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Abductive Reasoning in Scientific Information Literacy: Students' Understanding of Climate Change in Social Media

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Abstract: Students frequently encounter complex and sometimes misleading climate change information on social media, yet their ability to reason scientifically and evaluate sources remains limited. This study investigates how junior high school students engage in abductive reasoning to interpret such information through the lens of scientific information literacy. A qualitative case study involving eighth-grade students in Central Sulawesi, Indonesia, was conducted using think-aloud interviews, where students analyzed climate change–related social media posts. Thematic analysis mapped reasoning patterns across the exploration, examination, selection, and explanation stages. Findings show that students identified explicit scientific information, but their abductive reasoning was dominated by intuitive, experience-based responses rather than evidence-based reasoning. Their scientific information literacy was limited to basic access and personal verification, while skills in evaluating credibility and disseminating valid information were underdeveloped. The study proposes a conceptual model integrating five dimensions of information literacy with four stages of abductive reasoning to explain how students construct their understanding of climate change. Strengthening literacy can guide reasoning from intuitive to evidence-based explanations. Practically, the findings offer insights for educators and policymakers to design science learning strategies that integrate reasoning and literacy development in digital contexts.

Keywords: Abductive reasoning; Climate change; Evidence-based argumentation; Scientific information literacy; Social media

Introduction

Climate change is the most pressing global issue of the twenty-first century in many countries, including several Indonesian regions such as Central Sulawesi. Between 1981 and 2019, surface temperatures in Central Sulawesi increased by 0.015 to 0.045°C per year on average. This rise has had an influence on agriculture, fisheries, and the community's socioeconomic status (Alfiandy et al., 2022; Alfiandy, Permana, et al., 2020; Alfiandy & Permana, 2020). In the digital era, social media has become a dominant source of information about climate change, expanding public access but also spreading misinformation that can distort students' understanding of scientific phenomena. The complexity of this issue requires students to have a strong scientific understanding in order to be able to relate climate phenomena to real life. Social media broadens access to global concerns, promotes discourse, and stimulates public engagement (Schäfer, 2025). Imperiale et al. (2022) emphasize the importance of simplifying scientific information without eliminating its essential meaning so that it can be understood by the general public. Thus, social media has enormous potential as a means of

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spreading knowledge but also poses challenges in maintaining the accuracy and integrity of information, including for students. Coletti et al. (2022) examined how users engage with scientific content across different social media platforms to better understand how audiences perceive science communication online. Storani et al. (2025) investigated how climate change and climate-related disinformation are conveyed on social media by examining over 20 million posts on Facebook, Instagram, Twitter, and YouTube between 2018 and 2022. Misinformation and disinformation may quickly spread on social media due to cognitive biases, viral content, and personalized algorithms (Aïmeur et al., 2023; Essien, 2025; Hilary et al., 2021). Climate misinformation creates false claims and restricts collective access to vital and accurate knowledge, which is necessary for informed decision-making (Essien, 2025). In the era of social media, the traditional mechanisms ensuring the credibility of scientific information have been disrupted, requiring science education to address not only scientific practices but also the epistemic dimensions of science communication (Höttecke et al., 2020). Science literacy has become a large and established field of research, but it needs to be expanded to face the challenges of modern science communication and misinformation in digital media (Li et al., 2021).

This situation exacerbates the knowledge crisis in the post-truth age. The study by Saputra et al. (2025) also shows that the level of scientific literacy of Indonesian students is still low. The situation in Indonesia is increasingly concerning. The 2022 PISA results (OECD, 2023) reveal low scientific literacy among students, particularly in linking scientific phenomena to daily life. This gap highlights a critical educational problem where Indonesian students struggle not only with scientific reasoning but also with evaluating the credibility of scientific information. This finding indicates an urgent need to strengthen students' competencies in evaluating and interpreting scientific information critically, especially in online contexts. Previous relevant studies have examined the importance of information literacy (Januarti et al., 2024), scientific information literacy (Wang et al., 2023), and critical thinking skills (Puig et al., 2021) in dealing with disinformation about science, especially on social media. However, previous research has not explored how scientific information literacy interacts with students' reasoning processes, especially abductive reasoning, in understanding scientific issues disseminated through social media.

However, despite these existing studies, previous research has treated scientific information literacy and abductive reasoning as separate constructs. There is still limited research integrating the two to investigate how students understand complex scientific issues such as climate change through social media. This challenge underscores the importance of scientific information literacy in understanding the complexity of scientific information on social media, especially regarding climate change issues, which requires students to not only be able to read and evaluate information but also to build their understanding. To address this challenge, science education in junior high school plays a crucial role in developing scientific thinking skills. Previous research shows that abductive reasoning supports critical thinking skills, accurate hypothesis formation, and the ability to navigate complex information (Rahmah et al., 2020).

Students still find it difficult to filter information, evaluate credibility, and express scientific opinions appropriately (Chen et al., 2021; Wang et al., 2023). These limited skills make students vulnerable to the flow of scientific disinformation on social media (Ho et al., 2017). To address this challenge, scientific information literacy is an important competency, as it helps students critically evaluate and utilize evidence-based information (Brown, 2023; Gil Quintana et al., 2020; Susilawati et al., 2023). Furthermore, abductive reasoning skills are also relevant. This reasoning trains students to formulate hypotheses based on limited information and then test them through scientific thinking processes (Engelschalt et al., 2023). Previous research shows that abductive reasoning supports critical thinking skills, accurate hypothesis formation, and navigating complex information (Furqoni et al., 2022; Klichowicz et al., 2021; Osborne et al., 2023).

Although scientific information literacy and abductive reasoning have been extensively studied separately, this study fills an existing research gap by integrating these two constructs to explore how students construct their understanding of climate change, particularly the issue of rising temperatures in Central Sulawesi, through social media platforms like Instagram. This integration represents a significant novelty in this study as it provides a new analytical framework for examining how reasoning and literacy work together when students encounter real-world scientific information in digital contexts.

This research is crucial for addressing current educational needs by preparing students to critically and responsibly navigate the digital information environment. It provides empirical evidence on how students interpret climate change-related content on social media through abductive reasoning. This is crucial for designing science learning that integrates media literacy and reasoning training. By linking scientific information literacy with abductive reasoning, this research offers an innovative perspective that bridges the cognitive and epistemic aspects of science

learning, particularly relevant to the challenges faced by Indonesian students in the post-post-truth era.

This approach is expected to not only strengthen the relatively low cognitive aspects of Indonesian students (Tang, 2025) but also train them to critically evaluate, interpret, and use scientific information in the face of diverse information flows on social media. Therefore, this research is important because it offers a new perspective on how science education can empower students to critically evaluate and communicate scientific information through social media—an essential competence in the post-truth era (Nasr, 2021). The importance of improving the way science is delivered to the community lies in its role in preventing misunderstanding, reducing anxiety, and supporting rational decision-making during crises (Crick, 2021). Thus, this study contributes to science education by equipping students with scientific information literacy and abductive reasoning competencies that are relevant to facing the challenges of the 21st century.

Method

Research Approach and Design

This study employed a descriptive qualitative approach with a case study design to explore students' abductive reasoning in interpreting scientific information about climate change on social media.

Participants

The participants were eighth-grade students from SMP Negeri 1 Sigi. In the first stage, a scientific information literacy questionnaire was distributed to identify students' competency levels. The questionnaire was developed based on Wang et al. (2023) and adapted to the context of climate change literacy. It consisted of items measuring information access, evaluation, and communication skills. Based on the results, students were categorized into high, medium, and low literacy levels. Two students were purposively selected from each category, resulting in six participants. This sampling ensured representation of abductive reasoning across different literacy levels.

Instruments and Data Collection

The main instrument was a case-based semi-structured interview with a think-aloud protocol (Reinhart et al., 2022). Students were given screenshots of Instagram posts related to climate change from the BMKG. During the interview, they were encouraged to express their thought processes in evaluating information, generating hypotheses, selecting explanations, and justifying their reasoning. The interview guide was developed based on the four stages of abductive reasoning, namely exploration, examination, selection, and explanation (Oh, 2016; Żelechowska et al., 2020) and integrated with the five scientific information literacy competencies (Wang et al., 2023).

Instrument Validation The interview guide was validated through assessment by experts with backgrounds in science education and information literacy. They evaluated content validity (the relevance of the questions to the constructs being measured) and construct validity (alignment with the stages of abductive reasoning).

Figure 1. Post on Instagram by BMKG showing temperature changes in Central Sulawesi

The interview instrument was developed with reference to the framework of abductive reasoning and scientific information literacy. The interview was designed to investigate students' abductive reasoning in assessing information about climate change disseminated on social media. The questions were open-ended and flexible to allow for in-depth data exploration. The table 1 shows the interview grid used in this study.

Table 1. Interview Grid

Stages of abductive reasoning	Scientific information literacy competency (Wang, 2023)	Indicator	Science information literacy	Interview questions
Exploration (Information Identification)	Ability to obtain scientific information	Students are able to identify key information from scientific content on social media.	Accessing and recognizing scientific information	What was the first thing that came to mind when you saw this post? What information do you think is important from this content? Do you think this information is scientific? Why?
Examination (Initial Hypothesis)	Ability to filter scientific information	Students formulate possible initial explanations for the scientific phenomena presented.	Filtering and evaluating scientific information	What do you think might be causing this phenomenon? Are there any other possible causes?
Selection (Choosing the Most Reasonable Explanation)	Ability to evaluate the credibility of scientific information	Students are able to choose the most reasonable explanation and base it on logic or evidence.	Evaluating information and selecting explanations	Of all the possibilities mentioned above, which explanation do you think makes the most sense? What is your reason for choosing that explanation?
Explanation (Argumentation & Scientific Communication)	Ability to express opinions on scientific information	Students are able to convey scientific explanations or arguments logically and communicatively.	Conveying scientific information logically and communicatively	How would you explain this phenomenon to your friends who do not have a background in science? How would you respond if someone disagreed?
Examination (Initial Hypothesis)	Ability to evaluate the credibility of scientific information	Students are able to describe how to verify and compare scientific information they encounter.	Evaluating scientific information	What do you do if you want to verify the accuracy of scientific information in the media? What sources of scientific information do you consider most reliable?
Examination (Initial Hypothesis)	Ability to obtain scientific information	Students demonstrate the habit of searching for and comparing scientific information from various media.	Accessing & comparing scientific information	Are you accustomed to seeking additional information before drawing conclusions? How often do you read or share scientific information?
Explanation (Argumentation & Scientific Communication)	Ability to disseminate scientific information	Students demonstrate the habit of sharing scientific information with others.	Disseminating scientific information	Have you ever shared scientific information on social media? Why did you share it, or why not?

Data Analysis

The data were analyzed using thematic analysis (Naeem et al., 2023). The process began with transcribing the interview recordings, followed by repeated readings to understand the data. From the transcripts, keywords and important quotes were identified, which then became the basis for forming initial codes. These codes were organized and refined into broader themes that captured the essential aspects of the data. These themes were then further interpreted to reveal underlying meanings and patterns. Next, the results of this process were synthesized into a conceptual model that describes the relationship between abductive reasoning and scientific information literacy. These conceptual themes were mapped onto this framework to identify how

students demonstrate abductive reasoning at various levels of scientific literacy.

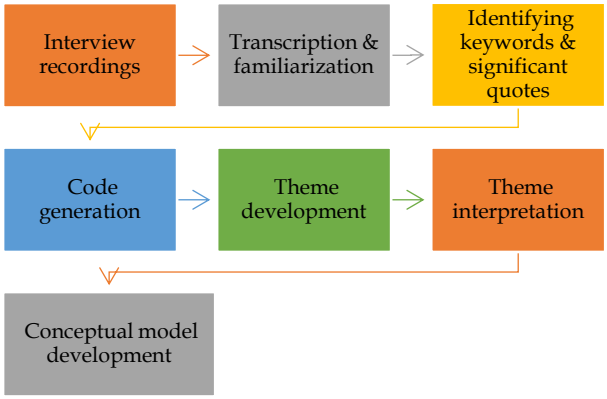


Figure 2. Research data analysis process (Naeem et al., 2023)

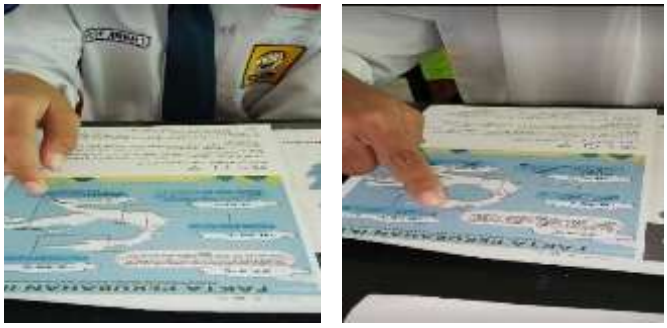
Results and Discussion

Result

Abductive Reasoning

Exploration (information identification)

Based on the results of the interviews and think-aloud protocols, most students were able to identify key information such as temperature, weather, and location in the Instagram posts. This shows that students are already able to recognise the scientific elements presented visually and textually in science information. S1 highlights the presence of 'information about temperature, weather, and the names of cities' while pointing to the numbers in the image. S2 confirms, "There is information about climate change in Sulawesi and the temperature in Palu, Poso and Toli-Toli." However, S3 was still confused and asked, "When did climate change occur, and how is it measured?"



(a) (b)

Figure 3. S1 (a) and S2 (b) analyze the information presented through think aloud

The analysis indicates that while some students focus on explicit information, others still struggle to connect the data with broader scientific concepts. This pattern shows variations in the depth of understanding, ranging from mere observation to the need for inferential reasoning.

Examination

Students interpreted differences in temperature data based on different initial assumptions. Through the think-aloud process, S1 associated the differences in numbers with geographical location and weather conditions. S2 emphasizes the number of trees and pollution as distinguishing factors: "There are many trees in Poso, while in Palu it is hot because there are few trees." S3 interprets temperature changes as a result of "changes in the moon or frequent weather changes."

Figure 4. Conducting interviews

The evidence suggests that students attempt to relate the data to their everyday experiences. However, these initial hypotheses are still heavily influenced by an intuitive conceptual framework (everyday framework) rather than data-based scientific knowledge.

Selection

Students demonstrate activity in considering various possibilities, choosing the explanation they consider most logical: S1 emphasizes "unexpected weather changes." S2 mentions "pollution and indiscriminate tree felling" as the main causes. S3 associates it with "natural events such as rain, strong winds, and geographical conditions." At this stage, students appear to start selecting arguments based on reasons they find most relevant. However, these reasons are still dominated by local environmental factors without any selection of explanations based entirely on objective scientific data.

Explanation

When asked to explain the phenomenon to others, students conveyed it in simple terms according to their understanding: S1 explained that climate is "a natural phenomenon... it changes; there are positive and negative sides." S2 compared regional conditions: "Poso is cold, unlike Palu, which is hot." S3 emphasized the importance of reading, understanding, and then sharing

information with friends. The results suggest that students' argumentation skills remain limited to simple comparisons and local experiences. Although there were efforts to communicate explanations, the arguments used were not yet fully based on strong scientific data. Argumentation skills should be built upon facts and scientific reasoning (Syarqiy et al., 2023).

Scientific Information Literacy
Obtaining Information

From interviews and careful thought, students obtain information mainly from observing images and reading. However, most interpret it simply, for example, by relating it to the position of the region or daily weather. This finding indicates that while students can access information, their processing remains descriptive rather than analytical.

Information Filtering

Most students consider pollution and tree felling to be the most reasonable explanations. For example, S2 stated, "There are few trees in Palu, but there are many trees in Poso." This pattern indicates that the filtering process is based more on observations of the surrounding environment than on comprehensive scientific evaluation.

Credibility Evaluation

Students assessed the information as true for different reasons:Statement S1, namely that it was consistent with daily weather conditions (S1). Statement S2, namely the presence of the BMKG logo and the official "Iklim Sulteng" account (S2). Statement S3, namely the presence of monitoring data, dates, and years in the post (S3). The findings show that students use various credibility indicators: some are based on personal experience (everyday verification), some refer to the authority of the source (official logo), and some look at data evidence. However, most have not triangulated information from various sources.

Figure 5. S2 showing BMKG information sources

Information Dissemination

Most students rarely share scientific information on social media. The reasons vary: they are not active on social media, feel that others already know, or only share information when events are considered important. The evidence reveals that participatory scientific information literacy remains low, indicating that students' potential as agents of scientific information dissemination on social media is not yet optimized.

Figure 6. S4 shows how to share information on instagram

Expressing Opinions

In expressing their opinions, students emphasized factors such as geographical location, number of trees, and weather changes. For example, S2 stated: "the temperature is different... the reason is because there are still many trees in Poso and there is not too much pollution." The findings suggest that students' arguments remain simple and are largely rooted in local experiences. Strengthening is needed so that students are able to connect empirical data with more abstract scientific concepts.

Next, to synthesize these findings, a conceptual model was developed to describe the interaction between scientific information literacy and abductive reasoning. This model shows how students' ability to acquire, filter, and evaluate scientific information supports the various stages of abductive reasoning (exploration, examination, selection, and explanation). These processes together shape students' understanding of climate change information on social media, which in this study is often influenced by local experiences but is gradually directed towards abductive reasoning to construct more evidence-based hypotheses. The following are the findings of the conceptual model developed from the integration of abductive reasoning through students' scientific information literacy. The conceptual model (Figure 2) illustrates how the five dimensions of scientific information literacy interact with the four stages of abductive reasoning to construct students' understanding of climate change on social media.

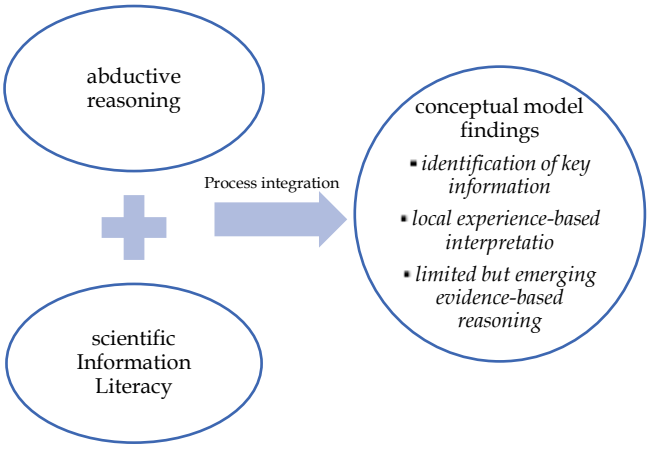


Figure 7. Conceptual model based on findings from students' abductive reasoning through science information literacy related to climate change on social media

Discussion

Abductive reasoning is a circular and interconnected process, which involves identification, selection, and context-based observations (Jeon et al., 2022). Results indicate that during the exploration stage, most students could identify explicit scientific information presented in Instagram posts, such as temperature, weather, and location. These findings indicate that students already have basic skills in recognizing visual and textual data. However, most students were not yet able to connect explicit information with more abstract scientific concepts. This condition aligns with OECD (2023), which reports that Indonesian students still struggle to connect scientific phenomena with everyday life.

At the examination stage, students try to relate data to everyday thinking frameworks for instance, geographical factors, tree density, or natural phenomena such as rain and wind. This pattern suggests that their abductive reasoning remains influenced by everyday frameworks. During the reasoning process, individuals tend to link the phenomena studied with prior knowledge, and then new knowledge is sought when previous knowledge is corrected and integrated (Zulkipli, 2020). According to Osborne et al. (2023) and Furqoni et al. (2022), abductive reasoning begins with the use of an initial conceptual framework that is often intuitive before developing into more scientific hypotheses. These findings are also consistent with research by Ho et al. (2016), which states that students are prone to intuitive biases when interpreting complex scientific information on social media. Consistent with Vosniadou (2019), students' initial understanding is typically rooted in intuitive conceptual frameworks (framework theories) that simplify complex scientific phenomena and often differ from formally accepted scientific frameworks. Consequently, their reasoning relies more on intuition shaped by prior learning experiences and is less frequently grounded in scientific, data-based analysis (Rahmah et al., 2020).

The selection stage shows that students begin to sort out the reasons they consider most logical, even though these reasons are still dominated by local experiences such as tree felling or pollution. This finding highlights students' limited ability to connect empirical data with scientific frameworks. This finding contrasts with the results of Engelschalt et al. (2023), who emphasize that one of the primary functions of abductive reasoning is to train students to test hypotheses using available empirical data rather than relying solely on everyday experiences. Accordingly, the results of this study indicate that the students are still at an early stage in developing evidence-based abductive reasoning skills.

At the explanation stage, students can convey climate phenomena in simple language, for example, through comparisons of conditions between regions or by emphasizing the importance of sharing information. However, the emerging arguments are not yet fully supported by scientific data and still rely on intuitive explanations. This is in line with the findings of Upmeier zu Belzen et al. (2021), which show that the scientific arguments of junior high school students are often still limited to everyday experiences.

Therefore, reinforcement of scientific information literacy is needed so that students can develop evidence-based reasoning. In terms of scientific information literacy, students obtain information mainly through direct observation of images or short texts, but the processing is still descriptive. The filtering process relies more on observations of the surrounding environment than on comprehensive scientific evaluation. When evaluating credibility, the indicators used are also diverse. Some students rely on personal experience. Others refer to source authority, such as the BMKG logo, and some look at data evidence in the form of numbers and dates. This pattern is consistent with the findings of Wang et al. (2023) that students tend to use simple criteria in assessing the credibility of information and are not yet accustomed to triangulating from various sources. In addition, the results of the study show that the dissemination of scientific information is still low. Most students rarely share climate change information on social media because they are less active or assume that others already know.

This finding is important because, according to Gil Quintana et al. (2020), scientific information literacy is not only about the ability to understand and evaluate but also the skill to disseminate credible information participatively in digital spaces. Thus, the low level of

dissemination in this study indicates that the potential of students as agents of scientific literacy on social media has not been optimally utilized. The conceptual model developed in this research highlights how integrating scientific information literacy with abductive reasoning can enhance students' understanding of climate change information. The five dimensions of scientific information literacy (acquiring, filtering, evaluating credibility, disseminating, and expressing opinions) complement the four stages of abductive reasoning (exploration, examination, selection, and explanation).

This aligns with the perspective of Osborne et al. (2023), who emphasize that the development of scientific literacy needs to be integrated with reasoning skills to train critical thinking abilities in dealing with complex information flows. In the context of this study, this integration is realized through the interconnection between scientific information literacy and abductive reasoning, which have rarely been studied in depth.

Conclusion

The research findings reveal that junior high school students were able to identify explicit scientific information in social media posts related to climate, but their abductive reasoning and information literacy were still dominated by intuitive and local experiences. In the exploration and examination stages, students relied more on everyday experiences than scientific concepts. In the selection and explanation stages, arguments remained simple and lacked support from evidence-based reasoning. Similarly, their information literacy is limited to descriptive access and personal verification, while credibility evaluation and information dissemination are still underdeveloped. The results emphasize the importance of integrating abductive reasoning and scientific information literacy. The conceptual model developed in this study shows how five dimensions of information literacy support the four stages of abductive reasoning in shaping students' understanding of climate change. This integration helps explain why students remain at the intuitive reasoning level when information literacy is weak and how strengthening literacy can guide abductive reasoning toward evidence-based hypotheses. The contribution of this research lies in the explicit link between abductive reasoning and scientific information literacy in the context of learning about climate change through social media, an approach that has been rarely studied. Practically, science educators can use these insights to design strategies that train students to distinguish between evidence and personal experience, evaluate credibility by integrating sources, and actively participate in sharing credible climate change information online. This study is limited to a small group of eighth-grade students at a junior high school in Central Sulawesi, thus limiting the generalization of the findings. Further research needs to explore broader contexts and intervention models that integrate abductive reasoning and scientific information literacy into classroom practice, particularly regarding the use of social media as a source of scientific learning.

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Conflicts of Interest
No conflict interest.

References

Aïmeur, E., Amri, S., & Brassard, G. (2023). Fake news, disinformation and misinformation in social media: a review. *Social Network Analysis and Mining*, *13*(1), 30. https://doi.org/10.1007/s13278-023-01028-5

Alfiandy, S., & Permana, D. S. (2020). Tren Curah Hujan Berbasis Data Sinoptik Bmkg Dan Reanalisis Merra-2 Nasa Di Provinsi Sulawesi Tengah. *Jurnal Sains & Teknologi Modifikasi Cuaca*, *21*(2), 63–72. https://doi.org/10.29122/jstmc.v21i2.4132

Alfiandy, S., Permana, D. S., Nurjaman, A. W., Kurnia, W. G., Prastika, L., Panggabean, H., Rahman, M. S. D. P., Wulandari, S., Setiawan, H., Hendrawan, A., & Miranda. (2020). Analisis Iklim Provinsi Sulawesi Tengah berdasarkan Data Pemantau Cuaca Otomatis BMKG. *Buletin GAW Bariri*, *1*(1), 1–11. https://doi.org/10.31172/bgb.v1i1.5

Alfiandy, S., Rangga, I. A., & Permana, D. S. (2022). Pola Peningkatan Suhu Udara Berdasarkan Data BMKG Dan Era5 Di Provinsi Sulawesi Tengah. *Jurnal Analisis Kebijakan Kehutanan*, *19*(1), 63–70. https://doi.org/10.20886/jakk.2022.19.1.63-70

Brown, J. J. (2023). Social Media Reflection Assignment: a Simple Classroom Intervention To Help Students Examine Scientific Claims in Social Media. *Journal of Microbiology & Biology Education*, *24*(1). https://doi.org/10.1128/jmbe.00155-22

Chen, J., Lin, C.-H., & Chen, G. (2021). A cross-cultural perspective on the relationships among social media use, self-regulated learning and adolescents' digital reading literacy. *Computers & Education*, *175*, 104322.

https://doi.org/10.1016/j.compedu.2021.104322

Coletti, A., Mcgloin, R., Oeldorf-Hirsch, A., & Hamlin, E. (2022). Science Communication on Social Media: Examining Cross-Platform Behavioral Engagement. *The Journal of Social Media in Society*, *11*(2), 236–263. Retrieved from https://thejsms.org/index.php/JSMS/article/view/995

Crick, M. J. (2021). The importance of trustworthy sources of scientific information in risk communication with the public. *Journal of Radiation Research*, *62*(Supplement_1), i1–i6. https://doi.org/10.1093/jrr/rraa143

Engelschalt, P., Röske, M., Penzlin, J., Krüger, D., & Upmeier zu Belzen, A. (2023). Abductive reasoning in modeling biological phenomena as complex systems. *Frontiers in Education*, *8*. https://doi.org/10.3389/feduc.2023.1170967

Essien, E. (2025). *Climate Change Disinformation on Social Media: A Meta-Synthesis on Epistemic Welfare in the Post-Truth Era*. https://doi.org/10.20944/preprints202505.0146.v1

Furqoni, F. N., & Subekti, A. S. (2022). Kemampuan penalaran abduktif siswa ditinjau dari gaya belajar. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, *7*(6), 812–819. https://doi.org/10.17977/jptpp.v7i6.16807

Gil Quintana, J., & Osuna-Acedo, S. (2020). Transmedia Practices and Collaborative Strategies in Informal Learning of Adolescents. *Social Sciences*, *9*(6), 92. https://doi.org/10.3390/socsci9060092

Hilary, I. O., & Dumebi, O.-O. (2021). Social Media as a Tool for Misinformation and Disinformation Management. *Linguistics and Culture Review*, *5*(S1), 496–505. https://doi.org/10.21744/lingcure.v5nS1.1435

Ho, S. S., Yang, X., Thanwarani, A., & Chan, J. M. (2017). Examining public acquisition of science knowledge from social media in Singapore: an extension of the cognitive mediation model. *Asian Journal of Communication*, *27*(2), 193–212. https://doi.org/10.1080/01292986.2016.1240819

Höttecke, D., & Allchin, D. (2020). Reconceptualizing nature-of-science education in the age of social media. *Science Education*, *104*(4), 641–666. https://doi.org/10.1002/sce.21575

Imperiale, M. J., & Casadevall, A. (2022). Thinking about Social Media, Scientific Information, and Public Communication. *MSphere*, *7*(5). https://doi.org/10.1128/msphere.00422-22

Januarti, I. M., & Muliyadi, L. (2024). Development of Ethnoscience-Based Student Worksheet Using the Guided Inquiry Learning Model to Increase Students' Learning Motivation and Scientific Literacy: A Review. *International Journal of Science Education and Science*, *1*(1), 13–18. https://doi.org/10.56566/ijses.v1i1.109

Jeon, J., & Shin, D. (2022). Students' Abductive Reasoning according to Scientific and Historical Knowledge. *Universal Journal of Educational Research*, *10*(5), 356–367. https://doi.org/10.13189/ujer.2022.100505

Klichowicz, A., Richter, T., & Singer, M. (2021). Information stored in memory affects abductive reasoning. *Psychological Research*, *85*, 1200–1215. https://doi.org/10.1007/s00426-020-01338-8

Li, Y., & Guo, M. (2021). Scientific Literacy in Communicating Science and Socio-Scientific Issues: Prospects and Challenges. *Frontiers in Psychology*, *12*, 758000. https://doi.org/10.3389/fpsyg.2021.758000

Naeem, M., Ozuem, W., Howell, K., & Ranfagni, S. (2023). A Step-by-Step Process of Thematic Analysis to Develop a Conceptual Model in Qualitative Research. *International Journal of Qualitative Methods*, *22*. https://doi.org/10.1177/16094069231205789

Nasr, N. (2021). Overcoming the discourse of science mistrust: how science education can be used to develop competent consumers and communicators of science information. *Cultural Studies of Science Education*, *16*(2), 345–356. https://doi.org/10.1007/s11422-021-10064-6

OECD. (2023). *PISA 2022 Results The State of Learning and Equity in Education* (1st ed., Vol. 1). OECD Publishing.

Oh, P. S. (2016). Roles of Models in Abductive Reasoning: A Schematization through Theoretical and Empirical Studies. *Journal of The Korean Association For Science Education*, *36*(4), 551–561. https://doi.org/10.14697/jkase.2016.36.4.0551

Osborne, J., Zucker, A., & Pimentel, D. (2023). *Tackling scientific misinformation in science education*. Stanford University.

Puig, B., Blanco-Anaya, P., & Pérez-Maceira, J. J. (2021). "Fake News" or Real Science? Critical Thinking to Assess Information on COVID-19. *Frontiers in Education*, *6*. https://doi.org/10.3389/feduc.2021.646909

Rahmah, N., Darsikin, D., Kade, A., & Muslimin, M. (2020). The Models of Physical Intuition Students use Phenomenological Elements in Solving Physics Problems. *Jurnal Pendidikan Fisika*, *8*(2), 163–176. https://doi.org/10.26618/jpf.v8i2.3352

Reinhart, A., Evans, C., Luby, A., Orellana, J., Meyer, M., Wieczorek, J., Elliott, P., Burckhardt, P., & Nugent, R. (2022). Think-Aloud Interviews: A Tool for Exploring Student Statistical Reasoning. *Journal of Statistics and Data Science Education*, *30*(2), 100–113.

https://doi.org/10.1080/26939169.2022.2063209
Saputra, W. T., Rustaman, N. Y., & Rusyati, L. (2025). Exploring the Relationship between Logical Reasoning Skills, Scientific Literacy, and Academic Achievement in Science Courses Among Secondary Students: A Mixed Method Study. *Jurnal Penelitian Pendidikan IPA*, *11*(1), 303–315. https://doi.org/10.29303/jppipa.v11i1.9547
Schäfer, M. S. (2025). Social media in climate change communication: State of the field, new developments and the emergence of generative AI. *Dialogues on Climate Change*, *2*(1), 49–55. https://doi.org/10.1177/29768659241300666
Storani, S., Falkenberg, M., Quattrociocchi, W., & Cinelli, M. (2025). Relative engagement with sources of climate misinformation is growing across social media platforms. *Scientific Reports*, *15*(1), 18629. https://doi.org/10.1038/s41598-025-03082-9
Susilawati, Doyan, A., Rokhmat, J., & Muliyadi, L. (2023). Analysis Validation of Modern Physics Learning Media Based on Smartphone Integrated Project Based Learning to Improve Students' Creativity and Scientific Literacy. *Jurnal Penelitian Pendidikan IPA*, *9*(10), 7888–7892. https://doi.org/10.29303/jppipa.v9i10.5404
Syarqiy, D., Yuliati, L., & Taufiq, A. (2023). Exploration of Argumentation and Scientific Reasoning Ability in Phenomenon-Based Argument-Driven Inquiry Learning in Newton's Law Material. *Jurnal Penelitian Pendidikan IPA*, *9*(9), 7264–7272. https://doi.org/10.29303/jppipa.v9i9.4589
Tang, K. (2025). Conceptions of climate change across cognitive, affective, and behavioural dimensions among adolescents: Insights from Indonesian upper-secondary students. *Npj Climate Action*, *4*(1), 47. https://doi.org/10.1038/s44168-025-00245-2
Vosniadou, S. (2019). The Development of Students' Understanding of Science. *Frontiers in Education*, *4*, 32. https://doi.org/10.3389/feduc.2019.00032
Wang, H., Li, L., Wu, J., & Gao, H. (2023). Scientific Information Literacy: Adaption of Concepts and an Investigation Into the Chinese Public. *Media and Communication*, *11*(1), 335–248. https://doi.org/10.17645/mac.v11i1.6077
Żelechowska, D., Żyluk, N., & Urbański, M. (2020). Find Out A New Method to Study Abductive Reasoning in Empirical Research. *International Journal of Qualitative Methods*, *19*. https://doi.org/10.1177/1609406920909674
Zulkipli, Z. A. (2020). Identifying Scientific Reasoning Skills Of Science Education Students. *Asian Journal of University Education*, *16*(3), 275. https://doi.org/10.24191/ajue.v16i3.10311