socio-technical challenge rather than merely a limited knowledge deficit [1,2]. This perspective emphasises that false and misleading content emerges not only from individual misunderstandings but from the interaction between human cognition, social dynamics, and technological infrastructures.

During the 2016–2020 cycle of "infodemic," research came together around the "information disorder" framework by Wardle and Derakhshan [3], which includes misinformation, disinformation, and malinformation. This framework gave everyone common terms to use in debates about measurement and policy. The literature also highlights conceptual challenges in distinguishing misinformation from disinformation, particularly when the intentions of those who share false content are difficult to ascertain, an issue explored in depth by recent philosophical analyses [4].

The modern use of the term disinformation reflects this evolution. Western scholarship typically treats it as a loan translation of Soviet *dezinformatsiya*, a term reported in intelligence contexts from the 1920s and subsequently codified in Soviet reference works [5–7]. The use of English increased significantly after the 1950s, with a wider use of dictionaries starting in the 1980s. This was in line with Cold War debates about propaganda and active measures [5,7,8]. This diffusion underscores a key distinction in the literature: while techniques of deception have deep historical roots, the modern category term disinformation—and its policy salience—are products of 20th-century statecraft.

In the most recent years, three research streams developed concurrently. The first issue is supply and diffusion: who makes fabricated content, how it is spread and kept going, and how platform incentives affect visibility and reach [9]. The second examines susceptibility, integrating cognitive, affective, social, and narrative mechanisms to elucidate why falsehoods persist and why corrections frequently leave residual influence [10,11]. The third examines the efficacy of interventions set up to counter disinformation, encompassing prebunking, media literacy initiatives, accuracy prompts, interface friction, post hoc corrections, and provenance or policy safeguards [11,12].

New cumulative evidence makes it even clearer who is at risk and what works. An individual participant data meta-analysis (31 experiments; 11,561 U.S. participants; 256,337 headline judgments) distinguishes discrimination ability (the capacity to differentiate true from false) from

response bias (a general inclination to classify items as true or false). It demonstrates that source display, in conjunction with headlines, enhances discrimination—yielding heterogeneous subgroup gains—and identifies demographic and cognitive moderators [13]. A complementary toolbox synthesis in Nature Human Behaviour[1] delineates nine individual-level interventions aligning strategies with objectives and evidential robustness [12]. A meta-analysis of media literacy interventions encompassing 49 experiments (N = 81,155) indicates a moderate overall effect on resilience (d = 0.60), with enhanced outcomes for multi-session programs, in cultures with higher uncertainty avoidance, and among college students compared to crowdsourced adults [14].

Together, these strands reflect a growing consensus that disinformation must be understood systemically, as an interplay between producers, environments, and audiences. This entry synthesises these perspectives while offering an accessible overview of the history, drivers, and countermeasures of disinformation.

2. History

The English term disinformation is generally traced to the Russian *dezinformatsiya*, a Soviet intelligence term that entered official and semi-official usage by the mid-20th century [5,15]. Archival and lexicographic notes indicate early institutional use in the 1920s (reports of a "special disinformation office" in 1923), inclusion in Russian dictionaries by 1949, and a definition in the Great Soviet Encyclopedia (1952) as "false information with the intention to deceive public opinion" [5–7].

Historians and other specialists in the field exercise caution against "recentism," given the close association of contemporary concerns for disinformation with social platforms and AI [16,17]. While the modern concept of disinformation is rooted in twentieth-century political and intelligence practices [8,15], earlier media systems also enabled various forms of intentional deception, strategic persuasion, and fabricated content [18,19]. Examining these antecedents helps illustrate how evolving communication infrastructures shaped the possibilities for large-scale

informational manipulation. These cases are selected for their exemplary relevance in the sea of unreliable information, to reiterate, also from a methodological point of view, the importance of acquiring a perspective on the history and evolution of untrustworthy information.

Across different epochs, a small set of recurring communicative logics can be observed. One concerns fabrication and forgery, the deliberate production of false documents or narratives to legitimise authority or mobilise hostility. The Donation of Constantine—exposed philologically by Lorenzo Valla but used for centuries to support papal temporal claims—illustrates how textual fabrications can stabilise power arrangements when they resonate with prevailing institutional and religious frameworks [20]. Later, the Protocols of the Elders of Zion became a paradigmatic case of politically instrumentalised forgery, circulating internationally as evidence for a fictitious Jewish conspiracy and informing antisemitic propaganda across regimes and decades [21,22].

A second enduring logic is strategic persuasion as an instrument of statecraft, observable long before the modern era. Ancient empires already made systematic use of political messaging to construct legitimacy, consolidate power, and shape collective memory. In Augustan Rome, monumental inscriptions such as the Res Gestae Divi Augusti[2] and widespread visual programs documented by historians and classicists were carefully crafted to celebrate imperial achievements, glorify military victories, and present the emperor as restorer of order and prosperity [23,24]. These practices combined controlled narratives, symbolic communication, and curated public imagery to influence perceptions across the empire, illustrating an early and sophisticated form of state-sponsored persuasion. The twentieth-century Soviet doctrine of *dezinformatsiya* later formalised these strategies into a repertoire of "active measures," including selective leaks, planted stories, forged documents, and psychological operations designed to manipulate geopolitical perceptions [8,15,19,25]. Western responses included counter-propaganda and public diplomacy efforts such as the United States Information Agency and transnational broadcasters like Radio Free

Europe/Radio Liberty, which sought to shape perceptions behind and beyond the Iron Curtain [26,27]. These historical continuities show that many features of contemporary influence operations—narrative construction, symbolic legitimacy, and strategic manipulation of information—extend deep into antiquity, even as digital infrastructures have transformed their scale and speed.

A third historical pattern involves the acceleration and scaling of information enabled by successive media infrastructures. The Reformation pamphlet economy and later civil-war propaganda in England show how cheap print, literacy growth, and dense distribution networks could rapidly disseminate polemical or misleading materials, transforming political communication [28–30]. In the nineteenth century, the mass press and its commercial logics amplified sensational narratives: the Great Moon Hoax [31,32] of 1835 and the "yellow press" of the Spanish–American War era [33] illustrate how economic incentives favoured spectacular and often unreliable stories, foreshadowing contemporary attention-based dynamics. Studies of the Yugoslav wars and the Rwandan genocide have shown how broadcast and print media can be weaponised to dehumanise adversaries, mobilise violence, and entrench divisive narratives [34,35].

Finally, the most recent hybrid media environment combines these long-standing tendencies with novel technological affordances. Analyses of Russian information operations describe a "firehose of falsehood" model, in which high-volume, multi-channel, and often contradictory messaging seeks to overwhelm verification, and fragment shared reality [15,19,36]. In parallel, platform-based ecosystems and market-shaping incentives on digital media have created new conditions for disinformation production and amplification, where political, economic, and ideological motives intersect with algorithmic curation and engagement-optimised business models [18,37,38].

Viewed through these recurring logics, disinformation appears not as a uniquely contemporary anomaly but as a persistent feature of mediated communication, whose forms evolve alongside political institutions, media infrastructures, and economic incentives. This conceptual perspective

provides the backdrop for examining how present-day socio-technical environments interact with cognitive, social, and narrative mechanisms to sustain and amplify misleading content.

3. Supply and Diffusion of Disinformation

Disinformation is intentionally created and disseminated to influence beliefs, behaviours, or public debate, typically for political, economic, or ideological purposes. A large body of research shows that multiple actors—state and non-state, collective and individual—participate in its production and spread. Political actors may deploy disinformation to undermine trust in institutions, polarise societies, or gain electoral advantage, while commercial actors often pursue financial incentives such as advertising revenue or increased visibility [9,18,37,38]. Ideological groups and individual users may circulate misleading content to reinforce group identity, express grievance, or mobilise collective action [39–41].

Disinformation is amplified not only by its creators but also by ordinary users, who often share false content because it aligns with their prior beliefs or emotional states. Emotional and identity-based motivations—particularly anger, moral outrage, or confirmation bias—play a central role in driving engagement and diffusion [42,43].

Digital platforms significantly shape these dynamics. Recommendation systems, virality metrics, and frictionless sharing create environments in which sensational or emotionally charged content travels quickly and broadly. Platform features such as closed groups, personalised feeds, and microtargeting can intensify echo chambers and increase exposure to misleading information [41,44,45]. At the same time, business models centred on engagement may inadvertently incentivise the spread of controversial or polarising content, complicating efforts to curb disinformation [46,47].

Research shows that disinformation unfolds differently across regions, shaped by diverse media systems, political pressures, and cultural practices. In many Asia-Pacific countries, where news consumption is strongly mediated by mobile devices and encrypted messaging apps, the

speed and opacity of information flows have facilitated the circulation of misleading content within tightly knit social and family networks, influenced by cultural norms, local politics, and linguistic diversity [48,49]. Across Sub-Saharan Africa, motivations for sharing false content often differ from Western assumptions: people may circulate unverified information out of civic duty, amusement, or political engagement, relying on locally embedded cues of credibility rather than institutional trust [50,51]. Latin American countries, characterised by high social media penetration and historically low confidence in traditional media, face recurring waves of fabricated content and identity-driven polarisation, often amplified by partisan or commercial actors [52–54]. Although psychological factors underlying susceptibility—such as analytic thinking and accuracy motivation—appear consistent across countries, comparative studies reveal substantial regional variation in media trust, platform governance, and the effectiveness of interventions [44,55,56].

Taken together, these global perspectives underscore that disinformation is not a uniform phenomenon but one that reflects and reshapes local information cultures, power structures, and communicative norms.

4. Psychological, Social, and Narrative Drivers

A developed body of literature explains why people perceive certain falsehoods as true, spread them widely, and avoid correcting them. Understanding susceptibility to disinformation requires examining multiple interconnected dimensions: the cognitive mechanisms that make false information seem credible, the emotional and social dynamics that drive its spread, the narrative frameworks through which communities interpret information, and the platform architectures that shape exposure and engagement. Together, these factors create complex ecologies in which disinformation can take hold and persist despite correction efforts [57–59].

4.1. Cognitive Mechanisms and Emotional Influences

Repetition and processing fluency are fundamental: familiar statements are easier to process and thus perceived as more truthful (the illusory truth effect), even when audiences have pertinent knowledge [59,60]. Once encoded, misinformation can persist in shaping inference post-correction—the continued influence effect—unless the correction provides a causally adequate alternative that addresses the explanatory void left by the myth [57,60]. Numerous sharing decisions are executed with limited contemplation; thus, accuracy prompts that highlight precision prior to action can enhance subsequent sharing discernment in both experimental and field studies [61].

These cognitive biases are influenced by emotion and identity [2,58]. Moral-emotional language in social media posts attracts attention and enhances sharing [62]; anger appears particularly effective at making content viral in networked environments [63].

4.2. Social Dynamics and Network Effects

People rely on others for epistemic guidance: beliefs are shaped by social trust, status signals, and network structure. Formal models and empirical studies demonstrate how homophily, conformity, and reputational dynamics can produce polarised group beliefs, even among individuals seeking truth [64]. Online, interface cues—such as social endorsement indicators, source attributions, and popularity metrics—function as credibility heuristics that expedite evaluation and influence user behaviour; on a large scale, disinformation has been shown to disseminate more rapidly and extensively than true news, attributable in part to advantages in novelty and emotional response [65–67].

4.3. Narrative Frameworks

Narratives persuade by inducing transportation, an immersive state that reduces counter-argumentation and facilitates enduring attitude change; meta-analytic evidence substantiates these effects across various contexts [68]. Compelling stories can bypass evaluative filters and outcompete

fact-only corrections, an asymmetry particularly salient in conspiracy narratives that supply clear villains, dramatic conflicts, and coherent explanatory frameworks in emotionally engaging arcs [69,70].

Recent work on the narrative processes behind disinformation [71] represents a fundamental shift in approach: moving from treating it primarily as a problem of factual inaccuracy to recognising it as a manipulation of the narrative frameworks through which communities make sense of reality. While fact-checking remains essential, this research demonstrates that facts are never encountered in isolation—they are always interpreted through narratives, the mental structures that communities use to organise information, assign meaning, and construct coherent understandings of the world. Disinformation exploits this reality by embedding falsehoods within narrative frameworks that resonate with specific communities' values, identities, and ways of seeing, making factual corrections insufficient when the underlying narrative structure remains intact. This approach shows that effective interventions—including fact-checking, prebunking, and media literacy—must therefore operate on two levels: addressing factual accuracy while simultaneously engaging with the narrative dimension that determines how facts are received, interpreted, and integrated into belief systems. This dual focus is particularly crucial in polarised contexts, where different communities may acknowledge the same facts yet interpret them through incompatible narrative frameworks, leading to parallel realities and communication breakdowns.

4.4. Platform Design

Platform architecture shapes exposure, attention, and engagement with misleading content [72,73]. Ranking systems reward material that elicits strong reactions; recommendation algorithms create feedback loops that increase the visibility of sensational or congruent content; frictionless sharing reduces opportunities for reflection; and design choices such as infinite scroll, autoplay, or prominent engagement metrics can amplify cognitive biases [57]. The PNAS individual-participant meta-analysis [13]

shows how source visibility influences discrimination, illustrating how even minor interface decisions can affect judgment processes. Susceptibility emerges from the interplay of cognitive (fluency, memory), emotional (arousal, moral language), social (identity, group norms), and architectural (algorithmic curation, user-flow design) factors [57].

5. Strategies for Prevention and Mitigation

Interventions for tackling disinformation are most efficacious when regarded as complementary, situated at various phases of the disinformation life cycle, and implemented across socio-ecological strata. Across reviews, five families come up again and again: boosting (building competence through prebunking and media literacy), nudging (choice architecture), debunking (post-exposure corrections), labels, and system-level guardrails [57,58,74–76]. An up-to-date toolbox in Nature Human Behaviour[3] combines 81 studies into nine categories for individuals: accuracy prompts; debunking/rebuttals; friction; inoculation; lateral reading/verification; media-literacy tips; social norms; source-credibility labels; and warning/fact-checking labels. Each category has targets, scope, and evidence summaries that go along with the four-family schema used here [12].

5.1. Boosting: Building Competencies Through Prebunking and Media Literacy

Building individual competences against disinformation involves two complementary approaches that enhance people's ability to recognise and resist manipulation: prebunking (or psychological inoculation) and media and information literacy (MIL) interventions.

Brief inoculations alert individuals to manipulation techniques and either pre-refute them (passively) or engage users in simulated manipulation (actively; through mini-games), thereby cultivating mental "antibodies." A comprehensive study program, which included a substantial YouTube field experiment, demonstrated that concise (approximately 90-s) technique-based prebunking videos enhanced the

recognition of manipulation and diminished susceptibility [57]. Effects are moderate and scalable, but they diminish without reinforcement, necessitating booster exposures and incorporation into ongoing education [77].

MIL improves verification (like lateral reading), source evaluation, and understanding of platform incentives. A randomised trial conducted in the United States and India demonstrated that a brief digital media literacy module enhanced the ability to discern truth [11]. A 2024 meta-analysis of 49 experiments (N = 81,155) indicates a moderate overall effect on resilience to misinformation (d = 0.60), with more pronounced effects for multi-session programs, in cultures with higher uncertainty avoidance, and among college students compared to crowdsourced adults. Specific improvements include reduced belief (d = 0.27), enhanced discernment (d = 0.76), and diminished sharing (d = 1.04) [14]. These findings enhance the inoculation theory by demonstrating that structured, repeated exposure and refutation strategies are more effective than singular sessions, while also offering new recommendations for educational systems [78]. Modern policy guidance advocates for the treatment of Media and Information Literacy (MIL) as ecosystem infrastructure, integrating schools, libraries, community organisations, creator training, newsroom standards, and platform partnerships with the life cycle of a socio-ecological matrix [1].

Some studies note unintended side effects of boosting activities: when poorly designed, these interventions can lead individuals to adopt an overly generalised scepticism, resulting in reduced trust even toward reliable content or institutions. While these effects tend to be small and context-dependent, they highlight the importance of designing interventions that promote critical discernment rather than indiscriminate distrust [79].

Together, these competence-building interventions are widely regarded as among the most effective long-term strategies for countering disinformation, though they require sustained investment and time to achieve widespread impact across populations.

5.2. Nudging (Choice Architecture)

Accuracy prompts—simple reminders to evaluate accuracy before sharing—consistently enhance sharing discernment, yielding small yet significant effects across multiple experiments [61]. As part of a broader suite, friction and social-norm nudges can be useful, provided they are tailored to context and audience and combined with complementary interventions [12]. Effects can vary depending on the context and may diminish without repetition; nudges should be viewed as low-cost adjuncts rather than substitutes for more intensive interventions [58].

In addition to general warnings, making source information clear at the time of judgment enhances performance. The PNAS meta-analysis indicates that source display with headlines enhances discrimination on average, yielding greater advantages for certain subgroups. This implies that specific, informative cues can more consistently enhance veracity judgments compared to general labels [13]. Decisions at the interface level about where and how to show provenance, authorship, or editorial processes are examples of choice architecture.

5.3. Debunking (Post-Exposure Correction)

Fact-checking and corrections are effective tools for reducing belief in misinformation, but their impact is moderate and varies by context, message design, and individual differences [80]. Fact-checking, media literacy, inoculation, and accuracy prompts can all work together to make it easier to confront false information.

The *Debunking Handbook 2020* establishes best practices: present the fact first, caution against the myth, and elucidate the fallacy [74]. Meta-analyses show that fact-checking and corrections have small to moderate positive effects on belief accuracy, but these effects vary depending on the topic, audience, and format [76]. Concerns about "backfire effects" have diminished as methodologies have advanced; when corrections adhere to best practices, backfire occurrences are infrequent [61,74].

5.4. Warning and Labels

Labels can take multiple forms, including: Warning labels, which signal that content has been disputed or lacks verification; Source-credibility labels, indicating the trustworthiness or expertise of an outlet; Context or information-quality labels, providing additional details, links, or provenance information; Fact-checking labels, summarising third-party review. (Semi)-automated labels promise to work on a large scale, but they do not always do so. Specific labels linked to evidence generally surpass generic warnings; performance differs among languages and platforms, and mislabeling may lead to confusion or excessive moderation [58]. It appears that aligning labels with paths for source transparency and verification is important. The evidence examined indicates that source visibility and task-relevant cues at the decision point may yield more dependable enhancements than generic warning banners [12,13].

5.5. Guardrails at the System Level

Infrastructure and governance at the upstream and midstream levels set the rules for how individual-level measures work. Effective trust signals require distinguishing between two complementary dimensions: assertive provenance and inferred context [81]. Assertive provenance refers to claims made by content creators or sources about a piece of content's origin, authenticity, and history—such as who created it, when, and whether it has been altered. Standards like C2PA enable this by specifying cryptographically verifiable Content Credentials for capture and edit history, allowing creator tools and platforms to attach tamper-evident provenance, which is especially important for synthetic media. Inferred context, by contrast, encompasses the broader ecosystem of information surrounding content: how it has circulated, been modified, or been verified by third parties, as well as the reputation and track record of sources within specific domains. Building robust trust frameworks requires both dimensions, especially as synthetic media becomes increasingly sophisticated and widespread.

The European Union's Digital Services Act requires very large platforms to do systemic-risk assessments, take steps to reduce those risks, and have their work checked by an outside party. The Strengthened Code of Practice on Disinformation adds commitments to demonetisation, fact-checking access, and political advertising transparency [82,83]. These actions move responsibility up and down the chain, which balances out the natural tendency to put too much on end users.

6. Conclusions

The collected evidence depicts disinformation as a systemic, socio-technical issue. Processing fluency and memory dynamics render familiar falsehoods credible; emotional resonance, identity affirmation, and narrative coherence direct attention and influence persuasion; social trust, status indicators, and network configurations determine diffusion; and platform design influences exposure and subsequent action [2,10,58]. These mechanisms—and their interactions—explain why disinformation thrives in contemporary information environments and why no single intervention can fully address it.

There are many levels of effective practice. At the preventive edge, prebunking (short, technique-based videos; active inoculation games) and media and information literacy (verification, lateral reading, and AI/media awareness) cultivate competencies that persist within individuals and communities [1,11,14,57]. At the time of action, accuracy prompts, careful friction, and prominent source cues push people to pay attention to accuracy [12,13,61,81]. After exposure, well-structured corrections generally diminish misperceptions, particularly when they offer credible alternatives [74,76,80]. Narrative-layer tools encourage individuals to be more receptive to new ideas by prompting them to reflect on their interpretation of facts [71]. Additionally, at the system level, provenance and platform transparency create the right conditions: end-user competence cannot handle everything when creation and distribution are optimised for speed and scale [81–83].

The effects of disinformation are real but usually small to moderate. They can fade away without reinforcement and differ depending on the domain and audience [58]. Layered deployment with periodic boosters enhances durability. There are still gaps: non-Western contexts are not well represented in the research; there is not enough evidence on multimodal and AI-generated deception; and there is a need for standardised outcome measures, clear reporting, and deployment research that connects laboratory effects to platform-scale impact under credible governance regimes.

Taken together, the evidence suggests that disinformation is best approached as a socio-technical problem: one emerging from the coupling of human cognition, social dynamics, and digital infrastructures. Addressing it requires aligning individual-level competencies with system-level incentives and governance. As communication technologies continue to evolve, so too must the strategies designed to strengthen information integrity and support resilient democratic societies.

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2. Paper 2

Title: Teachers' Competencies in Evaluating Digital Sources and Tackling Disinformation: Implications for Media Literacy Education

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Abstract

This study examines teachers' competencies in evaluating digital content and tackling disinformation through analysis of pre-test data from 243 Italian primary and secondary school teachers participating in a media literacy training program. Drawing on the DigComp 2.2 framework, we assessed seven key digital literacy competencies, including source evaluation, social media verification, and visual literacy. Our findings reveal significant gaps between teachers' digital engagement patterns and their critical evaluation skills, particularly in visual content assessment. Using cluster analysis, we identified four distinct teacher profiles: Skeptical and Vulnerable Teachers, Traditional Trust-Based and Uncritical Teachers, Digitally Engaged and Trusting Teachers, and Balanced Critical Evaluators. The results show that teachers are moderately good at finding assertive signs of reliability, but they have trouble with more difficult "inferred context" tasks, especially when it comes to judging visual content. The study shows that different types of professional development are needed and suggests specific ways to help teachers improve their media literacy skills in a world where digital information is getting more complicated.

Keywords: Information Literacy, Teachers, Digital Skills, Digital Content, Disinformation.

1. Introduction

Disinformation, defined as the deliberate dissemination of incorrect or misleading information, represents a growing threat to democratic processes, public health, and social trust (Pérez-Escolar et al., 2023; Bennet et al., 2018). The rapid digitalization of information sharing has intensified this challenge, with the COVID-19 pandemic highlighting how surges of misinformation can amplify societal discord and jeopardize public safety (Springer et al., 2022). Within this context, educational institutions face mounting pressure to develop students' capacity to navigate an increasingly complex information landscape (Nygren et al.,

2024). A report by IDMO (2023) indicates that both educators and students perceive themselves as frequently encountering disinformation.

Recent research demonstrates that students often struggle to differentiate between credible and biased information sources (Breakstone et al., 2021; Martini et al., 2024), making them particularly vulnerable to manipulation in digital environments (Jones-Jang et al., 2021). This vulnerability has prompted academic, civil, and governmental entities to advocate for the integration of media literacy education into core curricula. Organizations such as the UNESCO (2018) and the European Union (2022a; 2022b) have identified media literacy – the ability to critically analyze, evaluate, and comprehend information sources – as a fundamental defense against disinformation (Bruno et al., 2023). The European Commission's DigComp 2.2 and DigCompEdu frameworks specifically emphasize digital and information literacy as essential competencies for contemporary education (European Commission, 2022a; 2022b).

Evidence supporting the effectiveness of media literacy interventions against disinformation continues to emerge (Kozyreva et al., 2024; Roozenbeek et al., 2023; Bateman et al., 2024; Dame Adjin-Tettey, 2022). A comprehensive meta-analysis of 49 studies revealed that media literacy interventions significantly enhance resilience to misinformation ($d = 0.60$), reduce belief in false information ($d = 0.27$), and decrease the likelihood of sharing misinformation ($d = 1.04$) (Huang et al., 2024). Similarly, educational programs aligned with European Commission guidelines have demonstrated success in increasing perceived social media literacy and reducing conspiracy beliefs among young adults (Gross & Balaban, 2024).

However, the successful implementation of media literacy education depends critically on teacher preparedness. Current research indicates a substantial gap between institutional expectations and educators' readiness to deliver media literacy interventions effectively (Erdem et al., 2018; Tsankova et al. 2023; Tan et al., 2024; Zaçellari et al., 2024). While many teachers demonstrate proficiency in using digital resources for

classroom instruction (McNelly, 2021), they often lack the specific competencies needed to teach critical evaluation skills (Ranieri et al., 2017; Ranieri et al., 2021). This disparity is reflected in broader European trends, with an Ipsos Mori (2021) survey revealing that only 9% of Europeans across 11 nations have received training in distinguishing between accurate and inaccurate online information, despite 58% expressing interest in such training.

The persistent gap between the recognized importance of media literacy education and its effective implementation underscores the need for systematic research into teacher preparedness.

This study addresses this need by examining the media literacy competencies of Italian primary and secondary school teachers through analysis of pre-test data from a professional development course designed and delivered within the media literacy programme Open the Box (www.openthebox.io). By identifying specific deficiencies in educators' media literacy abilities and their capacity to transmit these skills, this research aims to inform the systematic integration of media literacy into educational curricula. Our findings contribute to the growing body of research on comprehensive media literacy education (Livingstone, 2012; Greenhow & Lewin, 2016) while providing practical insights for educational policy and teacher training programs in the European context.

The study is guided by the following research questions:

Q1- To what extent are educators equipped to identify and evaluate disinformation in its different appearances, including manipulated images, sponsored content, and dubious news sources?

Q2- What behavioral patterns in teachers' skills and approaches to digital sources can be identified in order to propose customized training programs for enhancing information literacy?

A survey was administered to Italian teachers attending a series of courses on information literacy organized by the media literacy program Open the Box. The results are analyzed using descriptive statistics tools

and a multivariate analysis technique, namely cluster analysis useful to create groups among statistical units according to their features.
After the description of Methods for data collection and analysis in Section 2, the authors provided the results (Section 3) and a discussion about the findings in Section 4.

2. Methods

This study seeks to evaluate the foundational competencies of primary and secondary school teachers in topics related to disinformation resistance.

2.1. Sample and Variables

The data provided here originate from a pre-training evaluation aimed at assessing teachers' foundational abilities in identifying and appraising different forms of digital information. Table 1 lists the variables used in the analysis.
A total of 279 educators engaged in the pre-test, conducted across four separate teacher training programs held in Italy during the 2023-2024 school year. After deleting missing data, the final sample was made by 243 teachers. The sample taken has an average age of 51 years, in line with the average age (52 years) of Italian teachers (Svimez, 2024).

The pre-test questionnaire comprised four sections: (1) demographic data, (2) media consumption and trust patterns, (3) self-assessment of issues pertinent to digital literacy (including definitions of fake news, disinformation, and misinformation), and (4) the capacity to assess the reliability of digital content. In this last part, educators were introduced to seven distinct forms of digital content derived from real- world case studies (see Annex).
Participants were instructed to evaluate the trustworthiness of each item via a multiple-choice question (e.g., "Which of these two sites is more reliable?"; "Has this image been altered?") and to provide a concise written rationale for their selection.

Responses were assessed through both quantitative and qualitative methods. Quantitative responses were assigned a score of 1 (correct) or 0 (incorrect), whereas qualitative arguments were evaluated on a 1–5 scale, with 1 denoting insufficient and 5 signifying extremely good.

Table 1 - Variables list.

Group	Variables	Description	Range/Options
Social media	Facebook Whatsapp Telegram YouTube Instagram Twitter / X Pinterest TikTok	Binary variables attesting to the use of each social media	Yes/No
	social_n	Sum of social media used among the previous listed	Min: 0 Max: 8
	social_hours	Number of hours during which teachers used social media the day before the survey	Min: 0 Max: 7
Information sources	TV_info radio_info web_info social_info friends_info online_news_info family_info	Binary variables attesting to the use of each information source	Yes/No
	info_sum	Sum of information sources used among the previous listed	Min: 0 Max: 7
Confidence in information sources	TV_trust radio_trust newspaper_trust social_trust web_app_trust family_trust friend_trust	Ordinal variables describing the confidence levels of teachers in each source	Min: 0 (lower) Max: 5 (higher)
	sum_trust	Sum of the trust levels referred in the previous list	Min: 0 Max: 40

Assessment	Reliable	Assessment to question related to checking the ability to differentiate reliable from misleading sources	Min: 0 Max: 4
	Trustworthy	Assessment to question related to checking the ability to evaluate trustworthy versus deceptive news content	Min: 0 Max: 4
	Sponsored	Assessment to question related to checking the ability to recognize sponsored content	Min: 0 Max: 4
	Verified	Assessment to question related to checking the ability to identify verified profiles on social media	Min: 0 Max: 4
	Satirical	Assessment to question related to checking the ability to distinguish satirical material from factual content	Min: 0 Max: 4
	Decontextualized	Assessment to question related to checking the ability to detect decontextualized images	Min: 0 Max: 4
	Manipulated	Assessment to question related to checking the ability to identify manipulated photographs	Min: 0 Max: 4
	Assessment	Sum of the scores in all questions	Min: 0 Max: 28

The final score allocated 25% to quantitative responses, due to the potential for random accurate answers, and 75% to qualitative responses, as they offer greater insight into the teachers' critical thinking abilities.

This analysis centers on seven critical competencies vital for digital literacy, as highlighted in the DigComp framework (European Commission, 2022a). These include:

1. Differentiating reliable from misleading sources,
2. Assessing trustworthy versus deceptive news content,
3. Recognizing sponsored content,
4. Identifying verified profiles on social media,
5. Distinguishing satirical material,
6. Detecting decontextualized images, and
7. Identifying manipulated photographs.

These competencies represent essential skills for educators in assessing the authenticity and reliability of various digital resource kinds within a progressively intricate information environment.

2.2 Analysis Methods

We used descriptive statistics tools to reply to Q1 and verify teachers' levels of information literacy.

To reply to Q2, we conducted a cluster analysis to differentiate the skills and habits of teachers in our sample. Cluster analysis is a multivariate analysis technique that, starting from the distance between statistical units, generates groups in which the units are most similar to each other and distant from those in the other clusters (Hair et al., 2014; Bartholomew et al., 2008).

We studied solutions with three and four clusters using different types of distance and agglomeration methods. Finally, we performed hierarchical clustering, calculating the Euclidean distance and using the Ward agglomeration method (Ward.D) that is the solution that give the possibility of better identifying multiple teachers' profiles. The variables used in the Cluster Analysis were the quantitative ones, namely social_n, social_hours, info_sum, sum_trust, and assessment. We chose a 4-cluster solution that better fits our data.

Analysis was conducted using R/R Studio and packages: stats, psych, corrplot.

3. Results

3.1. Competencies of teachers in evaluating digital content (Q1)

The findings from the pre-test reveal key insights into the foundational competencies of teachers in evaluating digital content. These results highlight the significant challenges educators face in navigating and assessing the reliability of information in the digital landscape, as well as their reliance on traditional media hierarchies and surface-level evaluation strategies.

Social Media Usage and Information Sources

Around half of the teachers interviewed declared to account for 3-5 social media; 77% of teachers stated to have spent 1-2 hours using social media the day before the survey (see Figure 1). Table 2 shows that teachers overwhelmingly favor traditional communication tools, with WhatsApp being the most used platform (97%), followed by Facebook (70%) and Instagram (64%). Usage of platforms popular among younger demographics, such as TikTok (14%) and Twitter/X (14%), remains minimal. This pattern suggests a potential disconnect between educators and the digital spaces their students frequently engage with, emphasizing the need for training to bridge this gap.

When it comes to sources of information, half of teachers declared consuming more than 4 sources (Figure 2). In Table 3 we found that traditional media dominate, with 75% of teachers relying on TV for news, followed by online newspapers (63%) and social media (59%). Family (57%) and friends (44%) are also significant sources, reflecting a strong dependence on close networks for information. This reliance highlights a lack of confidence in navigating broader digital ecosystems.

Figure 1 - Number and time spent on social media by teachers.

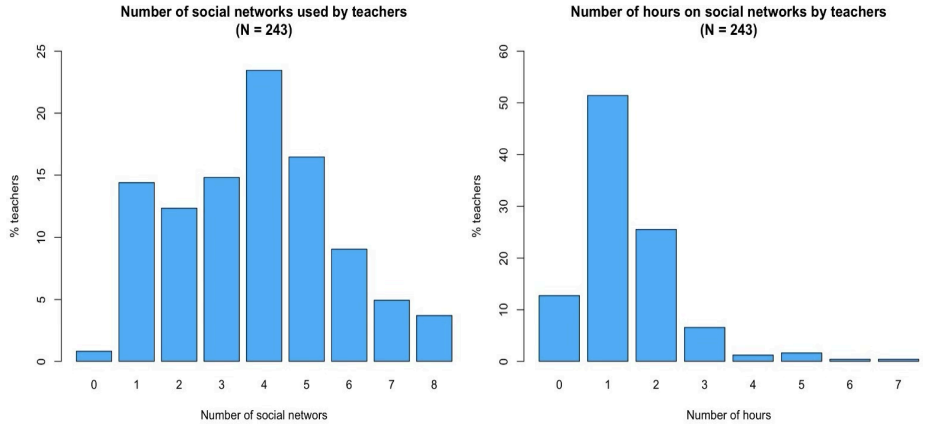


Table 2 - Social media use by teachers (N = 243).

Social Media	Percentage
WhatsApp	97%
Facebook	70%
Instagram	64%
YouTube	43%
Telegram	42%
Pinterest	34%
TikTok	14%
Twitter / X	14%

Figure 2 - Number of information sources by teachers.

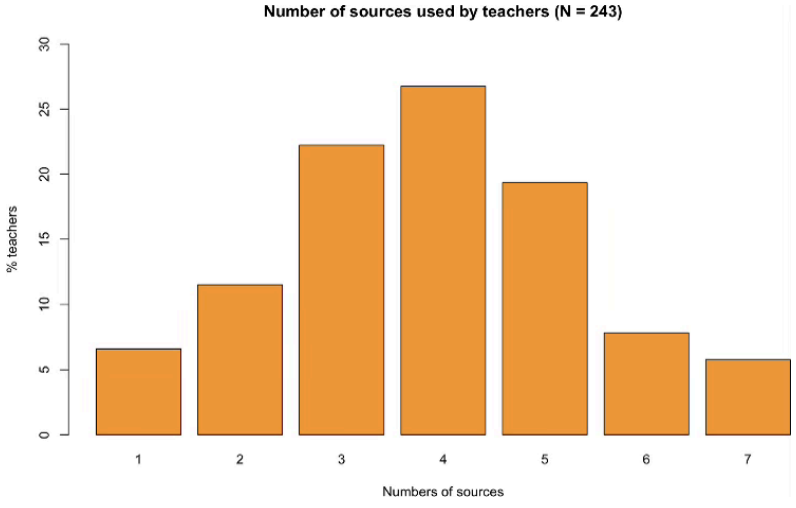


Table 3 - Information source used by teachers (N = 243).

Information Sources	Percentage
TV	75%
Online Newspapers	63%
Social	59%
Family	57%
Radio	45%
Friends	44%
Web	43%

Trust Levels in Information Sources

Teachers exhibit a polarized trust dynamic, with high levels of trust in traditional media like TV and newspapers, while expressing skepticism towards digital platforms. Figure 3 indicates that the upper limit for the variables social_trust and web_app_trust is lower than for all other variables. The percentage of teachers expressing high trust levels (scoring 3, 4, or 5) was 77% for family, 72% for newspapers, 70% for friends, 65% for radio and 58% for TV compared to only 40% for web applications and 19% for social media.

This bias appears rooted in outdated hierarchies of trust rather than an evidence-based evaluation of reliability.

Teachers' reluctance to engage critically with digital sources underscores their limited understanding of "post-mediality" (Eugeni, 2015; Moriggi, 2023), where traditional and digital media increasingly overlap and influence one another. This highlights the importance of fostering critical evaluation skills to address such biases.

Assessment of Digital Literacy Skills: challenges with Visual Sources

Teachers were assessed on their ability to evaluate seven key competencies identified in the DigComp 2.2 framework, including

differentiating reliable from misleading sources, evaluating news content, and detecting manipulated images. Results in Figure 4 indicate moderate proficiency in identifying reliable websites and recognizing verified profiles on social media (e.g., blue checkmarks). With the minor exception of sponsored content, less than 25 percent of teachers scored 60 percent on the questions, i.e., sufficiency. Teachers struggled significantly with more "inferred context" tasks, such as distinguishing trustworthy content or manipulated photographs, "leveraging information available on the open web to infer where a piece of content came from, how old the content may be, what claims are being made about it and by whom, etc." (Hebbar et al., 2024).

Moderately better performance only occurs in the case of evaluating "assertive provenance" signals, such as recognising a social media profile from the blue checkmark. In opposition to "inferred context" activities, Hebbar et al. (2024) define assertive provenance as "techniques used at the creation or editing stage to provide a clear signal regarding the means of creation of a piece of content".

Visual literacy emerged as a critical area of weakness. Teachers had the most difficulty evaluating visual content, such as detecting manipulated images or identifying the original content of a photograph. This aligns with the text-centric nature of traditional schooling, which prioritizes textual analysis over visual and multimedia literacy (Rivoltella, 2020; Farné, 2021). The lack of an integrated aesthetic literacy framework, as discussed in Manovich's concept of post-medial aesthetics (2001), further emphasizes the need for systematic training that incorporates visual and multimedia evaluation skills.

Checking correlations (Figure 5), higher values were revealed among variables in the same groups. Correlations among variables belonging to different groups were generally low, between -0.24 and 0.31. They suggested weak connections among the number, time spent, and trust in social media, mistrust in family and friends, and higher scores on information literacy assessment. In particular, trust in newspapers

corresponds to higher values in the assessment scores, contrary to trust in the family.

Figure 3 - Trust levels in sources by teachers.

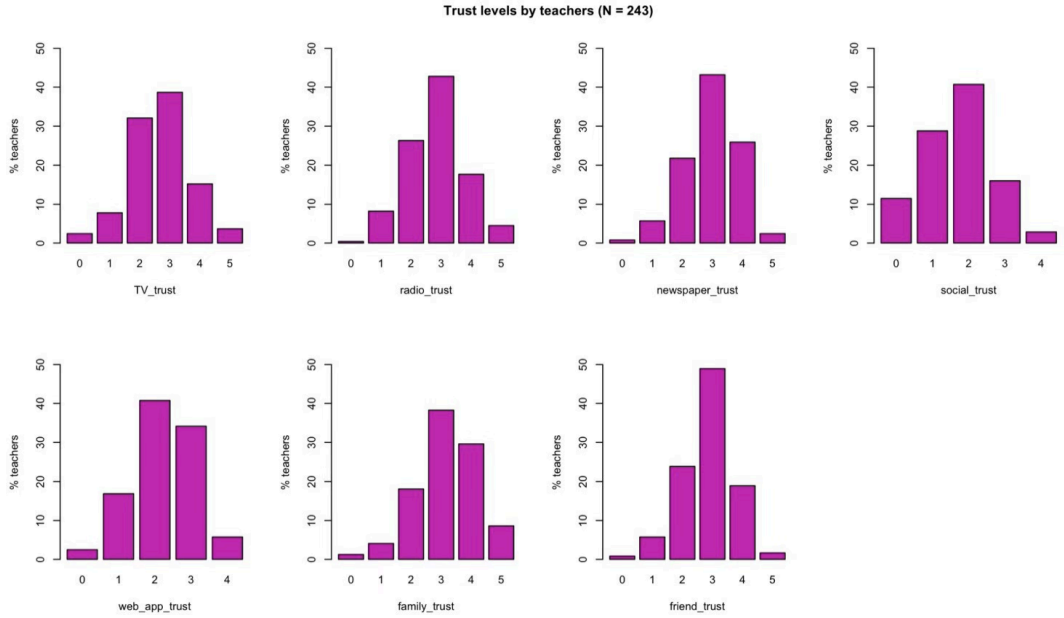


Figure 4 - Boxplots of the score on questions on information literacy.

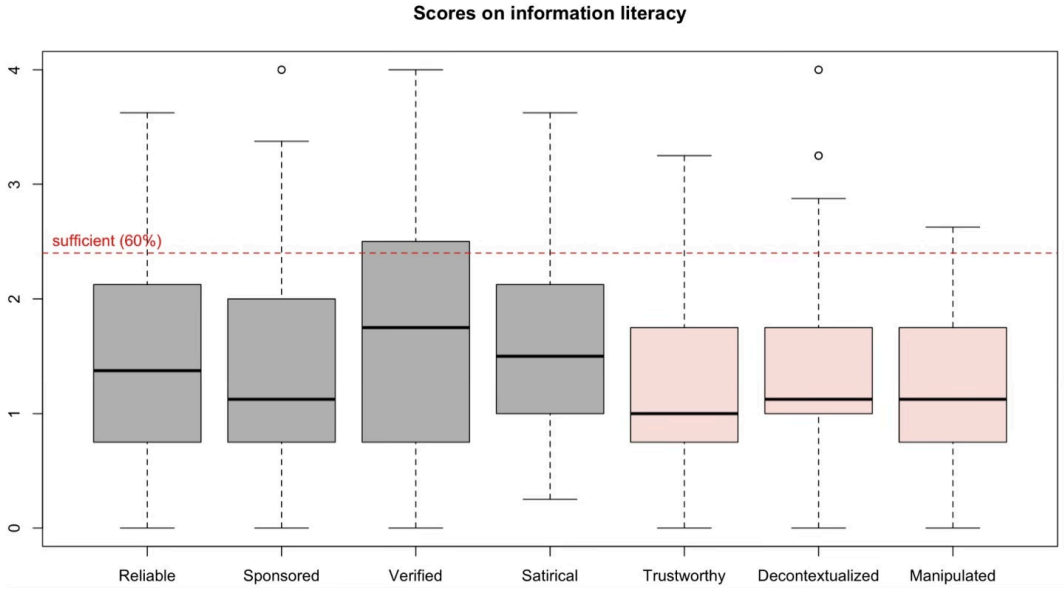
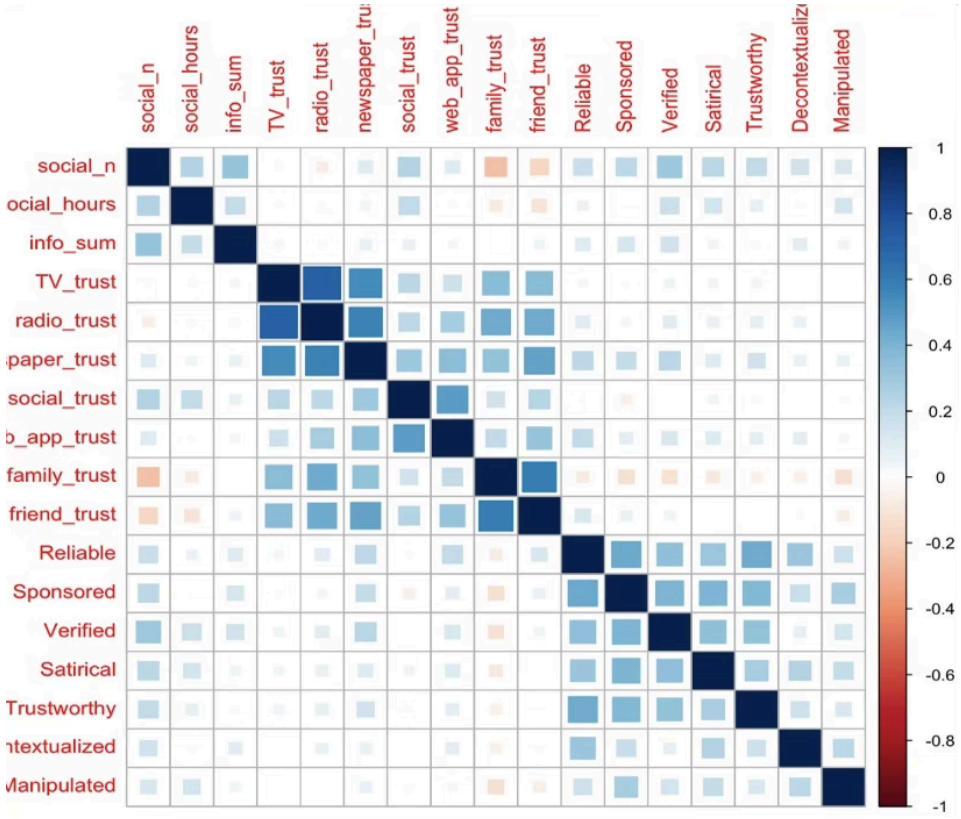


Figure 5 - Correlation matrix.



3.2. Behavioral patterns in teachers' skills and approaches to digital sources (Q2)

Our analysis revealed four clusters of different sizes as shown in the dendrogram in Figure 6.

The first cluster, the less numerous (N = 30, 12%), includes teachers who make fairly frequent use of social media and consult a good number of social and information-seeking tools. Compared to the others, they have the lowest levels of trust in information sources and perform poorly in the information literacy assessment questions. We define this cluster as Skeptical and Vulnerable Teachers.

The second cluster, on the contrary, is the most numerous (in fact, it gathers 40 percent of the teachers in the sample, N = 98). It is composed of teachers who, compared to the other clusters, use less social media and resources for a limited amount of time (usually one hour), have a strong

reliance on familiar sources (particularly family, friends and radio), and have lower assessment results than the other clusters. We define this cluster Traditional Trust-Based and Uncritical Teachers.

Cluster 3 (N = 57, 24%) and Cluster 4 (N= 58, 24%) have similar sizes. Teachers in Cluster 3 have higher levels of use and trust than all other clusters except in the assessment, where instead, teachers in Cluster 4 have the best scores on the information literacy assessment while declaring moderate levels of use and trust in sources. We define cluster 3 Digitally Engaged and Trusting Teachers and cluster 4 Balanced Critical Evaluators.

Figure 7 shows the boxplots on variables used for clustering for each group.

The radar chart on the left in Figure 8 confirms the just- described different use of social media by teachers: high for cluster 3, moderate for cluster 1 and 4, low for cluster 2. Basically, the trends do not differ substantially from the order of preferences in the entire sample. Instead, the sources predominantly preferred by teachers vary in the four clusters (right side of Figure 8).

In cluster 1, the majority of teachers choose TV (73%), family (67%), and friends (63%), followed by web applications (60%), online newspapers (57%), and in last place radio (47%) and social media (47%).

In cluster 2, 82 percent chose TV. Family, online newspapers, social media, and radio have percentages between 40 and 52. Around a third of teachers in the cluster refer to web applications and friends to gain information.

As said, the number of sources in Cluster 3 is generally high. Among the most used are social media (91%), TV (86%), and online newspapers (79%), followed by family and friends, and finally web applications and radio, which, however, stand above 50 percent.

In the fourth cluster, 74 percent of teachers use online newspapers, followed by social media (59%) and TV (55%) which falls to third position. Friends are, after all, with 34% of preferences.

Figure 6 - Dendrogram.

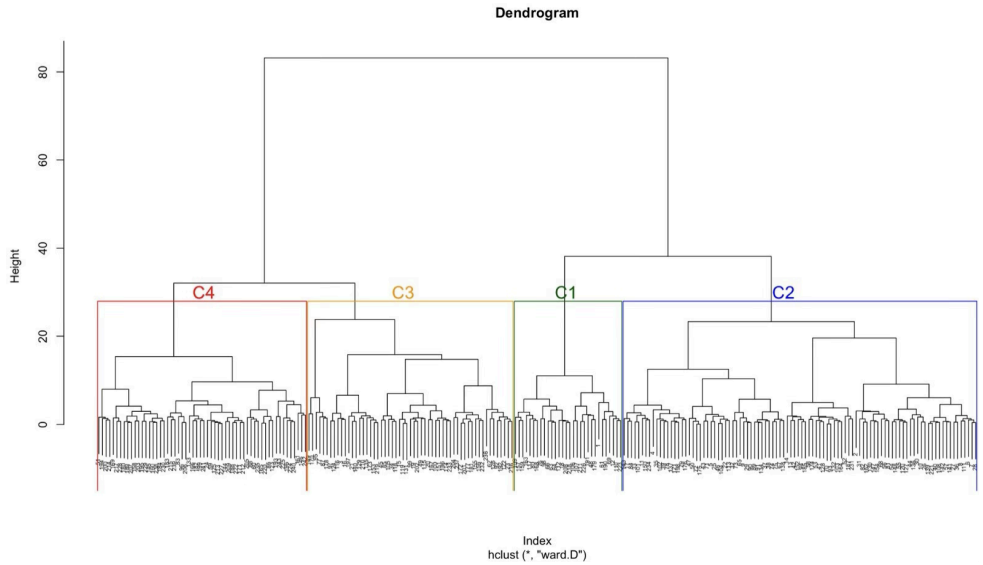


Figure 7 - Variables distribution in clusters (social_n, social_hours, info_sum, sum_trust, and assessment).

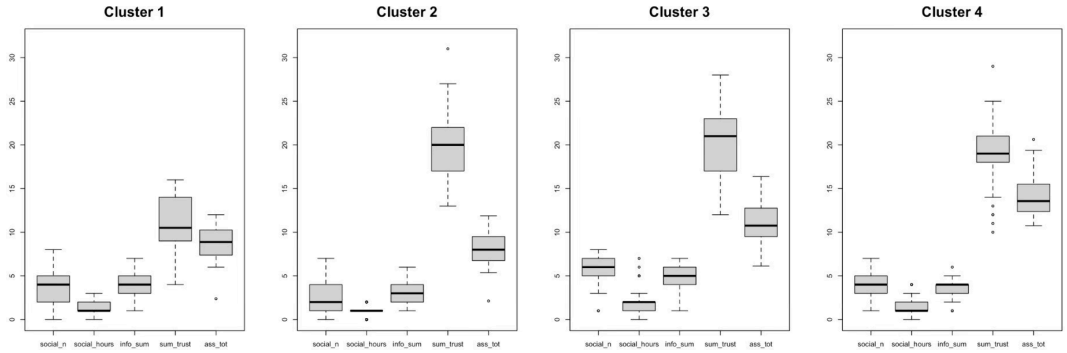
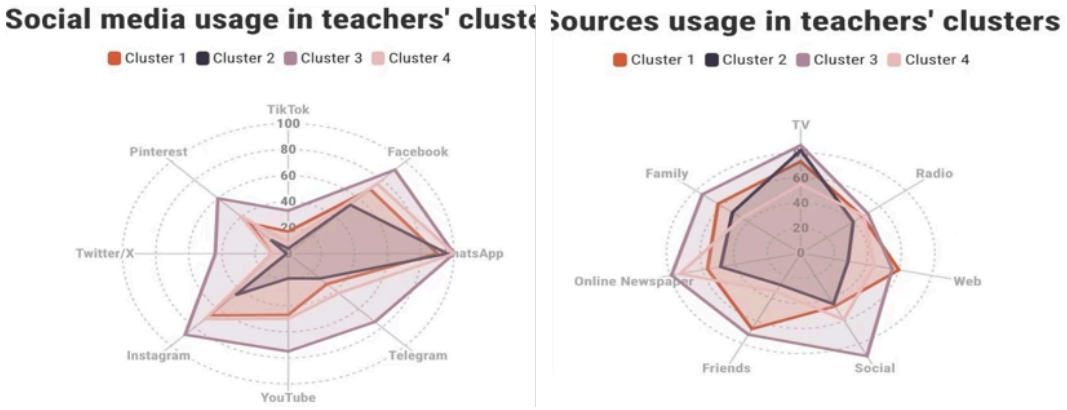


Figure 8 - Use of Social media (left) and Sources (right) in teachers' clusters (radar charts were made with Flourish).



4. Discussion

This study provides critical insights into teachers' competencies in evaluating digital content and their readiness to implement media literacy interventions, contributing to the growing body of research on educational responses to disinformation (Dame Adjin- Tettey et al., 2022; Bak-Coleman et al., 2021; Nygren et al., 2024). Our analysis reveals several key patterns that have important implications for teacher training and educational policy within the European context.

An initial result of this contribution – obtained through descriptive statistics – has allowed us to measure the level of digital competence of primary and secondary school teachers. Despite frequently being invited by educational institutions to address the topic of disinformation in the classroom, only 1 in 4 teachers (25%) manage to achieve a sufficient level of media and information literacy competencies. 3 out of 4 teachers (75%) register moderately low or insufficient competencies, which certainly makes them unprepared to deal with the issues of verifying digital sources and addressing disinformation in the classroom.

These insights underline the need to promote training campaigns that can reach as many teachers as possible to improve their media and information literacy skills and equip them with the content and

methodologies to be able to carry out classroom activities independently with their students.

Secondly, in order to better understand the digital behavior and attitudes of the teachers in our sample, we carried out a cluster analysis that allowed us to distinguish four distinct teachers' profiles, each representing different combinations of digital engagement, trust patterns, and media literacy competencies:

1. *Skeptical and Vulnerable Teachers* (12% of sample): these teachers show moderate social media usage (3-4 platforms) and consume multiple information sources, particularly TV (73%) and interpersonal networks (family 67%, friends 63%). Despite their skepticism toward information sources, they paradoxically demonstrate poor performance in information literacy assessments, particularly struggling with visual content verification. This combination suggests that their skepticism may arise from uncertainty rather than critical evaluation skills.
2. *Traditional Trust-Based and Uncritical Teachers* (40% of sample): the largest cluster comprises teachers with limited digital engagement (1-2 platforms, typically one hour daily) but high trust in traditional sources, especially TV (82%) and mainstream media. Their below-average performance in media literacy assessments, particularly in identifying sponsored content and manipulated images, coupled with strong reliance on family networks, suggests a traditional approach to information consumption that may leave them exposed to digital misinformation.
3. *Digitally Engaged and Trusting Teachers* (24% of sample): these teachers demonstrate the highest digital platform engagement (5-6 platforms) and diverse information source usage (social media 91%, TV 86%, online newspapers 79%). While they show high trust levels across sources, their media literacy assessment scores remain moderate, indicating a gap between digital participation and critical evaluation skills. Their broad and trusting engagement suggests a need for focused training in analytical skills.

4. *Balanced Critical Evaluators* (24% of sample): this group shows the most promising profile, combining moderate digital engagement with measured trust levels and the highest scores in information literacy assessments. They prioritize online newspapers (74%) over traditional TV (55%) and show particular strength in identifying manipulated content and evaluating source reliability. Their balanced approach to digital media consumption aligns with stronger critical evaluation skills.

These profiles emphasize the heterogeneity of teachers' digital competencies and the necessity for diversified professional development approaches. Varying configurations of digital interaction, trust dynamics, and media literacy skills require the design of educational interventions other than one-size-fits-all, as is often done at the institutional level. An initial assessment of teachers' skills, knowledge, and attitudes would make it possible to tailor the needs of different groups of teachers.

Third, when we look more closely at the profiles of the different types of teachers, it's clear that most of them have a strong preference for traditional media information sources (especially clusters 1 and 2). This attitude manifests in high confidence in mainstream sources like television and newspapers, while maintaining persistent skepticism toward digital platforms. The reliance on family and friends as information sources, observed mostly in clusters 1 and 2, reflects what McLuhan (1970) conceptualized as "tribal media" behavior. This behavior points to a larger issue with finding your way around complicated digital spaces, which makes teachers turn to comfortable social networks to check information. Such behavior may limit educators' ability to model effective digital literacy practices for their students, who increasingly engage with diverse online information ecosystems (Common Sense Media, 2022).

Moreover, another piece of evidence concerns teachers' struggle across all clusters with "inferred context" evaluation tasks, especially regarding visual content. The participants showed moderate ability at finding "assertive provenance", like verified social media profiles, but they had a

lot of trouble using argumentation and "inferred context" to assess untrusted websites or visual content that had been taken out of its original context. This failure is confirmed in the broader research conducted by McGowan-Kirsch et al. (2023) on the importance of image-based misinformation literacy.

Many media literacy interventions focus on an approach that is sometimes excessively prescriptive and solution-based, paying attention only to the more technical and operational aspects of content evaluation. The results of this study, on the other hand, underline – confirming Manovich's (2021) intuition – the need for a post-media aesthetic education, that is to say, training courses that enable teachers (and consequently students) to read and write the 'new alphabets' of the contemporary world (Rivoltella, 2020; Gee, 2007).

While comprehensive research on students' susceptibility to misinformation is well established, empirical studies specifically investigating teachers' competencies in evaluating digital sources and resisting disinformation remain relatively limited. Findings from the Czech Republic and Slovakia (Kopecký et al., 2023) confirm the presence of critical gaps among educators, with a significant proportion of teachers either misidentifying disinformation or recommending unreliable sources. These results align with our study's identification of widespread difficulties in "inferred context" tasks and visual verification. More broadly, international assessments such as ICILS (IEA, 2018) and TALIS (OECD, 2018) highlight persistent training needs among teachers in ICT and digital content evaluation, corroborating our observation that technical familiarity does not equate to critical digital literacy. The cluster profiles we identified further echo qualitative findings from pan-European studies (TeaMLit, 2023), which emphasize the heterogeneity of teachers' digital confidence and resilience to misinformation, reinforcing the need for differentiated and targeted professional development programs.

The results of this study should be considered within certain limitations. The study's focus on Italian teachers may limit its generalizability to other educational contexts, though the alignment with broader European trends

suggests similar patterns may exist across the region. Additionally, the pre-test nature of our data provides a snapshot of initial competencies but does not capture the potential impact of subsequent training interventions. Future research could benefit from longitudinal studies examining how teachers' digital literacy competencies evolve through professional development programs and their impact on classroom practices, particularly in light of the rapidly evolving nature of digital disinformation.

5. Conclusions

This study provides insights into the current state of teachers' digital literacy competencies and their readiness to address disinformation in educational contexts. Our findings reveal a complex landscape where technical familiarity with digital platforms does not necessarily translate into critical evaluation skills. The identification of four distinct teacher profiles highlights the need for nuanced, targeted approaches to professional development in media literacy education.

The persistent gap between surface-level evaluation skills and deeper analytical capabilities, particularly in visual content assessment, suggests that current approaches to teacher training may need significant revision. Our results indicate that while teachers can often identify basic reliability indicators (based on "assertive provenance" signals), many struggle with the "inferred context" techniques needed to evaluate complex digital content effectively. This challenge is particularly acute in the evaluation of visual materials, where less than 25% of teachers achieved sufficient proficiency scores.

These findings have immediate implications for educational policy and teacher training programs. They highlight the urgent need for enhanced training in information and visual literacy, particularly given the increasing prevalence of image-based misinformation in digital environments.

Authors contributions

According to CRediT system: **Nicola Bruno**: Conceptualization, Methodology, Investigation, Project Administration, Supervision, Writing - Original Draft, Writing - Review & Editing; **Annamaria De Santis**: Methodology, Formal analysis, Data Curation, Visualization; **Stefano Moriggi**: Conceptualization, Methodology, Investigation, Writing - Review & Editing.

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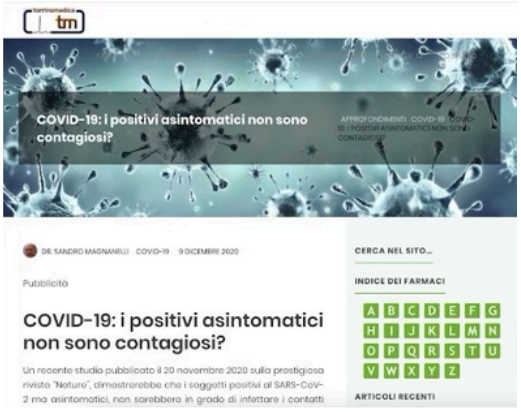
Annex - Questionnaire

1. Reliable Sources

Immagina di essere alla ricerca di informazioni sul Covid-19. Ti imbatti in queste due fonti: Il Primato Nazionale: https://archive.vn/MSa6f
Torrino Medica: https://archive.vn/uQcP6

Quale consideri più affidabile? Per quale motivo?





2. Sponsored contents

Dopo aver letto questo articolo su La Repubblica, come valuti i contenuti?

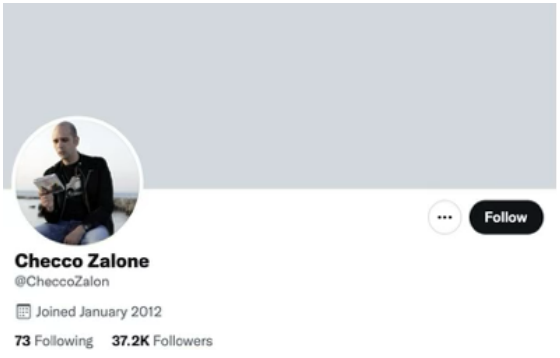
- Attendibile
- Non attendibile
- Non so Per quale motivo?



3. Verified profiles

Quale di questi due profili è più attendibile?

- Checco Zalone
- Alessandro Cattelan Per quale motivo?





4. Satirical content

Come valuti questa notizia del Comune di Bugliano?

- Attendibile
- Non attendibile Per quale motivo?



5. Clickbaiting news

Quale titolo di queste due notizie ti sembra poco attendibile?

- TPI https://perma.cc/CM6X-LVME
- Viral Magazine https://perma.cc/59BM-G3VA Per quale motivo?





6. Decontextualized images

Mentre navighi online, ti imbatti in questa foto con il titolo "In Siria, dormendo tra i propri genitori". Come la consideri?

- Attendibile

- Non attendibile Per quale motivo?



7. Manipulated photos

Come valuti questa foto condivisa su Twitter?

- Attendibile
- Non attendibile Per quale motivo?


Pictures
@BestWorldPix
Follow
Last night's supermoon over in Greece
RETWEETS
128
FAVORITES
173
10:58 PM - 25 Jun 2015

3. Paper 3

Title: Remediating Prebunking in Practice: Enhancing Teachers' Competencies for Digital Source Evaluation and Disinformation Detection

Authors: Nicola Bruno, Annamaria De Santis, Stefano Moriggi

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Abstract

This study evaluates a national program for media literacy training designed to enhance Italian teachers' competencies in digital source evaluation and disinformation detection. Using a “remediated prebunking” approach, the program involved 115 primary and secondary school teachers across Italy in a blended learning experience combining online modules with hands-on workshops. The intervention focused on two core areas: digital source verification and visual literacy for detecting manipulated images. A pre-post quasi-experimental design assessed six competency domains through mixed-methods evaluation emphasizing argumentative reasoning over simple classification accuracy. Results demonstrated significant improvements across all domains, with particularly notable gains in visual literacy and collaborative analytical skills. These findings suggest that “remediated prebunking” methodologies can effectively address systematic gaps in teacher preparation for tackling disinformation in digital citizenship education, providing evidence-based guidance for scalable professional development interventions.

Keywords

Disinformation, Media literacy, Prebunking, Teacher education, Visual literacy

1. Introduction

In the post-media information environment (Eugeni, 2015), where visual, textual, and algorithmically curated content converge on digital platforms, the ability to evaluate the credibility of information has become a core civic competency (Council of Europe, 2025). As disinformation proliferates across social media, messaging apps, and news aggregators (Pérez-Escolar et al., 2023), the ability to assess sources critically—especially when content is emotionally charged, visually manipulated, or algorithmically amplified—is both urgent and foundational to democratic resilience. This challenge is especially pressing within the European context, where only 9% of citizens across 11 countries

report having received training on distinguishing true from false information, despite 58% expressing interest in such training (Ipsos Mori, 2021).

The present study specifically investigates teachers' media literacy needs as a crucial precondition for empowering students to navigate today's complex information environment. Teachers must be able to both recognize manipulative content and guide learners through the analytical practices required to navigate the digital sphere. However, multiple studies show that educators—those responsible for preparing new generations of digitally literate citizens—are themselves often underprepared to critically evaluate online information, particularly visual content (Erdem et al., 2018; Ranieri et al., 2018; ICILS, 2018; Trust et al., 2022; Tsankova et al., 2023; Zaçellari et al., 2024). Key policy frameworks and guidelines such as DigComp 2.2 (European Commission, 2022a), the *Guidelines for Teachers and Educators on Tackling Disinformation* (European Commission, 2022b), and UNESCO's Handbook for Journalism Training (UNESCO, 2018) emphasize the crucial role of educators in tackling disinformation and mediating digital culture. These policy documents call on teachers not only to develop their own media literacy skills but also to transfer them effectively to students. Previous research (Bruno et al., 2025) shows that Italian teachers, even with some digital experience, have a hard time understanding digital sources and evaluating their trustworthiness: only one in four participants reached the minimum threshold of proficiency in tasks related to verifying digital content, while a majority struggled with visual and contextual evaluation. While teachers can often identify assertive cues of reliability, such as verified profile badges or source URLs, their ability to evaluate content based contextual provenance (Hebbar et al., 2024) remains limited. Teachers also demonstrated polarized trust dynamics—placing disproportionate confidence in traditional media like television while dismissing digital platforms as untrustworthy. Such an imbalance suggests not just a skills deficit but a deeper cultural misalignment with the nature of today's post-media environment (Moriggi, 2023).

These findings align with broader research from other projects, which documented systematic gaps in teachers' digital and media literacy competencies across multiple countries, revealing that current teacher education programs inadequately prepare educators for the complex demands of digital citizenship instruction (Ranieri et al., 2018; Trust et al., 2022). Recent comparative reports such as TeaMLit (2023) confirm these patterns, emphasizing wide heterogeneity in teacher readiness and calling for differentiated approaches to professional development.

This mismatch between institutional expectations and teacher readiness is particularly concerning. While several training programs for teachers on countering disinformation and source evaluation have been promoted recently (at least in Italy through the program of professional development Scuola Futura by the Minister of Education), these interventions rarely make explicit their methodological framework, nor do they measure impact through systematic pre- and post-training assessment. This gap limits our understanding of which approaches are most effective and how to design evidence-informed interventions for teacher professional development. This lack of evaluation is particularly problematic in light of international evidence showing that not all media literacy interventions are equally effective. A meta-analysis of 49 media literacy interventions confirms that, although they can significantly reduce belief in misinformation ($d = 0.27$) and likelihood of sharing it ($d = 1.04$), effectiveness varies substantially depending on instructional strategy and intensity (Huang et al., 2024). The meta-analysis synthesized findings from 49 experimental studies ($N \approx 81{,}000$ participants) and reported an overall medium effect size ($d = 0.60$), with higher efficacy observed in multi-session and classroom-based interventions.

In response to the lack of empirical data on the effectiveness of professional development programs focused on disinformation, we developed and delivered a national media literacy training program between 2023 and 2024, involving 243 primary and secondary school teachers across Italy. The training was designed around a 12 hours blended learning model and integrated both synchronous and asynchronous

activities in online formats, as well as in-person workshops in selected regions. The program aimed to enhance teachers' competencies in verifying digital sources, while equipping them with concrete strategies to design and implement classroom activities on media literacy.

The program consisted of two core modules: (1) Evaluating Digital Sources, where teachers applied the TAG method - *Trova* (Find), *Analizza* (Analyze), *Guardati intorno* (Look around) - to assess websites and other digital sources; and (2) Visual Verification, where participants engaged with real-world examples of image-based manipulation, from decontextualized photos to doctored visuals. In both modules, teachers were challenged to go beyond surface-level cues and develop reasoning strategies based on lateral reading, contextual analysis, and the use of verification tools (e.g., reverse image search).

The pedagogical architecture of the training drew upon a remediated application of prebunking strategies, as theorized in attitudinal inoculation research (Cook, Lewandowsky & Ecker, 2017) and recontextualized for educational settings (Bruno & Moriggi, 2023a; 2023b). This approach aligns with recent rapid evidence assessment findings demonstrating that effective media literacy interventions must employ strategies that prompt conscious and rational engagement with content and develop critical thinking skills, rather than relying on passive information delivery (Anstead et al., 2025). Prebunking involves exposing learners to weakened forms of manipulative content before they encounter it in real-world scenarios, thereby fostering a form of "cognitive immunity" (van der Linden, 2023). The improvement of prebunking means combining the psychological ideas of giving warnings and countering false information with active teaching methods like case studies and working together. Crucially, the training moved beyond passive exposure to manipulative content, engaging participants in active, collaborative activities requiring them to reconstruct the genealogy of disinformation, applying an inquiry-based approach. This hands-on learning approach aimed to not only enhance understanding of concepts but also to tackle a major issue with prebunking efforts: the temporary nature of resistance to misleading

information, often called "informative decay" (van der Linden, 2023). By embedding analytic reasoning in group-based case work, we sought to make protective effects more durable and transferable to classroom practice (Gallese et al., 2025).

To evaluate whether this pedagogical model could produce measurable improvements, we measured teacher competencies through pre- and post-questionnaires completed by 115 participating teachers, examining how the integration of media literacy content with remediated prebunking methodologies can improve both personal competencies and pedagogical readiness in addressing disinformation.

The structure of our evaluation was guided by two central research questions, which reflect both the effectiveness and the pedagogical mechanisms of the intervention.

1) How effective is a "remediating prebunking" professional development program in improving teachers' competencies across six key domains of digital source evaluation and disinformation recognition?

- Sub-question: Does the program improve both technical accuracy and argumentative reasoning competencies in media literacy tasks?

2) Which training formats and pedagogical approaches within the program are most effective for developing durable media literacy competencies?

- Sub-question: How do hands-on, collaborative workshop activities compare to other delivery formats in terms of learning outcomes?

By addressing these questions, our study contributes to the growing empirical literature on teacher education in media and information literacy (MIL), building specifically on the systematic deficiencies documented in European teacher preparation (Ranieri et al., 2018) and responding to calls for multidimensional professional development approaches (Ranieri, 2021, Trust et al., 2022). We offer practical guidance for designing scalable, evidence-informed interventions in formal, non-formal, and informal learning environments.

In current research and policy discourse, disinformation refers to false or misleading information that is fabricated, presented, or disseminated with the intent to deceive and to inflict public harm. The scientific literature distinguishes between disinformation, misinformation, and malinformation to capture the different nuances of information disorders (Wardle & Derakhshan, 2017). This distinction expands the notion of disinformation beyond the binary opposition of true and false by including the communicative intentions behind the act of information production. It also constitutes one of the conceptual pillars of the training offer proposed to teachers, as further redefined in Bruno et al. (2023a). However, in this paper we use the term disinformation as an umbrella concept encompassing the various forms of information disorder, without emphasizing differences in intentionality, since these distinctions are not directly relevant to our analysis.

2. The Structure of the Training

In response to the critical gap identified in teachers' ability to evaluate sources and detect disinformation (Bruno et al., 2025), a national professional development initiative for media literacy training was launched between 2023 and 2024. The training was promoted by Open the Box, a media literacy program active in Italy since 2020, and a network of Italian schools participating in the “Scuola Futura” professional development initiative supported by the Ministry of Education. The duration of the training is 12 hours and it offered diverse delivery formats, combining fully online modules (both synchronous and asynchronous activities) with synchronous workshops (both online and in-person), depending on local organizational contexts.

The program was implemented across multiple institutional and geographical settings between 2023 and 2024, reaching educators through diverse delivery modalities while maintaining pedagogical consistency. This flexible implementation strategy enabled adaptation to local organizational needs while preserving core learning objectives. Of the 233 teachers initially enrolled across seven distinct course iterations, 115

completed both the training program and the pre- and post-assessment protocols that form the basis of this analysis. The table below summarizes the courses:

Table 1 - Outline of the training programme.

Course Title	Participants	Pre/post Assessment	Delivery Mode
Das - Alla prova dei fatti (Investigating the facts) 1 (IC Einstein)	77	39	Online
Das - Alla prova dei fatti (Investigating the facts) 2 (IC Einstein)	44	13	Online
Media Literacy 1 (IC3 Modena)	27	6	Online
Media Literacy 2 (IC3 Modena)	10	2	Online
Critical Thinking for Digital Citizenship (IC Mondovì 2)	30	26	In-person
Media Literacy (Check It Out)	15	3	Online
Critical Thinking for Digital Citizenship (IC Borsellino - Valenza)	30	26	In-person
Total	233	115	

This paper's analysis includes only the 115 teachers who completed the final evaluation activities, out of the total 233 enrolled. Regardless of delivery format, each course followed a shared curriculum built around two core thematic modules:

A. Evaluating Digital Sources

This module addressed the ability to assess the trustworthiness of digital sources, emphasizing lateral reading and detection of deceptive formats (clickbait, sponsored content, satirical misrepresentation), in line with Area 1.2 of the DigComp 2.2 framework: "Evaluating data, information and digital content" (European Commission, 2022a).

The first module provided both historical context and practical application frameworks for digital source evaluation. Teachers began by examining three decades of media evolution—from the emergence of citizen journalism to the contemporary proliferation of AI-generated content—and developed a conceptual understanding of how information ecosystems have transformed. Central to this module was the TAG method (Trova, Analizza, Guardati intorno), a systematic framework enabling comprehensive evaluation of digital sources across multiple formats, including websites, social media posts, and multimedia content. The TAG method is based on the Civic Online Reasoning (COR) methodology for source evaluation developed by the Stanford History Group (McGrew et al., 2023). Through hands-on analysis of real-world case studies, teachers developed competencies in evaluating source credibility, conducting reverse image searches, identifying sponsored content and clickbait techniques, and distinguishing between satirical news and verified information sources. This approach moved beyond simple checklist approaches to foster deep analytical reasoning about information provenance and reliability indicators.

B. Visual Literacy and Manipulated Images

The second module addressed the critical gap in educators' visual literacy competencies (Aljalabneh, 2024), focusing specifically on image-based disinformation techniques. This module focused on visual disinformation—such as doctored photos, AI-generated images, and decontextualized visuals. Drawing from post-media aesthetic education (Moriggi, 2023), the course introduced four typologies of image manipulation and guided teachers in using tools like reverse image search,

metadata analysis, and contextual cross-checking. Teachers collaborated on identifying visual manipulation and constructing reasoned justifications for their assessments. The training emphasized the cognitive asymmetry between identifying "assertive provenance" (e.g., verified badges) and the more complex "inferred context" analysis (Hebbar et al., 2024). Through collaborative analysis of real-world examples, teachers learned to apply verification tools and techniques, including reverse image searching, metadata analysis, image forensics techniques and tools, and contextual cross-referencing. This hands-on approach enabled teachers to develop both technical competencies in detecting visual manipulation and critical reasoning skills for recognizing decontextualized or strategically staged imagery.

Inspired by inoculation theory (Cook, Lewandowsky, & Ecker, 2017) and adapted for educational contexts (Bruno & Moriggi, 2023a), the programme introduced a two-phase "remediated prebunking" model:

- Phase 1 – Passive Prebunking: Teachers were exposed to weakened manipulative content (e.g., deepfakes, fake headlines) and provided with forewarnings and explanatory debunking elements.
- Phase 2 – Active Prebunking: Teachers worked collaboratively to reverse-engineer the genealogy of real disinformation cases through inquiry-based, media-archaeological practices. They traced sources, checked claims, and reconstructed timelines, fostering inquiry-based reasoning.

This hybrid strategy addresses the limitations of short-lived cognitive resistance ("informative decay") documented in recent literature (van der Linden, 2023) and promotes durability and transferability of critical literacy skills.

As highlighted above, the educational architecture of the training drew inspiration from recent reinterpretations of prebunking strategies (Cook et al., 2017; Ecker et al., 2022), adapted for educational contexts by Bruno and Moriggi (2023).

In more detail, the "remediated" prebunking activities included two

different but complementary steps. At first, teachers learned about disinformation tactics by watching multimedia examples and receiving clear warnings about how these tricks work, along with explanations of why the claims are false. This foundational exposure created awareness of common manipulation strategies while building cognitive defenses against future encounters with similar content. The training then moved to active prebunking, where teachers worked together to analyze specific misinformation campaigns and figure out how they started using research-based methods. By integrating passive exposure with active, inquiry-driven casework, the training aimed to build what Ecker et al. (2022) describe as "cognitive immunity." Participants were trained to recognize manipulative techniques and prepared to design similar educational activities for their students. This aligns with a view of teachers as co-creators of knowledge and digital culture mediators (Frau-Meigs, 2024; Trust et al., 2022).

The course helped participants build what is known as "cognitive immunity," which means being mentally and culturally ready to understand and spot misleading information, by balancing learning about disinformation tactics with teamwork and active analysis. Acquiring this 'immunity' is the first step in a training program during which teachers will acquire the knowledge and skills needed to design similar immersive educational experiences with students. At the end of the training, they should be able to share tools, cases, and activities that will enable their students to learn how to decipher the logic of the unreliable through the two stages (active and passive) of remediated prebunking.

3. Methodology

To evaluate the effectiveness of our remediated prebunking intervention, we employed a pre-post quasi-experimental design. The assessment included four parts that aimed to gather initial information and track skill improvement: personal demographic information, the use and trust of media sources, an understanding of digital literacy concepts, and hands-on evaluation of seven different types of real-world digital

content case studies. This mixed-methods approach enabled comprehensive assessment of both declarative knowledge and applied analytical skills essential for effective media literacy instruction.

The practical assessment component focused on 7 core competency domains essential for digital source evaluation (see Table 2). These domains reflect DigComp 2.2's Area 1.2 on "Evaluating data, information and digital content" and aim to simulate high-frequency cognitive demands in today's online media environments. Each domain was evaluated using different but similar case studies in the pre- and post-tests for keeping the measurements consistent.

Table 2 - Overview of Assessed Media and Information Literacy Competencies.

Code	Competency Domain	Description
[RELIABLE]	Source Reliability Evaluation	Distinguish between reliable and misleading websites or online information sources
[SPONSORED]	Sponsored Content Recognition	Identify commercially sponsored news or content disguised as editorial
[VERIFIED]	Social Media Verification	Recognize verified social media accounts and distinguish them from fake or impersonated profiles
[SATIRICAL]	Satirical Content Discrimination	Distinguish satire or parody from factual news articles or posts

[TRUSTWORTHY]	News Trustworthiness Assessment	Evaluate the credibility and balance of digital news items beyond surface cues
[DECONTEXTUALIZED]	Visual Decontextualization Detection	Detect authentic images misused out of context to mislead or manipulate public perception

Each competency assessment combined quantitative and qualitative evaluation methods. Teachers provided binary classifications (e.g., Reliable/Unreliable) accompanied by open-ended questions for arguing their decisions. The scoring methodology weighted qualitative reasoning more heavily than simple classification accuracy, with closed-response answers contributing 25% and explanatory comments contributing 75% of the total score. This scoring design reflects our pedagogical focus on reasoning and transfer, rather than rote recognition of superficial features. Two trained reviewers assessed all open-ended answers using a set guideline that looked at the quality of evidence, the complexity of reasoning, and the correct use of verification methods. The combined score of quantitative and qualitative assessment ranged from 0 to 4 for each question; the minimum level of proficiency was set at 2.4 (60% of the total score).

Analysis focused on six of the seven competency domains: [RELIABLE], [SPONSORED], [VERIFIED], [SATIRICAL], [TRUSTWORTHY], and [DECONTEXTUALIZED]. The [MANIPULATED] domain was excluded due to technical inconsistencies in post-test administration that compromised data quality.

We assessed the normality of the differences between the pre- and post-test scores for six variables using the Shapiro-Wilk test ($\alpha = 0.05$). The null hypothesis for this test is that the data are normally distributed.

Next, we conducted a one-tailed t-test on paired samples (greater, $\alpha =$

0.05) to compare the results of the two tests. The null hypothesis in this case was that the mean difference between the post-test and pre-test scores was equal to or less than 0 (as a consequence, post-test > pre-test). For the variables where the normality assumption was not met according to the Shapiro-Wilk test, we used the non-parametric one-sided Wilcoxon signed-rank test for paired samples (greater, $\alpha = 0.05$) instead of the t-test. The null hypothesis was that the true location shift is equal to or less than 0. The results describe further investigations into the variation of teachers' scores, taking into account the identified proficiency point.

4. Results

Previous publications (Bruno et al., 2025) have comprehensively detailed the demographic and baseline characteristics of our sample. Briefly, the participating teachers demonstrated moderate digital engagement patterns, with more than half reporting active use of 3–5 social media platforms. Daily social media consumption was relatively modest, with 73% of teachers spending 1–2 hours on these platforms the day before the survey, while 15% reported no social media use. Platform preferences reflected generational patterns, with universal adoption of WhatsApp, followed by Facebook (78%) and Instagram (62%). Notably, usage of platforms popular among younger demographics remained minimal, including TikTok (17%) and Pinterest (27%). Teachers demonstrated high levels of trust in traditional media sources, particularly television and online newspapers, as well as information from family networks, while expressing skepticism toward digital platforms as information sources.

Baseline assessment revealed significant deficiencies across all six competency domains, confirming the need for targeted intervention. As illustrated in Figure 1 and detailed in Table 3, pre-training performance distributions showed concerning patterns. For the [TRUSTWORTHY] and [DECONTEXTUALIZED] domains, even the third quartile scores fell well below the established proficiency threshold of 2.4 points, indicating that 75% of teachers lacked adequate competency in these critical areas. The

[RELIABLE] and [SPONSORED] domains showed marginally better performance, with third quartile scores slightly below sufficiency, while only the [VERIFIED] and [SATIRICAL] domains demonstrated third quartile performance just above the minimum threshold.

Following the intervention, substantial improvements were observed across all competency domains. Post-training distributions demonstrated marked upward shifts, with third quartile scores exceeding the proficiency threshold for all six assessed competencies. This overall improvement shows that the remediated prebunking methodology effectively helped participants overcome the various skill gaps identified at the start, allowing most of them to reach a satisfactory level of competency in all areas of evaluating digital sources.

Figure 1 - Boxplot of the distributions of six skills related to pre- and post-test.

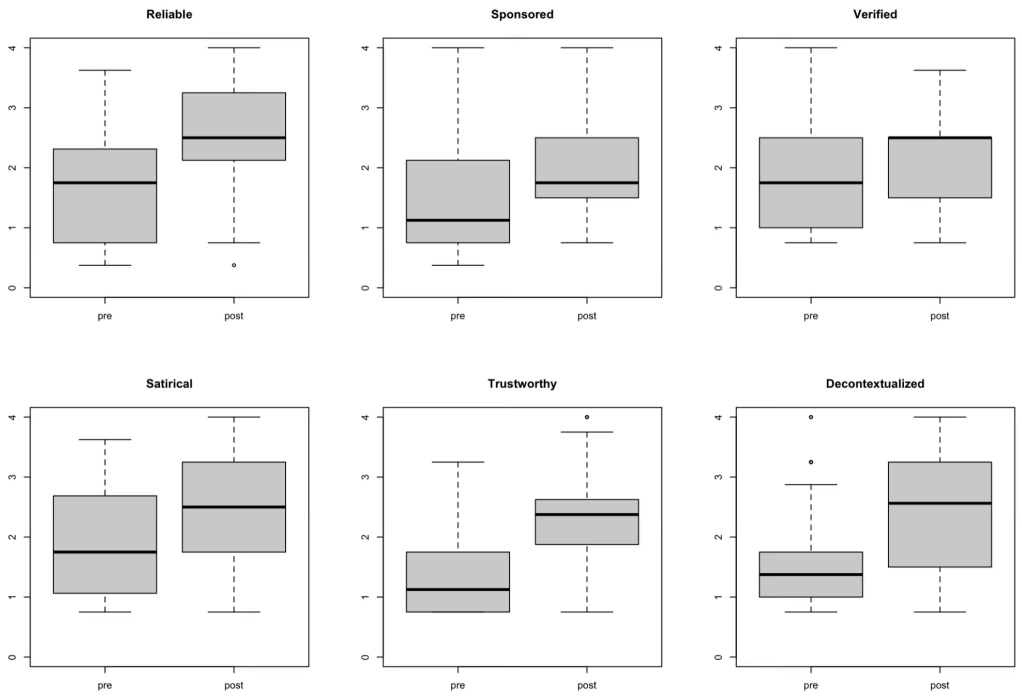


Table 3 - First and third quartile in the distribution for each skill in pre- and post- test.

Competency	Pre-test		Post-test	
	1st quartile	3rd quartile	1st quartile	3rd quartile
[RELIABLE]	0.750	2.312	2.125	3.250
[SPONSORED]	0.750	2.125	1.500	2.500
[VERIFIED]	1.000	2.500	1.500	2.500
[SATIRICAL]	1.062	2.688	1.750	3.250
[TRUSTWORTHY]	0.750	1.750	1.875	2.625
[DECONTEXTUALIZED]	1.000	1.750	1.500	3.250

Before using a hypothesis test to verify that the difference in scores between the pre- and post-tests is significant, we checked that the differences follow a normal distribution using the Shapiro-Wilk test (Table 4). Given $p < 0.05$, for the variables [SPONSORED], [SATIRICAL], and [TRUSTWORTHY], we cannot reject the null hypothesis of normality. Consequently, we applied a one-tailed paired t-test to compare the results of the pre- and post-tests. For the other three variables ([RELIABLE], [VERIFIED], and [DECONTEXTUALIZED]), we rejected H0 and applied a one-sided Wilcoxon signed-rank test for paired samples (Table 5). In both cases, we found that the post-test results were better than the pre-test results with 95% confidence, meaning the differences are likely real and not just random chance. So, we can assume the results are related to the suggested training path, even if they aren't compared to the control group.

Table 4 - Shapiro-Wilk test for difference between pre-and post-test scores in each skill.

Normality test Shapiro-Wilk test (α = 0.05)				
Competency	N.	W	p-value	H_0
[RELIABLE]	108	0.97048	0.01667	Rejected
[SPONSORED]	115	0.98325	0.1619	Accepted
[VERIFIED]	115	0.94069	6.861e-05	Rejected
[SATIRICAL]	112	0.97817	0.06335	Accepted
[TRUSTWORTHY]	108	0.98529	0.2823	Accepted
[DECONTEXTUALIZED]	107	0.96899	0.01324	Rejected

Table 5 - t-test a una coda (greater difference) for each skill.

Hypothesis test				
One-tailed t-test on paired samples (α = 0.05)				
Competency	df	t	p-value	H_0
[SPONSORED]	114	5.5112	1.121e-07	Rejected
[SATIRICAL]	111	7.0324	8.77e-11	Rejected
[TRUSTWORTHY]	107	12.445	2.2e-16	Rejected
One-sided Wilcoxon signed-rank test for paired samples				
Competency	V		p-value	H_0
[RELIABLE]	4688.5		2.626e-12	Rejected

[VERIFIED]	2706	1.581e-06	Rejected
[DECONTEXTUALIZED]	4723.5	8.469e-12	Rejected

We verified the percentages of teachers who achieved a better score in the post-test compared to the pre-test to better understand the phenomenon and the effects of the training path on their learning (Table 6). Around 80% of the teachers obtained a better result on the post-test for the skills related to [TRUSTWORTHY], [RELIABLE], and [DECONTEXTUALIZED]. A slightly lower percentage (69.6%) obtained a better result in the [SATIRICAL] question. About half of the teachers (53.9%) achieved a better score in the [VERIFIED] question, with approximately 30% of teachers maintaining the same score in both the pre- and post-tests. The percentage decreases in the [SPONSORED] question, where the score between the repeated tests increases for only 24.3% of the teachers.

Table 6 - Percentage of teachers who get better or worse scores in pre- and post-test for each skill.

Competency	N.	Pre > Post	Pre = Post	Pre < Post
[RELIABLE]	108	14.8%	5.6%	79.6%
[SPONSORED]	115	66.1%	9.6%	24.3%
[VERIFIED]	115	17.4%	28.7%	53.9%
[SATIRICAL]	112	23.2%	7.21%	69.6%
[TRUSTWORTHY]	108	11.1%	7.4%	81.5%
[DECONTEXTUALIZED]	107	19.6%	3.7%	76.6%

In addition, we subset the sample to 96 teachers, choosing those for whom no NA was recorded in the pre- and post-tests for all six skills. We then operated on the proficiency score (2.4 = 60% of the score). The percentage of teachers who exceeded the cut-off score increases with different sizes (Figure 2). The [TRUSTWORTHY] and [DECONTEXTUALIZED] variables have the biggest increases, but they also have the lowest percentage at first. They are followed in order by [RELIABLE], [SATIRICAL], [VERIFIED], and [SPONSORED].

In detail (Figure 3), we see that:

- For all the skills, there is a percentage of teachers who obtained a score lower than 2.4 in the pre-test and remained in the same range in the post-test. The quota is high for [SPONSORED], [TRUSTWORTHY], and [VERIFIED] variables (53.1%, 47.9%, and 43.8%), about 30 percent for the other skills. Although, as stated in Table 3, the improvements involved a high number of teachers, these were not enough in all cases to move teachers' skills above the proficiency level.
- Except for the [VERIFIED] question, there is a percentage of teachers who obtained proficient scores in the pre-test but lost points in the post-test. It is close to 10% for [RELIABLE] and [SPONSORED] variables, and 3–4% for the others.
- There is a percentage (from 21.9 to 53.1) of teachers who obtained not adequate scores in the pre-test and improved to proficiency in the post-test. The percentage is larger in the [DECONTEXTUALIZED] question, lower in the [SPONSORED] and [VERIFIED] ones. For the last, however, many teachers have achieved and maintained proficiency since the beginning of the course.

Figure 2 - Comparison of the percentage of teachers that exceed the passing score in pre- and post-tests.

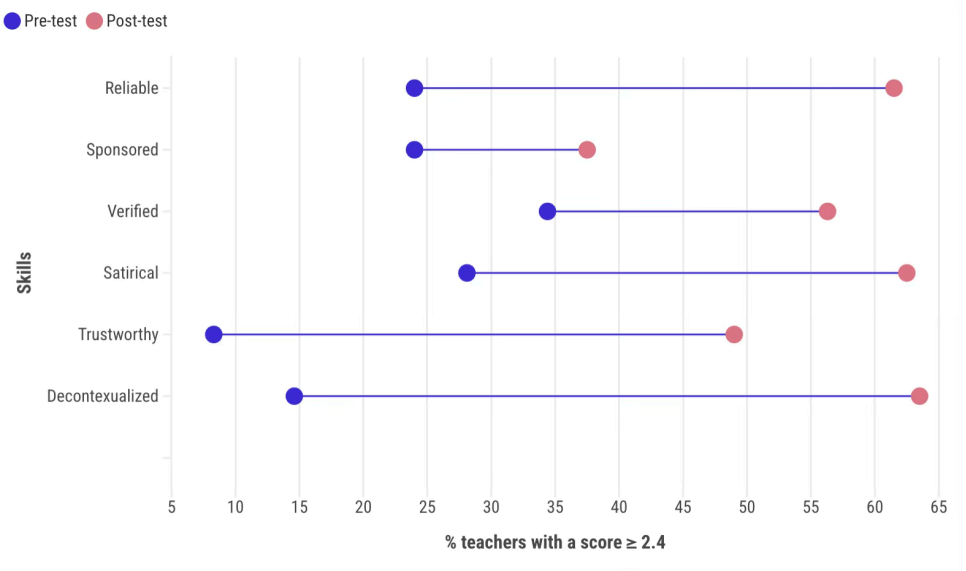
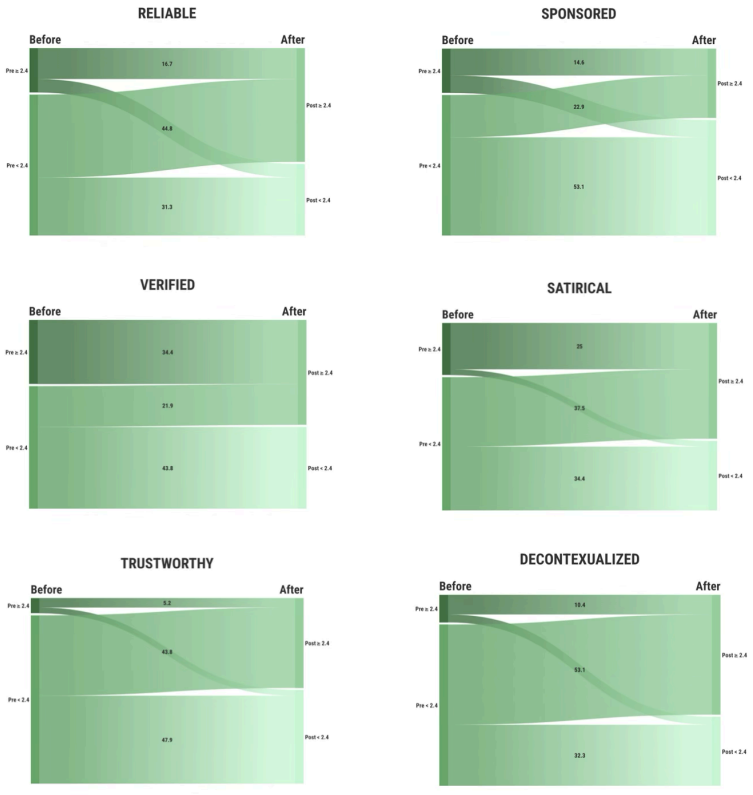
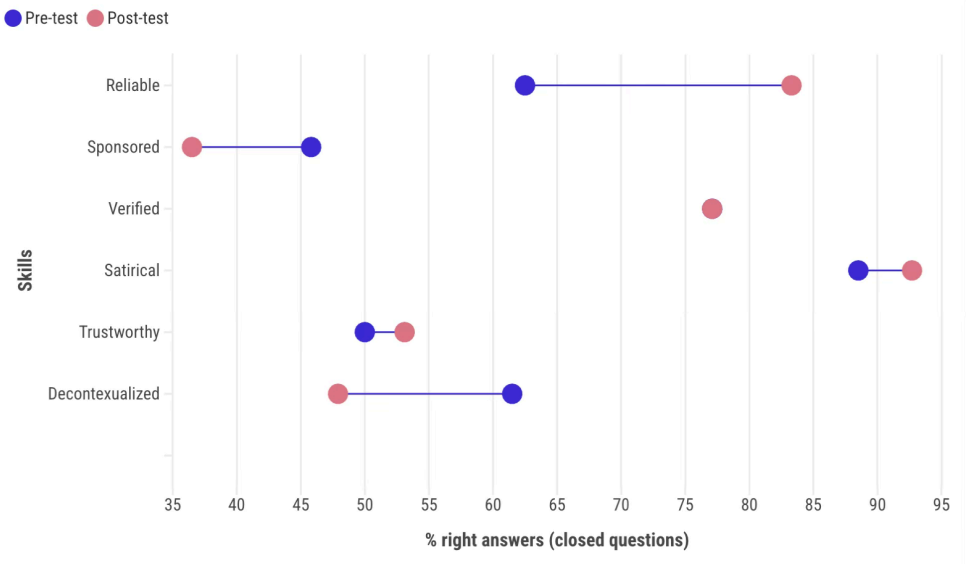


Figure 3 - Comparison of the percentage of teachers who exceed or do not exceed the passing score in pre- and post-tests.



To better understand the mechanisms related to worsening or improving results, we investigate whether there were differences in the scores achieved in closed-ended questions and comments for all the variables. Figure 4 displays the percentage of teachers who answered the closed-ended question correctly, which contributes to the score for each skill. As can be seen, this increase is relevant for the [RELIABLE] competency and moderate for the [TRUSTWORTHY] and [SATIRICAL] variables (the latter, however, started from a very high percentage). The percentages of pre- and post-tests coincide perfectly for the [VERIFIED] competency, while showing a reduction for [DECONTEXTUALIZED] and [SPONSORED] questions. For the former, there was generally an important improvement between the two repeated measures, which was not confirmed in the latter. According to these early results, the difference in scores is largely due to the teachers' comments; it can be assumed that the training was not always sufficient to yield a correct and unique answer to the closed question. However, even if there is no absolute certainty about the topics, the training path has improved teachers' argumentation and awareness of issues related to the reliability of sources.

Figure 4 - Comparison of the percentage of teachers who answer correctly to the closed question for each variable.



5. Discussion

This study set out to evaluate whether a blended, prebunking-oriented teacher training program could enhance six key competencies for detecting mis- and disinformation among Italian educators (Research Question 1), and whether hands-on, collaborative formats contributed more effectively than passive delivery to durable learning outcomes (Research Question 2). Our findings provide compelling evidence for the effectiveness of remediated prebunking approaches while revealing important insights about the nature of developing media literacy skills that extend beyond simple binary skill acquisition.

The noticeable improvements seen in all six areas — [RELIABLE], [SPONSORED], [VERIFIED], [SATIRICAL], [TRUSTWORTHY], and [DECONTEXTUALIZED] — show that preventive methods based on inoculation theory can help teachers become more resilient to digital misinformation. These results match recent studies showing that effective media literacy programs need to use methods that encourage active thinking and understanding of content instead of just giving information passively (Anstead et al., 2025). By exposing participants to weakened examples of manipulation and guiding them through structured refutation strategies, our program created the cognitive "antibodies" theorized in the prebunking literature while addressing the systematic deficiencies in teacher preparation documented across European contexts. In a digital environment saturated with emotional content and visual manipulation, even a small shift in interpretive awareness can mark the difference between passivity and agency.

Our findings are particularly noteworthy as they extend beyond quick-fire recognition tasks to include qualitatively richer justifications and deeper analytical reasoning. Teachers demonstrated wider use of verification terminology and more explicit reference to lateral-reading heuristics in their post-training responses. It’s as if teachers moved from knowing the answer to understanding the question. They learned to trace the logic behind the manipulation, even when certainty was out of reach. This growth in quality often surpassed the improvement in correct

answers, with some areas showing a big increase in teachers meeting the basic standards, even when their accuracy in simple right-or-wrong questions only improved a little. The [DECONTEXTUALIZED] domain exemplifies this pattern: while correct multiple-choice responses actually declined slightly, the proportion of teachers achieving sufficiency more than quadrupled (from 14.6% to 63.5%). The improvement in this domain means that teachers became better at explaining their reasoning, even if they didn't always find clear answers—an important skill for shifting from basic teaching methods to more advanced analytical practices.

Such argumentative competence represents perhaps the most valuable outcome of our intervention, as it equips educators to teach why content is credible or not rather than relying on checklist heuristics alone. This capability is essential because teachers must model and scaffold complex cognitive processes for their students while adapting to the visual-centric nature of contemporary post-media aesthetics (Manovich, 2001). Rather than acting as gatekeepers of truth, teachers evolved into facilitators of how to navigate uncertainty, think critically, and engage ethically with information in complex media environments. The dramatic improvement in visual literacy competencies—particularly the four-fold increase in teachers successfully evaluating decontextualized images—addresses one of the most critical gaps identified in prior research, where visual content evaluation emerged as educators' weakest competency area.

The biggest improvements happened in areas where teachers participated in hands-on, group workshops — [RELIABLE] and [DECONTEXTUALIZED] — where they worked together to figure out the origins of questionable websites and reverse-search controversial images using the TAG method. This pattern directly address Research Question 2 and clearly shows that hands-on, inquiry-based learning is more effective for lasting understanding than just being passively exposed to information and supports Anstead et al.'s (2025) findings that media literacy programs work better when people actively think about and engage with the real case studies. These teamwork aspects focused on the advanced teaching skills needed for today's media education, going beyond old literacy methods to

include the changes that Manovich (2001) and Rivoltella (2020) say are needed in today's media landscape.

But not all gaps were bridged. Despite the overall progress, two domains—[SPONSORED] content recognition and [TRUSTWORTHY] news evaluation—remained particularly challenging. More than half of participants still failed to reach sufficiency in these areas, even after training. While [TRUSTWORTHY] showed significant relative growth, the [SPONSORED] domain lagged behind, with a high percentage of participants experiencing score regression.

A closer look at the course design reveals a likely cause: [SPONSORED] content was the only domain that lacked a dedicated hands-on workshop. Unlike [RELIABLE] and [DECONTEXTUALIZED], which benefited from group-based, inquiry-driven analysis, [SPONSORED] was addressed through brief, passive exposure.

These findings offer a clear answer to Research Question 2: formats that prioritize active, collaborative learning—such as case reconstruction and investigative tasks—lead to more robust and durable competency gains than those relying solely on expository content.

This contrast underscores a crucial pedagogical insight: awareness is not enough. Recognizing the subtle persuasive techniques embedded in native advertising or branded content requires time and reflection. Without these, even well-intentioned training may fall short. For educators to effectively mediate these challenges in the classroom, they must first engage with them in depth—not just encounter them in passing.

The ongoing difficulties in domains such as [SPONSORED] and [TRUSTWORTHY] also highlight a well-documented challenge in prebunking interventions: the phenomenon of informative decay, whereby the cognitive resistance acquired during training tends to weaken over time (van der Linden, 2023).

Like a vaccine without a booster, even well-internalized reasoning strategies can fade if they are not revisited, reinforced, or reactivated through continued engagement. In our study, this effect may partly explain

the limited improvement and occasional regression in performance in areas that received only minimal active training.

To counteract this decay, future iterations of the program should include structured booster activities—such as short refresh modules, review-based case studies, or personal reflection assignments—delivered at regular intervals after the main intervention. These low-intensity follow-ups could help reactivate cognitive defenses and support longer-term retention, especially in areas where subtle persuasive strategies—like native advertising—require deeper and repeated analysis. This approach aligns with research emphasizing that sustained professional development must address both technical competencies and the cultural shifts required for effective digital citizenship education (Ranieri et al., 2021; Trust et al., 2022).

Our findings suggest that policy guidelines should promote the use of detailed assessment criteria for evaluating teacher skills instead of just using pass/fail tests. Just as we urge students to explain their reasoning, our findings suggest that evaluating teachers' media literacy must go beyond checklists and embrace interpretive complexity. The fact that giving more importance to open-ended reasoning (75%) instead of just simple classification accuracy (25%) encourages deeper thinking shows that how we assess students can greatly affect their learning results. This insight helps ongoing conversations about the best ways to measure and improve media literacy skills while also recognizing the creative and interpretive aspects that today's media requires.

Several limitations constrain our conclusions and point toward future research directions. The study sample consisted of Italian teachers who voluntarily participated in the program, potentially introducing selection bias toward higher baseline motivation. A randomized controlled design with a true control group would strengthen causal claims about intervention effectiveness. Long-term follow-up studies are important to see how long the improvements last and to understand how skills might fade over time, especially since there are concerns about how lasting these effects are. Also, breaking down the results by how the program was

delivered (completely online or in person) could help us understand how much social interaction, being present, and reflecting at different times contribute to learning outcomes.

Even with these limitations, our study shows strong evidence that improved prebunking methods can effectively fill the gaps in how teachers are prepared for media literacy while also helping them develop the important skills needed for today's digital citizenship education. The success of the intervention in improving both technical skills and critical thinking shows a hopeful way to expand effective media literacy education that understands the complicated nature of today's media environments. As disinformation becomes more advanced and widespread, helping educators improve their skills through research-based teamwork is an important investment in strengthening democracy and developing digital citizenship.

6. Conclusions

This study demonstrates that remediated prebunking approaches can effectively enhance teachers' media literacy competencies, addressing critical gaps in educator preparation for digital citizenship instruction. The big improvements seen in six areas of skills, especially in visual literacy and source evaluation, show that working together and exploring topics is more effective than just traditional teaching methods.

Three key insights emerge from our findings. First, being able to argue and explain ideas well is often more important than just getting right or wrong answers, which means how we assess students can greatly impact their learning results. Second, experiential depth produces more durable gains than broad coverage, with hands-on workshops generating the strongest improvements. Third, the dramatic success in developing visual literacy competencies demonstrates that targeted interventions can rapidly address previously intractable skill deficits.

These findings have immediate implications for policy frameworks and teacher training design. Educational programs should prioritize active, collaborative methodologies while incorporating regular reinforcement

activities to counter skill decay. As false information becomes more advanced, helping teachers improve their skills using research-based methods is essential for strengthening democracy and teaching responsible online behaviour.

Authors contributions

According to CRediT system: **Nicola Bruno**: Conceptualization, Methodology, Investigation, Project Administration, Supervision, Writing - Original Draft, Writing - Review & Editing; **Annamaria De Santis**: Methodology, Formal analysis, Data Curation, Visualization; **Stefano Moriggi**: Conceptualization, Methodology, Investigation, Writing - Review & Editing.

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PART 3 -
DISCUSSION AND CONCLUSIONS

This final part brings together the main ideas, research results, and real-life effects discussed in this dissertation, (1) explaining the main contribution of the dissertation, (2) examining why the remediated prebunking approach is effective, (3) considering the effects on educational policy and practice, and (4) outlining directions for future research.

1. Research Contribution

This doctoral dissertation argues that in post-medial societies, where disinformation is a persistent, structural challenge rather than a rare exception, educational systems need to embrace preventive, ecological, and evidence-based strategies for media literacy education. The "remediated prebunking" methodology introduced and tested here offers a promising model for cultivating such educational capacity, beginning with teacher professional development and moving toward its thoughtful integration into curricula.

The research brings this thesis to life through a coherent progression across three papers. Paper 1 shows that disinformation is not a new phenomenon but a longstanding aspect of mediated communication, with its forms evolving in tandem with media infrastructures. The post-medial condition creates fertile ground for disinformation. Yet, the forces at play draw from cognitive, emotional, social, and narrative patterns that reach back well before the digital era. This historical and theoretical perspective illustrates the importance of responses that address root causes, rather than merely treating the symptoms.

Paper 2 documented the substantial gap between policy expectations and teacher readiness. While European and national frameworks position teachers as essential mediators of media literacy education, only 25% of

Italian secondary school teachers achieve sufficient competency levels. The disparity is especially pronounced in visual literacy, with fewer than 25% of educators exhibiting competence in identifying manipulated or decontextualized images. The identification of four distinct teacher profiles (Skeptical and Vulnerable, Traditional Trust-Based and Uncritical, Digitally Engaged and Trusting, and Balanced Critical Evaluators) reveals that teachers are not homogeneous and that effective intervention must recognize diverse starting points.

Paper 3 illustrates that targeted intervention can meaningfully close these gaps. The 12-hour blended learning program, grounded in remediated prebunking, led to notable improvements across competency domains. Importantly, the observed progress was rooted in enhanced argumentative reasoning, as revealed in qualitative analyses of open responses, rather than simply increased familiarity with test formats. This points to real growth in competency, with a promising potential for these gains to transfer into actual classroom practice.

2. Why Remediated Prebunking Works

The concept of prebunking has its roots in psychological research, which shows that being exposed to weaker versions of misinformation techniques can help build "cognitive antibodies" or "informational immunity." Large-scale studies have found that even short prebunking videos can sharpen people's ability to recognize manipulation and lessen their vulnerability to misleading content (Roozenbeek et al., 2022) (Van Der Linden, 2023).

However, turning psychological insights into practical educational strategies calls for what this dissertation terms "remediation" (Bolter & Grusin, 2002), that is, adapting methods developed in one context so they work effectively in another. While lab-based prebunking experiments usually involve short, isolated interventions measured over brief periods, educational settings require sustained engagement and thoughtful integration with broader learning goals, developmental appropriateness, and a focus on pedagogical transfer.

The remediated prebunking approach developed in this research adds several dimensions absent from standard psychological inoculation:

1) *The inquiry approach* invites learners to take an active role in uncovering the origins and journeys of media content, rather than simply absorbing information about manipulation techniques. Using methods from history, arts, and media archaeology, participants trace how content travels, transforms, and sometimes picks up misleading meanings along the way. This hands-on investigation fosters a deeper, more lasting understanding than simply memorizing types of manipulation.
2) *Collaborative analysis* acknowledges that disinformation is, at its core, a social problem that demands social solutions. Instead of training individuals in isolation, the methodology brings participants together for group investigation and discussion. This not only builds collective capacity but also models the kind of collaborative verification that real communities and organizations can practice.
3) *Metacognitive development* is about more than just getting evaluations right. It's about being able to explain the reasoning behind those judgments. The mixed-methods assessment, which places significant weight on open-response justifications, reinforces this focus throughout the training. Teachers practice articulating why they judge sources as reliable or not, building the explanation skills they'll need to pass on to their students.
4) *Pedagogical transfer* is a central concern. The training is crafted not just to boost teachers' personal skills but to equip them for practical use in the classroom. It addresses how to tailor activities for various age groups, handle student resistance, and weave media literacy into different subjects, making sure that learning goes far beyond individual skill-building.

The theoretical framework developed here reframes prebunking as a form of "preventive ecology" rather than simply a defensive intervention (Bruno

& Moriggi, 2023b). By drawing on evolutionary and ecological theory, this perspective helps us understand how educational design can foster collective resilience to information manipulation.

As Tomasello (2021) points out, our socio-cultural environments evolve as a way of adapting to new challenges. Educational systems are intentional efforts to prepare people for the realities they will face. The preventive ecology framework suggests that effective media literacy education should introduce students to "appropriate adaptive challenges"—experiences that help them develop the skills needed to thrive in today's complex information landscape.

This ecological perspective, inspired by Strate's (2017) tradition of media ecology, shifts our focus away from simply shielding individuals from specific threats. Instead, it emphasizes building systemic resilience. Just as protecting the environment means tackling pollution at its source, keeping our information ecosystem healthy requires educational strategies that strengthen collective critical thinking. The aim isn't just to protect individuals but to help create healthier information environments for everyone.

The four-phase intervention model puts this ecological perspective into practice. First, participants get advance notice, which helps them stay alert to possible manipulation and encourages critical rather than passive engagement. Next comes prior refutation, explaining manipulation techniques before participants encounter them in order to reduce their persuasive power. The explanation phase builds up recognition skills that can be applied in various situations. Finally, the activation phase, where participants actually create simulated disinformation, gives them hands-on insight into how manipulation works from the inside.

The remediated prebunking approach proves particularly suited to post-medial contexts for several reasons that connect back to the theoretical analysis in Chapter 1.

First, it treats disinformation as a structural challenge rather than an episodic problem. The ecological framing recognizes that manipulation is endemic to post-medial environments, not an external threat that can be

eliminated. This aligns with Balbi & Ortoleva's (2023) analysis of communication's inherent "imperfection" and with Phillips & Milner's (2021) observation that information pollution stems from multiple intertwined sources.

Second, it responds to the breakdown of traditional media hierarchies. In post-media environments, it's no longer easy to clearly separate authoritative from non-authoritative sources. The old advice ("trust newspapers, distrust social media") doesn't hold up when established outlets sometimes make mistakes, important news can first break on social platforms, and labels alone don't guarantee reliability. The TAG method and lateral reading strategies help teachers (and, in turn, their students) evaluate information on its merits rather than relying on broad categories.

Third, it tackles the reality that today's communication is multimodal. By focusing directly on visual literacy, the approach addresses the limits of traditional, text-focused education in a world filled with images and video. Visual verification skills (like reverse image searching, contextual analysis, and spotting manipulation) equip teachers to handle the kinds of content they and their students face every day.

Fourth, it develops skills that can transfer across situations, rather than just teaching facts about specific pieces of content. Since manipulation tactics are constantly changing, simply teaching how to spot particular false claims isn't enough—it quickly becomes outdated. By focusing on techniques that underlie many forms of manipulation, this approach helps learners stay prepared for whatever comes next.

3. Implications for Educational Policy and Practice

The research findings have direct implications for educational policy. Meaningful media literacy education has to start with teacher professional development. No matter how well-designed a curriculum is, it can't succeed without educators who are ready and confident to teach it. When policy requires media literacy instruction but overlooks teacher preparation, it sets schools up for disappointment and missed opportunities.

The baseline finding that 75% of teachers don't yet have the needed skills shows just how much professional development is required. One-off, voluntary workshops that only reach a few motivated teachers aren't enough. What's needed is a broad, systematic effort that's built into both initial teacher training and ongoing professional learning.

The intervention finding that focused training can make a real difference shows that the challenge isn't impossible to overcome. The 12-hour blended learning model is practical and fits into existing professional development systems. The positive results across different kinds of teachers suggest that this approach is flexible enough to work for educators with a variety of backgrounds and strengths.

However, professional development must go further than just teaching general "digital skills." Teachers need concrete abilities to evaluate sources, spot manipulation, and understand how disinformation actually works. They also need up-to-date ways of thinking about the new media landscape and practical strategies for turning their own skills into effective classroom lessons. The remediated prebunking approach is designed to meet all these needs.

The four teacher profiles found in this research highlight the importance of tailoring support. Skeptical and Vulnerable teachers might benefit most from building both confidence and skills: their natural skepticism can become an asset when combined with verification know-how. Traditional Trust-Based teachers may need help understanding how today's media environment differs from what they're used to. Digitally Engaged but Trusting teachers could grow from structured reflection on their own information habits. And those who are already Balanced Critical Evaluators might be ready to mentor colleagues or delve deeper into advanced teaching strategies.

Research on what makes professional development effective shows that programs with multiple sessions have a bigger impact than quick, one-time workshops (Huang et al., 2024). The 12-hour structure used in this research should be considered a starting point, since longer and more

deeply embedded experiences may lead to even greater and longer-lasting benefits.

While building teachers' skills is the crucial first step, the real aim should be to weave media literacy education into the school curricula, as has already been done for many years in Finland and as the United Kingdom is now preparing to do. Media literacy shouldn't stand alone as a separate course; rather, it should be a skill set developed across subjects and grade levels, touching every part of the educational experience.

Just as reading, writing, and math are everywhere in school, post-media literacy should be woven throughout the educational journey. History classes can guide students in evaluating primary and secondary sources; science lessons can unpack how data visualizations might mislead; literature studies can dig into persuasive techniques and rhetoric; art classes can explore visual manipulation; and social studies can show how stories shape our understanding of the world. In this way, media literacy becomes a foundation, not an add-on.

To make this integration a reality, several steps are needed. Curriculum guidelines should spell out media literacy skills that fit each age group, since what's right for kindergarteners isn't the same as for teenagers. Assessments should measure critical thinking and evaluation, not just memorization. Teachers need adaptable resources for different subjects and contexts. Schools must provide the time, technology, and support to make it all work. And teachers need opportunities to work together across subjects, breaking down silos and building unified approaches to media literacy.

The European Commission's Guidelines for Teachers and Educators (European Commission, 2022b) are a good starting point, but turning them into concrete classroom practices is still a work in progress. For real change, policy needs to move past encouragement and offer strong structural support that helps schools put media literacy into action.

Another key step is the introduction of Media and AI literacy for PISA assessment from 2029 onwards. In view of this integration, the OECD and the European Union are working on a framework that can standardise

learning objectives and assessment methods for media and AI literacy interventions.

The intervention research in this dissertation centered on teacher professional development, a necessary first step, since teachers need these skills before they can pass them on. But ultimately, the goal is to help students develop the competencies they need to navigate today's complex information environment.

Early evidence suggests that the remediated prebunking approach can work well with students too. The same methods have been tried with secondary school students through the Open the Box program linked to this research. Initial results are promising, showing improvements in student skills, though more thorough evaluation is under way and will be shared in future publications.

4. Core Competencies for Post-Media Literacy

This research highlights two core skills as absolutely essential for making sense of today's information landscape: source evaluation and visual literacy. Without these, it's nearly impossible to engage effectively with the complex media environment we now face.

4.1 Source Evaluation: Beyond Surface Indicators

Traditional approaches to source evaluation often focus on "assertive provenance": looking for visible markers of trustworthiness within the content itself. Students are taught to check "about" pages, verify author credentials, or examine web addresses for credibility signals. Methodologies such as the CRAAP test have operationalised this approach through structured checklists. However, in post-medial environments, these surface indicators prove insufficient: websites designed to appear credible can easily pass such tests while spreading disinformation (Caulfield, 2018) .

What is needed is competency in "inferred context" evaluation: the capacity to investigate beyond surface markers, verify claims through external sources, and construct understanding through lateral reading,

leaving a source to check it from the outside rather than diving deeper into a single website. This approach, characteristic of professional fact-checkers and visual investigators (Fuller & Ṿeytsman, 2021), forms the foundation of effective source evaluation in complex information ecosystems.

The emergence of generative artificial intelligence introduces a further challenge (Caulfield & Wineburg, 2023; Moriggi & Pireddu, 2024). Content produced by large language models cannot be adequately described through traditional categories of primary and secondary sources. Drawing on Serres' (2008) and Latour's (2005) concept of "quasi-objects," such content may be understood as "quasi-sources": hybrid entities combining data, algorithms, and human input, lacking clear authorial responsibility yet presenting themselves as authoritative text. As Floridi (2025) argues through the concept of "distant writing," the relevant question shifts from "who wrote this?" to "who designed this content, and according to what logic?"

Evaluating quasi-sources requires an integrated approach. Assertive provenance (watermarks, metadata, digital labels introduced through initiatives such as the Content Authenticity Initiative) provides technical markers of synthetic origin, but these can be removed or manipulated. Contextual analysis develops the interpretive sensitivity to recognise anomalies, inconsistencies, and patterns that betray artificial construction. This dual competency aligns with what Ginzburg (2023) termed the "inquiry paradigm": attention to marginal details that reveal what explicit narratives conceal.

The TAG method operationalises this integrated approach for educational contexts. "Trova" (Find) investigates the source itself. "Analizza" (Analyze) examines claims and evidence. "Guardati intorno" (Look around) extends verification beyond the source through lateral reading. This structure moves learners from surface indicators toward contextual investigation, an approach that proves essential whether evaluating traditional digital content or AI-generated quasi-sources.

4.2 Visual Literacy: The Critical Gap

This research identified visual literacy as the domain in which teachers encountered the greatest challenges. Fewer than one in four could reliably evaluate manipulated or decontextualised images, a finding that takes on greater significance given the centrality of visual content in contemporary information ecosystems. Visual disinformation exploits what scholars term the "seeing-is-believing heuristic": manipulated images bypass cognitive defences, evoke strong emotional responses, and persist longer in memory than textual information (Aljalabneh, 2024; Weikmann & Lecheler, 2022).

The qualitative analysis presented in Moriggi & Bruno (2025) reveals the specific nature of teachers' difficulties. The dominant stance when evaluating visual content was "suspicion without certainty": teachers expressed generalised doubt but could not articulate evidence-based justifications. Only 3.6% of responses demonstrated high-quality reasoning with coherent argumentation. More revealing was the near-absence of technical evaluation strategies: fewer than 3% of teachers identified visual inconsistencies or evaluated source credibility, and only 1.2% mentioned fact-checking tools such as reverse image search. Teachers performed somewhat better on contextual reasoning and recognition of staged or artistic construction, suggesting greater facility with symbolic interpretation than with forensic visual analysis.

This asymmetry illuminates an important pedagogical challenge. Traditional education develops competencies for interpreting visual rhetoric and symbolic meaning, but provides little training in the technical detection of manipulation. Yet post-media environments demand both: the capacity to read visual narratives critically and the practical skills to verify whether an image has been altered or decontextualised.

The intervention addressed this gap through dedicated visual verification training. Teachers practiced reverse image searches, contextual analysis, and recognition of manipulation indicators. The improvements observed demonstrate that these competencies can be developed through targeted instruction. However, the baseline findings underscore that visual literacy cannot remain an optional supplement to

text-based critical thinking. Educational policy must recognise it as a core competency for navigating contemporary information ecosystems.

5. Future Research Directions

The findings of this dissertation open several promising avenues for future inquiry that could extend and refine the remediated prebunking approach.

Control group analysis. As noted in Chapter 3, during two of the seven training courses, pre- and post-test questionnaires were administered to a randomized control group alongside the intervention participants. Analyzing these data will provide more robust causal evidence for the intervention's effectiveness and strengthen the empirical foundation of the remediated prebunking methodology.

Student-focused evaluation represents the most immediate next step. While this research concentrated on teacher professional development, the ultimate goal is to enhance students' media literacy competencies. Early results from the Open the Box program are encouraging, but rigorously controlled studies are needed to confirm the impact on young people and to determine whether the remediated prebunking approach effectively builds the skills required for lifelong critical engagement with information.

Longitudinal studies could track whether competency gains persist over months or years following intervention. Do improvements endure without reinforcement? What frequency and format of refresher activities best sustain skill retention? Understanding how these competencies develop or decay over time (particularly in the absence of ongoing support) would inform the design of maintenance strategies and follow-up programs.

Emerging technological challenges demand ongoing attention. AI-generated content (including deepfakes, synthetic text, and fabricated images) introduces novel verification challenges that current methodologies may not fully address. Future research should explore how media literacy education can adapt to these evolving threats and which competencies prove most transferable to new forms of manipulation.

Cross-national comparative studies would establish whether the findings generalize across different educational and media systems. Do teachers in other countries face similar competency gaps? Does the intervention produce comparable effects in different cultural contexts? Such research would clarify the boundaries of generalizability and identify adaptations needed for diverse settings.

Integration with curriculum development represents a crucial translational step. Research should examine how remediated prebunking can be effectively embedded across subject areas rather than delivered as standalone training. Research into effective models of cross-curricular media literacy integration would yield pragmatic insights for the execution of educational policy.

Moving forward will require ongoing commitment at every level. Policymakers need to see media literacy as a core civic skill that deserves a solid place in education. Schools and institutions should provide teachers the training and support they need to put these ideas into practice. Teacher education programs have to prepare new educators for today's media landscape. And researchers must keep exploring what works best for different people and in different settings.

The findings in this dissertation give reasons to be cautiously optimistic. With focused training, teachers' skills really can improve. We can teach these skills at scale, and the remediated prebunking approach helps build the kind of critical thinking that transfers across situations. But helping teachers grow is just the beginning. The real challenge is to weave media literacy into the curriculum so that every student learns the skills needed to navigate today's information world. This means moving beyond small-scale projects and making media literacy a core part of education everywhere.

Of course, education can't solve the disinformation problem on its own. Things like platform policies, information standards, laws, and civic culture all matter too. But education brings something unique: every person who learns to evaluate sources, spot manipulation, and share

information responsibly adds to the strength and resilience of our democratic society.

This dissertation hopes to support that collective resilience by designing, testing, and sharing an effective model for media literacy education. While the remediated prebunking approach is merely a single component, its effectiveness and readiness for scaling up are undeniable. The next step is to expand its reach, bringing these tools to more teachers and students, and helping build the strong educational foundations that post-medial societies need.

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