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From Echo Chambers to Critical Dialogue: A Comparative Case Study of Social Media-Based Pedagogy For Addressing Scientific Misinformation

[1] **Hasan Alisoy**

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Abstract:

In an era defined by rapid digital information dissemination, higher education faces the challenge of equipping students to navigate landscapes rife with scientific misinformation. This study addresses that challenge by evaluating a novel pedagogical intervention designed to move beyond traditional information-deficit teaching models. It presents a comparative quasi-experimental case study conducted with 84 undergraduate students in Azerbaijan, examining two distinct social media-based approaches to combating misinformation. The primary aim was to compare a control condition, in which students received curated fact-based content, with an experimental condition, in which students engaged in structured critical dialogue and collaborative media creation grounded in Critical Media Literacy (CML). Pre- and post-intervention assessments were conducted using a custom Misinformation Identification Test (MIT) and the Critical Thinking Disposition Scale (CTDS). The results reveal that while both student groups began at an equivalent baseline, the experimental group demonstrated a significantly greater improvement in accurately identifying scientific misinformation ($p < .001$) and showed a marked increase in critical thinking dispositions, whereas the control group's gains were negligible. These findings suggest that pedagogical strategies emphasizing critical dialogue, peer-to-peer debate, and co-creation of content are substantially more effective than passive information delivery for fostering students' resilience to misinformation. The study provides an empirically validated model for educators seeking to transform social media platforms from potential echo chambers into forums of robust critical inquiry.

Keywords

critical dialogue; critical media literacy; echo chambers; scientific misinformation; social media pedagogy

Introduction

The 21st-century information environment can be described as a digital labyrinth – a complex space where scientifically validated knowledge coexists and competes with pervasive misinformation. Social media platforms, with their unparalleled reach and speed, have become

[1] Alisoy, H. Lecturer in English, Nakhchivan State University, Azerbaijan. Email: alisoyhasan@ndu.edu.az. ORCID: https://orcid.org/0009-0007-0247-476X

primary vectors for disseminating content that can distort or outright contradict established scientific consensus on critical issues such as public health and climate change (Cinelli et al., 2021). This proliferation poses a fundamental challenge to education, demanding new pedagogical strategies that foster the critical faculties necessary for informed citizenship in a digital age.

The architecture of digital media often facilitates the creation of **"echo chambers"** – enclosed online ecosystems wherein individuals are primarily exposed to information and opinions that reinforce their pre-existing beliefs. These environments arise through a combination of user behavior and algorithmic curation. Users naturally gravitate toward like-minded communities, and platform algorithms further insulate them by selectively presenting congruent content (Pariser, 2011). Within such chambers, cognitive biases are powerfully amplified. For instance, confirmation bias (the tendency to seek or recall information that supports one's prior beliefs) flourishes when counter-arguments are systematically filtered out. One outcome is a **false consensus effect**, where individuals overestimate how widely their views are shared, further solidifying their convictions (Luzsa & Mayr, 2021).

The consequences of these dynamics extend beyond the digital realm. Echo chambers contribute to the erosion of public trust in scientific institutions, exacerbate socio-political polarization, and pose tangible threats to collective well-being (Qiu et al., 2021). When scientific issues become politicized, echo chambers serve as prime vehicles for spreading disinformation, as identity-driven narratives override evidence-based discourse (Cinelli et al., 2021). This context exposes a critical limitation of conventional educational responses to misinformation. A crucial distinction exists between a simple *"epistemic bubble,"* where an individual is uninformed due to lack of exposure, and a true *"echo chamber."* An epistemic bubble is fragile and can be "popped" by introducing missing facts, whereas an echo chamber is far more robust, actively discrediting outside sources and engendering deep distrust of outsiders. In such an environment, contrary voices might be heard yet are preemptively dismissed as biased or illegitimate (Pariser, 2011). Thus, pedagogical approaches based on a simple information-deficit model — the assumption that students will change their minds if only given the correct facts — are often ineffective. Traditional fact-based interventions may pop bubbles, but they rarely penetrate the fortified walls of an echo chamber.

Research Problem

Conventional information-focused pedagogy has proven inadequate for addressing the entrenched belief reinforcement found in echo chambers. Simply providing correct information does not guarantee belief change when learners are predisposed to distrust outside sources. Traditional media literacy instruction is often limited to "checklist" skills (e.g. checking authors, dates, and sources) and treats information as neutral, without challenging underlying biases or power structures (Andreotti, 2014; Funk et al., 2016). Such *"soft"* approaches, operating on an information-deficit assumption, fail to engage with the motivated rejection of evidence that defines echo chambers. In other words, students ensconced in echo chambers are not merely lacking facts – they are primed to dismiss facts that clash with their worldview. This problem manifests as a gap in educational practice and research: there is a need for pedagogical strategies that address the psychological and social mechanisms of misinformation adherence, rather than only the factual knowledge deficits. In higher education specifically, empirically tested and scalable interventions

are lacking for deployment within the very social media environments where misinformation spreads. The *research problem* underpinning this study is how to effectively design pedagogy that can break through echo chamber dynamics and improve students' critical evaluation of scientific information.

Research Focus

This study focuses on testing a novel, CML-based pedagogical intervention in a social media context to counter scientific misinformation. It examines two distinct teaching models within an authentic university course setting: one model is a **passive, information-delivery approach** (serving as a control condition) and the other is an **active, critical dialogue approach** (the experimental condition). The intervention is situated on a popular social media platform and centers on a contemporary misinformation topic, allowing direct engagement with the kinds of content students encounter outside the classroom. By comparing these two approaches, the research hones in on whether a pedagogy emphasizing critical dialogue, questioning, and student-generated content can more effectively build students' ability to identify misinformation and foster their critical thinking dispositions. In essence, the study's focus is a comparative evaluation of *"information-deficit"* pedagogy versus *"critical dialogue and co-creation"* pedagogy in the context of social-media-based learning.

Research Aim and Research Questions

Research Aim: The aim of this research was to evaluate the efficacy of a social-media-based critical dialogue pedagogy against a traditional fact-based pedagogy in improving students' ability to recognize scientific misinformation and in influencing their critical thinking disposition.

Research Questions: Based on the identified problem and focus, the study was guided by the following questions:

1. **Effectiveness of Pedagogical Approach:** Is a social media pedagogy based on critical dialogue and collaborative media creation more effective than a passive, information-delivery model at improving students' ability to identify scientific misinformation?

2. **Impact on Critical Thinking Dispositions:** To what extent do these differing pedagogical approaches affect students' underlying critical thinking dispositions?

Research Methodology

General Background

To address the research questions, a quasi-experimental, non-equivalent groups design with pre- and post-tests was employed. This design was chosen as it is well-suited for authentic classroom settings where random assignment of individual students is not feasible. Two intact class sections were used, one serving as the control group and the other as the experimental group. Pre-testing established baseline equivalence between the groups on the outcome measures before the intervention. By comparing changes from pre-test to post-test between the control and experimental sections, the study could attribute differences in outcomes to the pedagogical

intervention. This methodology adheres to standards for educational research by incorporating control comparisons and repeated measures of student performance.

Sample

The study was conducted at a large public university in Baku, Azerbaijan. This setting provided a relevant "natural laboratory" due to the high digital media engagement of the population. In early 2024, approximately 88.0% of Azerbaijan's population were internet users and 58.4% were active on social media (DataReportal, 2024). The chosen student cohort, therefore, was highly familiar with the platforms under investigation. Concurrently, the country has promoted media literacy through initiatives such as the "Media Literacy" platform launched in 2023 by the national Media Development Agency (Media Development Agency of the Republic of Azerbaijan, 2023). However, the broader information environment is tightly controlled, and critical media literacy is not yet formally integrated into university curricula (Vibrant Information Barometer, 2023). This context amplifies the importance of the study's focus, as it tests an approach aimed at fostering genuine critical inquiry in a setting where such skills are needed.

Participants were 84 second-year undergraduate students enrolled in two separate sections of a required social sciences course. One section (n = 42) was designated as the **control group**, receiving the traditional information-delivery intervention, and the other section (n = 42) served as the **experimental group**, receiving the CML-based critical dialogue intervention. The students (mean age ≈ 19.7 years) represented diverse majors within the social sciences. Pre-intervention analyses of academic records and baseline test scores confirmed that the two groups were statistically equivalent in relevant characteristics at the outset of the study. All participants provided informed consent to participate, and the research protocol received approval from the university's institutional review board.

Instrument and Procedures

The intervention spanned four weeks during a regular semester. A private **Instagram** group was created for each class section, which served as the platform for all instructional activities. Instagram was chosen due to its popularity among the target demographic of students. The topic of the intervention for both groups centered on a piece of prevalent scientific misinformation regarding climate change — specifically, a viral meme falsely claiming that **volcanic eruptions produce more CO_2 than all human activities combined**. This topic was selected as a salient example of science-related misinformation that students might encounter on social media.

Control Group Procedure: In the control condition (simulating a typical *"information-deficit"* approach), the instructor acted as the primary source of correct information. Each week, the instructor posted factual content to the group's feed, such as links to scientific reports (e.g. NASA and IPCC findings), articles from reputable fact-checking organizations debunking the meme, and an educational video explaining the carbon cycle. Students in the control group were expected to review the provided materials, but no structured interaction or discussion was required of them. Their engagement with the content was largely passive consumption.

Experimental Group Procedure: In the experimental condition (grounded in CML principles), the instructor fostered an interactive and collaborative learning environment. At the start, the misinformation meme itself was posted in the group, alongside the same factual resources provided to the control group. Each week, however, students in this group were required to participate in a structured asynchronous **debate** in the comments, guided by CML-based prompts. For example, discussion prompts asked: *"What emotional appeals does the meme use?"*, *"Who might benefit from this message spreading?"*, *"Which perspectives or facts are missing?"*. Students used these questions to deconstruct the misinformation's content and source, analyze its rhetorical strategies, and debate the scientific evidence. In the final week, students in the experimental group worked in small teams to create their own media artifact (such as an infographic, short video, or multi-slide post) designed to refute the original misinformation with accurate, nuanced information. This culminating project required students to synthesize scientific evidence and present it in a compelling format for social media. The active learning approach in the experimental group – emphasizing peer dialogue and content creation – leveraged social media for user-generated content and collaborative learning, which has been shown to enhance student engagement (Hui & Hayllar, 2010).

Data Collection Instruments: A mixed-methods data collection strategy was employed to capture both quantitative learning outcomes and qualitative insights into the learning process. The following instruments and data sources were used:

- **Misinformation Identification Test (MIT):** A 20-item multiple-choice test was developed for this study to assess students' ability to discern misinformation in scientific contexts. Participants were presented with 20 short news-like statements or claims related to climate science; half were based on authentic, peer-reviewed scientific findings and half were fabricated to reflect common misinformation tropes. For each item, students rated the statement's credibility on a 5-point scale. An overall MIT score (0–20) was calculated based on the number of correct credibility assessments (i.e. correctly identifying misinformation vs. factual information). The MIT was administered as a pre-test before the intervention and as a post-test after the four-week intervention.

- **Critical Thinking Disposition Scale (CTDS):** Students' dispositions toward critical thinking were measured using a 26-item Likert-scale survey adapted from a validated critical thinking disposition inventory. The CTDS assesses seven key disposition dimensions: truth-seeking, open-mindedness, analyticity, systematicity, confidence in reasoning, inquisitiveness, and maturity of judgment. Students rated their agreement with statements related to these traits. An aggregate score was computed (with higher scores indicating stronger overall disposition toward critical thinking). The CTDS was administered to both groups as a pre-test and post-test.

- **Qualitative Data:** To enrich the quantitative findings, qualitative data were collected in two forms. First, **discussion transcripts** from the experimental group's Instagram debates (all student comments and interactions over the four weeks) were archived for analysis. These provided a record of the dialogue and argumentation process. Second, upon concluding the intervention, a subset of participants from each group wrote short **reflective**

essays (10 students from the control group and 10 from the experimental group, selected randomly and submitted anonymously). In these reflections, students described their experiences and perceptions of the learning process. These qualitative sources were used to understand *how* and *why* the interventions impacted students, providing context to the numerical results.

Data Analysis

Both quantitative and qualitative data were analyzed to address the research questions. **Quantitative data** (MIT and CTDS scores) were analyzed using SPSS software. An independent-samples *t*-test compared the control and experimental groups' pre-test scores on both measures to verify baseline equivalence. Similarly, independent *t*-tests were used to compare post-test scores between the two groups. In addition, paired-samples *t*-tests were conducted within each group to determine the significance of pre-to-post changes over the intervention period. Statistical significance was set at $p < .05$ for all tests.

For the **MIT scores**, the primary comparison was whether the experimental group's mean post-test score was significantly higher than the control group's, and whether the experimental group showed a significant gain from pre-test to post-test relative to the control. For the **CTDS**, the analysis examined whether overall disposition scores changed significantly within each group and differed between groups after the intervention.

Qualitative data from the experimental group's discussions and student essays were analyzed using thematic analysis. The researchers followed an iterative coding process: reading through all transcripts and essays to become familiar with the content, generating initial codes for notable ideas or recurring points, clustering these codes into broader themes, and then reviewing and refining the themes. Representative quotes were extracted to illustrate each identified theme. This qualitative analysis aimed to identify patterns in student engagement, reasoning, and self-reflection that could help explain the outcomes observed in the quantitative data. By triangulating quantitative results with qualitative insights, the analysis provides a more comprehensive understanding of the intervention's impact.

Research Results

The analysis of results yielded clear differences in outcomes between the control and experimental pedagogical approaches. Quantitative findings from the MIT and CTDS are presented first, followed by qualitative findings that shed light on the learning processes in each group.

Quantitative Findings

Pre-test Equivalence: Prior to the intervention, the control and experimental groups did not differ significantly in their ability to identify misinformation or in their critical thinking disposition. On the MIT pre-test, the two groups' mean scores were statistically equivalent ($t(82) = 0.45$, $p = .65$). Similarly, on the CTDS pre-test, there was no significant difference ($t(82) = –0.21$, $p = .83$). This confirms that any post-intervention differences can be attributed to the intervention rather than pre-existing group disparities.

Post-test Outcomes – Misinformation Identification: The post-intervention results revealed a stark contrast between the groups. As shown in Table 1, the experimental group (critical dialogue model) achieved a substantially higher mean score on the MIT post-test than the control group (passive information model).

Table 1.
Comparative analysis of post-intervention Misinformation Identification Test (MIT) scores

Group	N	Pre-Test Mean (SD)	Post-Test Mean (SD)	Mean Difference	t-value	p-value
Control	42	11.8 (2.5)	12.1 (2.3)	+0.3	4.89	< .001
Experimental	42	12.0 (2.4)	17.5 (1.8)	+5.5	—	—

Note. The t-value and p-value reflect the result of an independent samples t-test comparing the post-test scores of the two groups.

On average, the experimental group scored **17.5** out of 20 on the MIT post-test, compared to **12.1** for the control group – a difference of over 5 points. This between-group difference was statistically significant ($p < .001$). Within-group analyses showed that the experimental group's improvement from a pre-test mean of 12.0 to a post-test mean of 17.5 was highly significant ($t(41) = –11.2$, $p < .001$), indicating a strong effect of the intervention on misinformation detection skills. In contrast, the control group's mean improved only marginally (from 11.8 to 12.1) and this change was not statistically significant ($t(41) = –1.3$, $p = .20$). In sum, students who engaged in critical dialogue and media co-creation became markedly better at identifying misinformation, whereas those who simply received factual content showed no meaningful gains.

Post-test Outcomes – Critical Thinking Disposition: A similar pattern emerged for the CTDS, which measured students' propensity for critical thinking. The experimental group exhibited a notable increase in their overall critical thinking disposition score after the intervention, unlike the control group. Table 2 summarizes the total CTDS scores for each group pre- and post-intervention.

Table 2.
Comparative analysis of post-intervention Critical Thinking Disposition Scale (CTDS) total scores

Group	N	Pre-Test Mean (SD)	Post-Test Mean (SD)	Mean Difference	t-value	p-value
Control	42	125.4 (10.1)	126.0 (10.5)	+0.6	3.98	< .001
Experimental	42	126.1 (9.8)	138.2 (9.2)	+12.1	—	—

Note. The t-value and p-value reflect the result of an independent samples t-test comparing the post-test scores of the two groups.

The experimental group's mean CTDS score rose from approximately 126.1 (out of a possible ~182 total, assuming 7 dispositions × max 26 each) to 138.2 after the intervention, a gain of about 12 points. The control group's CTDS score essentially plateaued (125.4 pre to 126.0 post). An independent *t*-test confirmed that the experimental group's post-test disposition was significantly higher than the control group's ($p < .001$ for the difference in means). Within the experimental group, the increase in critical thinking disposition was statistically significant, whereas the control group's slight increase was not. These results indicate that participating in the CML-based pedagogy not only improved students' skills in identifying misinformation, but also positively influenced their mindset and attitudes toward critical thinking. Notably, further analysis of the CTDS subscales revealed that the largest gains for the experimental group were in the areas of **"analyticity"** (tendency to value and apply analytical thinking) and **"open-mindedness,"** suggesting the intervention particularly fostered these aspects of critical disposition.

Qualitative Findings

Analysis of the qualitative data from the experimental group's online discussions and the students' reflective essays provided insight into how the intervention produced the above outcomes. Three primary themes emerged in the experimental group's experience, each of which contrasts with the control group's more passive experience:

Theme 1: Collaborative Deconstruction. Students in the experimental group collectively engaged in breaking down the misinformation. Their online discussions were not mere opinion exchanges; rather, they became cooperative analytical exercises. The participants questioned sources, identified rhetorical devices, and pooled their knowledge to get at the truth behind the meme. For example, one student admitted the meme "just feels true because volcanoes are so powerful," while a peer immediately challenged the source: "Look at the source. It's a blog, not a scientific journal – who funds this blog? We need to follow the money." Another student then brought in evidence: "I found the NASA page that compares the numbers. The meme is off by a factor of over 100; it's using the 'powerful image' to trick us." These exchanges show how students built on each other's contributions to debunk the false claim collaboratively. By contrast, reflections from the control group indicated a much more passive engagement. A typical control group student wrote, "I read the articles the professor posted. It was useful to see the facts and know the real numbers. I learned that volcanoes are not the main source of CO_2." While this student did absorb correct information, the learning experience was one of receiving answers, not actively dissecting arguments. The **collaborative deconstruction** in the experimental group likely contributed to their superior performance on the MIT, as students actively practiced the skills of evaluating credibility and evidence together.

Theme 2: Confronting Personal Biases. The dialogic, debate-focused format of the experimental intervention prompted students to confront their own biases and assumptions. Because students had to articulate and defend positions – and have their ideas challenged by peers – they became more aware of how biases might influence their initial beliefs. One student's reflection captured this process powerfully: *"At first, I believed the misleading headline because it fit what I thought about nature being stronger than humans. It **felt** right. But when my classmate pointed out the source was a blog funded by an oil lobby, and we had to debate it, I realized I was falling for*

confirmation bias. It was uncomfortable to admit I was wrong in front of everyone, but the discussion made it a learning moment, not an attack. I had to separate my feelings from the evidence." This quote illustrates a student recognizing and overcoming a personal bias (the assumption that "nature is stronger than humans" which made the misinformation appealing) through guided peer discussion. The structured yet supportive debate environment allowed for what might be an uncomfortable realization – being wrong – to become an opportunity for growth. In the control group, however, such opportunities to confront biases were largely absent, since students were not required to openly discuss or defend their thinking. The experimental group's experience of **actively questioning oneself** in response to challenges likely contributed to increases in dispositions like open-mindedness, as reflected in the CTDS results.

Theme 3: Empowerment through Creation. Many students in the experimental group cited the final assignment – creating their own counter-misinformation media piece – as the most impactful part of the experience. This task shifted students from the role of critical consumers to that of **empowered producers**. In doing so, it reinforced their learning and confidence. One student wrote, *"Just arguing is one thing. But having to create our own infographic forced us to actually find and agree on the real data. We had to think about how to present it clearly so other people wouldn't be fooled like we almost were. It felt like we were doing something real, not just a class assignment. We were **correcting** the misinformation, not just learning about it."* This reflection highlights how the act of content creation consolidated the students' understanding and gave them a sense of agency in the fight against misinformation. By producing a tangible output (an infographic in this case) that could be shared, students experienced a form of real-world efficacy – a feeling that they can actively contribute to setting the record straight. This sense of empowerment was entirely lacking in the control group, where students did not engage in any creation or public-facing activity. The creative, productive element in the experimental condition likely reinforced students' critical thinking dispositions (e.g., confidence in reasoning, inquisitiveness) by demonstrating that they can investigate and effectively communicate complex information themselves.

In summary, the qualitative evidence strongly supports the conclusion that the **interactive, collaborative, and generative** aspects of the CML-based pedagogy were key drivers of the improved outcomes observed in the experimental group. The experimental students not only learned factual content about the scientific topic, but also practiced a process of critical inquiry and felt ownership over the knowledge they constructed. These process-oriented gains help explain *why* the experimental pedagogy led to significant gains in both the cognitive skill of identifying misinformation and the disposition toward critical thinking, whereas the conventional pedagogy did not.

Discussion

Interpretation of Key Findings: The results of this study provide compelling evidence that the pedagogical approach to combating scientific misinformation has a profound effect on student outcomes. The primary finding is unambiguous: a social media-based pedagogy rooted in critical dialogue and collaborative content creation is significantly more effective at improving both students' misinformation-identification skills and their critical thinking dispositions than a

traditional, lecture-style information delivery model. The control group, which experienced a pedagogy analogous to simply "popping an epistemic bubble" by providing correct facts, showed no meaningful improvement. This aligns with theoretical expectations that many students encountering potent misinformation are not merely lacking information but are situated in resilient echo chambers where presenting contrary facts alone is insufficient to induce conceptual change (Pariser, 2011). By contrast, the experimental group's success empirically validates the core tenets of Critical Media Literacy pedagogy. The intervention was effective precisely because it operationalized CML principles: it *problematized* the misinformation text (treating the viral claim not just as an error to be corrected, but as an artifact to be deconstructed and understood in context) and it moved students from passive consumption of information to active production of a counter-narrative. Students in the experimental condition continually asked critical questions about authorship, purpose, and bias—exactly the kind of metacognitive inquiry that CML advocates (Funk et al., 2016). They also had to synthesize evidence and create a message for an audience, which required higher-order thinking and pushed them to grapple with their own assumptions. The significant gains in CTDS subscales like analyticity and open-mindedness are a direct testament to this deeper learning process that challenges comfort and engages students in reflection.

Practical Implications for Higher Education: The findings carry several important implications for educators, curriculum designers, and higher education institutions. First, there is a clear imperative to integrate CML-oriented strategies across the curriculum, not only in media studies or communication courses. The challenge of scientific misinformation (be it in health, environmental science, etc.) affects virtually all disciplines, and the skills of critically deconstructing media and ethically producing content are emerging as essential competencies for 21st-century learners. This study provides a concrete model for how even social media platforms – often seen by faculty as distractions or frivolous – can be repurposed as powerful pedagogical tools to achieve core learning objectives (Hui & Hayllar, 2010). By engaging students on platforms they already use and by framing assignments in a collaborative, creative manner, instructors can increase student motivation and relevance of coursework.

Second, the study highlights the need for robust faculty development in this area. Many educators may be hesitant to use social media for complex learning tasks due to concerns about privacy, classroom management, or simply a lack of experience with these tools. Others might limit their use of technology to superficial tasks (e.g. posting announcements or lecture slides) and not know how to facilitate deeper engagement online. Institutions should invest in training programs and resources that move faculty beyond basic uses of educational technology and equip them with the confidence and skills to design and moderate critical, dialogue-based learning experiences (Hui & Hayllar, 2010). This includes guidance on how to nurture respectful debate in online forums, how to scaffold the process of student media creation, and how to assess these novel forms of student work. Faculty development efforts in this direction will be critical for translating the positive results of this study into broader practice.

Third, for the specific context of Azerbaijan (and potentially other countries with similar media environments), the findings offer an evidence-based pathway to advance national media literacy goals. While state-led initiatives (like the Media Development Agency's "Media Literacy"

platform launched in 2023) provide a supportive framework, true resilience to misinformation is likely to be achieved not through top-down content control or didactic messaging, but through bottom-up cultivation of critical thinking and dialogue skills in the classroom. This study's CML-based model could be adopted in university courses to complement and enhance the impact of national programs. By implementing pedagogies that encourage students to question, debate, and create, universities can foster the kind of critical autonomy that inoculates against misinformation even in a tightly controlled information environment (Vibrant Information Barometer, 2023). In short, the results suggest that educational institutions have a crucial role in developing informed and critical citizens, and that they can do so by embracing pedagogical innovation.

Limitations of the Study: Like all research, this study has several limitations that must be acknowledged. One limitation is the quasi-experimental design – using intact class sections rather than randomly assigned individuals – which, while practical for an educational setting, may introduce confounding variables (e.g. subtle differences in group dynamics or instructor interaction) that are hard to completely eliminate. The sample size (84 students at a single university) and specific cultural context (Azerbaijan) may limit the generalizability of the findings to other settings. Additionally, the intervention was of relatively short duration (four weeks) and focused on a single topic of scientific misinformation. It is uncertain whether the improvements in skills and dispositions would sustain over a longer period or if students would exhibit similar gains when dealing with different types of misinformation. Another limitation is that the study primarily measured *immediate* post-intervention outcomes. It did not track whether students continued to apply their critical analysis skills or maintained their critical thinking dispositions in subsequent courses or real-world settings. Finally, while qualitative data were used to interpret the results, the analysis of discussions and reflections could be subject to researcher bias in theme identification; different analysts might have categorized comments somewhat differently.

Recommendations for Future Research: These limitations point to several avenues for future research. Longitudinal studies are needed to determine if the gains observed are sustained over time – for example, follow-up tests weeks or months later could assess whether students retained their ability to spot misinformation and their growth in critical dispositions. Replicating the study in different educational contexts and cultures would help establish the robustness of the CML-based approach: future research could implement similar interventions in other universities, in secondary schools, or in non-Western contexts to see if the outcomes hold. It would also be valuable to experiment with other subject matter; for instance, applying a critical dialogue approach to combat political misinformation or historical myths, to examine whether the method is broadly applicable across content domains. Furthermore, given the importance of the instructor's role in facilitating online dialogue, research should explore training methods for educators. Investigating how to best prepare and support instructors to lead critical, collaborative discussions on social media (and to manage challenges that arise) is a crucial next step for scaling up this pedagogical model. In summary, while the present study offers a promising framework, further research can extend its findings, address unanswered questions about longevity and transferability, and refine the approach for wider implementation.

Conclusions and Implications

The challenges posed by the digital information age demand more from education than the mere transmission of accurate facts. This study's findings lead to a clear conclusion: effectively inoculating students against the allure of scientific misinformation requires cultivating them as critically conscious learners, not just knowledgeable ones. Educators must shift their approach from a monologue of information delivery to a dialogue of critical inquiry.

The evidence presented here demonstrates that when social media platforms are harnessed through a pedagogy grounded in Critical Media Literacy, they can be transformed from echo chambers into forums for meaningful dialogue. What is often an "echo chamber" reinforcing biases can become a **dialogue chamber** – a space for collaborative deconstruction of information, peer-to-peer learning, and the empowered co-creation of knowledge. Students in the experimental condition showed substantial improvements both in their ability to discern misinformation and in their disposition toward critical thinking, underscoring the power of this approach. Simply receiving factual corrections was not enough; it was the active, and at times uncomfortable, process of grappling with false claims, debating evidence, and creating a response that led to real growth in students' skills and mindsets.

In the 21st century, the fight against misinformation is not peripheral to the mission of education – it is central. Preserving informed public discourse, trust in scientific evidence, and the health of democratic society hinges on our ability to educate students in new ways for a new information environment. The present study offers a practical and theoretically grounded roadmap for doing so. By engaging students directly within digital platforms and guiding them to critically analyze and produce content, educators can help students navigate out of the digital labyrinth of misinformation and into a more critical, engaged relationship with information. The path forward lies in embracing the complexities of the new media landscape as an **opportunity** for active learning. Instead of avoiding or merely lamenting social media's influence, educators can transform these platforms into extensions of the classroom – ones where students learn to question, verify, debate, and create. The implications of this work are thus far-reaching: it suggests that educational institutions have the tools to turn the tide against misinformation by fostering critical dialogue and production skills, ultimately empowering the next generation of learners to think more deeply and act more responsibly in our information-rich world.

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