Media Literacy Education against Fake News:

The Role of Strategic Framing

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Zusammenfassung

In den letzten Jahren haben sich Fake News, also Falschinformationen, die in Form journalistischer Beiträge gestaltet werden, um Internetnutzer zu täuschen, als eines der zentralen Probleme der modernen Zeit herausgestellt. Fake News untergraben das Vertrauen in etablierte Medienorganisationen und öffentliche Institutionen und behindern Bemühungen, sich mit den großen Herausforderungen unserer Zeit, wie beispielsweise globalen Pandemien oder dem Klimawandel zu befassen. Infolge dessen haben Forschende aus den Bildungswissenschaften sowie anderen Disziplinen, wie der Kommunikationswissenschaft und der Psychologie, Maßnahmen entwickelt, um dem weit verbreiteten Einfluss von Fehlinformationen entgegenzuwirken. Diese Strategien zielen darauf ab, kognitive Verzerrungen, zum Beispiel den Confirmation Bias, abzuschwächen, Medien- und Informationskompetenz zu fördern oder kognitive präventive Maßnahmen bereitzustellen, um die Auswirkungen von falschen oder irreführenden Informationen im Internet zu minimieren. Jedoch ist eine wichtige Schlüssel- bzw. Überzeugungsstrategie, die häufig von Verbreitern von Fake News angewendet wird, nämlich Framing, in diesem Kontext noch wenig erforscht. Framing bedeutet, dass einzelne Aspekte einer wahrgenommenen Realität in einem Text hervorgehoben werden, um eine bestimmte Problemdefinition, kausale Interpretation, moralische Bewertung oder Handlungsempfehlung zu begünstigen. Diese Technik wird von allen Arten von Nachrichtenmedien verwendet und kann besonders problematisch sein, wenn damit falsche oder irreführende Informationen verbreitet werden.

Framing kann als Strategie zur Überzeugung von Menschen betrachtet werden. Deshalb eignet sich das „Persuasion Knowledge Model“ (PKM), um die Wirkung von Framing im Kontext von Fake News zu beschreiben. Beim PKM handelt es sich um ein Modell zur

Erklärung der Funktionsweise menschlicher Persuasionsversuche. Es basiert auf dem Zusammenspiel zwischen einem Persuasionsagenten (agent), also einer Person oder Gruppe, die hinter einem Persuasionsversuch steht, und ihrem Ziel (target), wobei verschiedene Arten von Wissen eine Rolle spielen. Themenwissen (topic knowledge), bezieht sich auf das Verständnis und Vorwissen, über das Thema oder Problem, auf welches sich die persuasive Information, z.B. ein bestimmter Fake News Artikel, bezieht. Dies umfasst ihre Vertrautheit mit dem Thema und ihr Wissen über wichtige Ideen und Konzepte dazu. Agentenwissen (agent knowledge) bezieht sich auf das Verständnis des Ziels über den Ursprung der persuasiven Informationen, einschließlich Zuverlässigkeit, Vertrauenswürdigkeit und Expertise der Quelle. Persuasionswissen (persuasion knwoeldge) bezieht sich auf das Verständnis der Methoden und Taktiken, die verwendet werden, um andere zu beeinflussen oder zu überzeugen, einschließlich verschiedener Persuasionsstrategien und häufig verwendeter Taktiken von Desinformationsagenten.

Nachdem sowohl Framing, als auch das PKM im Kontext von Fake News noch weitgehend unerforscht sind, zielt diese Dissertation darauf ab, diese Lücke zu schließen. Dazu wird zunächst eine Studie zur Analyse des strategischen Framings typischer Fake-News-Inhalte vorgestellt (Studie 1). Im Anschluss wird eine zweite Studie präsentiert, im Rahmen derer eine Bildungsintervention implementiert wurde, um Medienkompetenz zu fördern und die Fähigkeit zur Unterscheidung wahrer und falscher Nachrichten zu verbessern (Studie 2). Darüber hinaus werden diese Ergebnisse in den breiteren Rahmen des PKM integriert, um eine weitere, ergänzende Perspektive auf die Problematik von Fake News zu bieten.

Studie 1 hatte zum Ziel, die Beziehung zwischen der Gestaltung von Fake-News-Inhalten und anschließenden Online-Diskussionen in Kommentarspalten in Bezug auf Emotionen,

Argumentation und sozialen Wissensaufbau zu untersuchen. Dazu wurde eine umfassende Inhaltsanalyse von Beiträgen sowie Kommentaren einer gängigen deutschsprachigen Fake-News-Plattform durchgeführt. Die Ergebnisse dieser Studie legen nahe, dass die Verbreiter von Fake-News zumindest in dieser Analysestichprobe aktiv eine Vielzahl von Framing-Strategien nutzen, nämlich emotionales, wertendes und semantisches Framing, um Diskussionen zu verzerren und irreführende Informationen zu verbreiten. Negative Emotionen, insbesondere Wut, überwogen bei anschließenden Online-Diskussionen, die durch Fake News ausgelöst wurden, deutlich die Positiven. Darüber hinaus wurde nach der Analyse des Engagements der Diskussionsteilnehmer in Bezug auf den sozialen Wissensaufbau deutlich, dass eine einseitige Dialogumgebung, die von nur wenigen Stimmen dominiert wird auftrat, möglicherweise im Sinne einer Echokammer. Schließlich wurde in dieser Studie untersucht, inwieweit die Verwendung von Framing-Strategien Emotionen, Argumentation und den Wissensaufbau von Rezipienten in den anschließenden Online-Diskussionen vorhersagen kann. Die Ergebnisse deuten darauf hin, dass emotionales und semantisches Framing in geposteten Nachrichtenartikeln Prädiktoren für negative Emotionen in den Kommentaren sind, was bedeutet, dass diese Framing-Strategien ihre Aufgabe, potentielle Leser emotional zu erregen, erfolgreich erfüllt haben. Während die Rolle von Framing seit Jahrzehnten im Kontext von Propaganda und Medieninhalten erforscht wurde, ermöglicht diese Studie Einblicke in die Auswirkungen der Gestaltung von Fake-News-Inhalten auf deren Konsumenten, vor allem in Bezug auf Emotionen und Diskussionen untereinander. Studie 1 legt damit nahe, dass Verbreiter von Fake News häufig erfolgreich Framing-Strategien einsetzen, um ihr Zielpublikum zu überzeugen, und dass das Publikum meist nicht über die notwendigen Kenntnisse (Persuasionswissen) verfügt, um diese Taktiken zu erkennen und zu identifizieren.

Studie 2 wurde in den frühen Phasen der Covid-19-Pandemie durchgeführt. Primäres Ziel dabei war es, einen asynchronen Online-Kurs für Studierende zu implementieren, der das Problem von Fake News durch die Förderung von Medienkompetenz mithilfe eines problemorientierten Ansatzes thematisiert. Durch intensives Engagement mit verschiedenen Framing-Strategien lernten die Studierenden typische Ansätze kennen, die von Fake-News-Verbreitern verwendet werden, um News-Konsumenten von fehlerhaften und irreführenden Informationen zu überzeugen. Zudem wurden im Rahmen von Studie 2 die Leistung der Studierenden in diesem Pilotkurs und ihre Lernergebnisse in Bezug auf die Erkennung von Fake News erhoben. Diese wurden durch einen Pre-Post-Test zur Glaubwürdigkeit von Fake News gemessen. Insgesamt legt die Studie nahe, dass Medienkompetenz in Bezug auf Kenntnisse über Framing-Strategien (Persuasionswissen) durch derartige Online-Kurse gefördert werden kann. Da diese Studie jedoch in einem Bachelor-Universitätskurs durchgeführt wurde, ist es schwierig, sie in ihrer derzeitigen Form zu skalieren, ähnlich wie viele andere Interventionen gegen Fake News. Im Kontext des PKM implizieren die Ergebnisse aus Studie 2, dass Persuasionswissen auch durch gezielte Interventionen über Persuasions-Strategien, beispielsweise Framing, vermittelt werden kann und nicht nur durch authentische Persuasionssituationen im Alltag, beispielsweise bei Exposition mit Fake News, wie ursprünglich im Modell angenommen.

Insgesamt umfasst diese Arbeit gängige theoretische Annahmen über Fake News und präsentiert zudem eine neue Perspektive auf die Thematik in Form des Persuasion Knowledge Models, wobei Framing eine zentrale Rolle zukommt. Dabei wird deutlich, dass die Art und Weise in der (Fehl-)Informationen durch Framing präsentiert werden maßgeblich zur Persuasion von Rezipienten beitragen kann, was gezielte Interventionen erforderlich macht. Die beiden Studien unterstreichen zudem die Bedeutung von Medien- und Informationskompetenz und

Überzeugungswissen für einen adäquaten Umgang mit Fake News und legen nahe, dass eine umfassende Vorgehensweise, die eine Vielzahl von Maßnahmen aus verschiedenen Disziplinen nutzt, essentiell ist, um dem komplexen Problem von Fake News entgegenzuwirken.

Abstract

In recent years, fake news has emerged as a significant obstacle of modern times. By fueling distrust in established media organizations and public institutions, it hinders efforts to tackle the pressing challenges of our time, such as global pandemics and climate change. In response, educational science, along with other disciplines such as communication science and psychology, developed measures to combat the widespread influence of misinformation. These strategies aim to counter biases, promote media and information literacy, and provide cognitive preventative measures to mitigate the impact of encountering false or misleading information online. However, research on one key strategy frequently employed by fake news disseminators, namely framing, remains scarce. This thesis seeks to address this gap by conducting an analysis of the strategic framing of typical fake news content (Study 1) and implementing an educational intervention to promote media literacy by improving discernment of both truthful and fake news (Study 2). Furthermore, these findings are incorporated into the broader framework of the persuasion knowledge model to provide an additional and complementary perspective on the challenge of fake news.

Keywords: misinformation, disinformation, fake news, framing, persuasion knowledge model

Contents

Introduction

Fake news has been a highlighted issue in the public eye ever since the 2016 US presidential election, with recent political and public health crises exacerbating the problem. The advent of digital media, web 3.0 applications, citizen journalism and the ease with which information can be shared and transmitted made fake news, i.e., incorrect or misleading information in the format of news journalism, a serious worry in today's society. Negative effects, such as political polarization (Azzimonti & Fernandes, 2022; Osmundsen et al., 2021), hazards to the general public's health (Melchior & Oliveira, 2022; van der Linden et al., 2020), and an erosion of trust in authorities and established institutions (Melki et al., 2021; Ognyanova et al., 2020) can result from the spread of false information. Additionally, it can lead to general distrust and confusion among citizens, making it challenging for people to distinguish between fact and fiction (Southwell, 2018). The dissemination of misleading information about COVID-19 is one of the most noteworthy instances of the effects of disinformation (Rocha et al., 2021). This includes false information regarding the virus' origins, the efficacy of particular therapies, and the security of vaccines (Loomba, 2021) which has exacerbated public confusion and distrust while impeding efforts to stop the virus's spread. This accompanying widespread flood of misinformation has been poignantly dubbed an "infodemic" even outpacing the virus itself (Brennen et al., 2020; Orso et al., 2020; Zarocostas, 2020).

In addition to the COVID-19 epidemic, fake news, rumors and conspiracy theories have been widely disseminated in an effort to influence recent political elections (Batista Pereira et al., 2022; Grinberg et al., 2019; Guess et al., 2020a; Alcott & Genztkow, 2017). This has raised questions about the legitimacy of democratic processes and the possibility of foreign interference during elections (Higgins, 2017). Furthermore, fake news has become ever more relevant with

the ongoing war in Ukraine which is accompanied by propaganda and disinformation (Kreft et al., 2023; Stănescu, 2022). Finally, arguably the greatest challenge for humanity in the current time and beyond, the fight against climate change, is obstructed by misinformation resulting in skepticism towards science and proven facts (Treen et al., 2020; Cook, 2019, van der Linden et al., 2017). As a result, comprehending the issue of disinformation and figuring out efficient methods to prevent it have emerged as crucial research subjects.

Several elements that contribute to the propagation of false information have been discovered by prior research. Individual factors, such as cognitive biases can play an important role. For instance, when evaluating whether a given piece of information is true or false, humans are biased to believe this information they encounter to be true (Marsh & Stanley, 2020). This truth bias results from being more efficient in terms of cognitive effort as only false information needs to be processed in more detail (Gilbert, 1991). Additionally, confirmation bias (Nickerson, 1998), might cause people to seek out information that supports their preexisting opinions even when it is wrong. This is especially dangerous in the context of fake news where users may be stumble into an ever-escalating rabbit-hole of falsehoods (Zhou & Shen, 2022). While confirmation bias is not necessarily linked to online information, the rise of digital technologies had a significant influence on connectivity through the emergence of online social networks. This leads to an enhanced diversity of information and potential viewpoints that users are exposed to. However, this broader and more accessible information ecosystem is also accompanied by significant downsides, as it can also amplify the effects of confirmation bias, as users may only search for and propagate information that aligns with their own beliefs. This can lead to the formation of isolated online communities that reinforce the same ideas repeatedly, so

called echo chambers (Rhodes, 2022; Del Vicario et al., 2016), resulting in fragmented online societies each with their own narrative and condemning different views.

False information can also be spread through the design of digital platforms , such as when algorithms favor engagement above accuracy (Vosoughi et al., 2018; Wardle & Derakshan, 2017). Additionally, fake news articles are often framed in a way to provoke emotional responses from readers, as individuals, who are more emotional, are more likely to believe false information, such as misinformation regarding Covid-19 (Ecker et al., 2022; Martel et al., 2020). To increase the sharing of fake news articles, headlines are typically designed to evoke emotions such as anger, fear, disgust, or empathy (Vosoughi et al., 2018). Misleading content, sensationalism, and clickbait are also often employed to achieve this goal (Mourão & Robertson, 2019). Research on framing in the context of fake news is scarce, which is why this thesis aims to fill this gap.

In general, research on misinformation and how to deal with it has been undertaken from the viewpoint of several disciplines. One notable area of research lies within social psychology (e.g., Ecker et al., 2022; De keersmaecker et al., 2020), cognitive psychology (e.g., Newman et al., 2020; Pennycook & Rand, 2018), and communication studies (e.g., Bakir & McStay, 2018; Bonnet & Rosenbaum, 2020). This direction focuses on persuasion episodes, individual knowledge and skills, and decision-making processes regarding the belief of information. This line of research often emphasizes inoculation and pre-bunking, i.e., preventively teaching about misinformation prior to exposure to it, as the preferred intervention method and typically involves internet-based field studies with various age groups (e.g., van der Linden et al., 2020). While this line of research has strengths such as large sample sizes and applicability in mass

communication, it fails to address the broader context of internet use and provide guidance for fostering information literacy through learning environments and instructional designs.

Another research line lies in the educational sciences and literacy research (e.g., Kiili et al., 2023; Wineburg et al., 2022) focusing on information corroboration, coherence, and applicability in the context of reasoning and problem-solving, i.e., media and information literacy. This research assumes that information, especially online, is often mixed with irrelevant or harmful data, and information literate individuals must be able to evaluate information in terms of relevance, credibility, and applicability. Interventions in this field are typically conducted in schools or at undergraduate university level (e.g., Breakstone et al., 2021; Wineburg et al., 2022) and emphasize cognitive processes and learning.

This thesis aims to provide a perspective on the issue of fake news from an educational science point of view. Given that the problem of misinformation is inherently based in cognitive psychology, social psychology, and communication science, this thesis includes theories and findings from this first more ontological line of research, which focuses on different slices of the problem of misinformation. Building upon this fundament and in conjunction with the second line of research, which aims to provide an answer to the problem of fake news through fostering media literacy with specific educational interventions, in this thesis one further approach of combating misinformation in form of a media literacy intervention focused on framing will be presented. To achieve this, the remainder of this thesis will first feature a theoretical overview of the main reasons why humans fall for misinformation, a model that explains how persuasive messages, such as fake news, are processed and a brief overview of one strategy that exploits exactly that, i.e., framing. Furthermore, specific interventions from the two overarching research lines that have established themselves in misinformation research, will be presented. In two

studies, the previously mostly unexplored role of framing in the context of misinformation will then be highlighted. Study 1 presents an exemplary analysis of framing on a common fake news site and its relationship with subsequent user discussions, while Study 2 introduces an educational intervention that aims to improve the discernment of truthful versus fake news in form of a university course. Finally, findings from the framing analysis and consequences for research and practice, gained from the intervention study, will be discussed within the larger context of misinformation research. This improves the existing theory landscape by including framing while also providing an approach to counteract this persuasive strategy. Additionally, these implications for the existing misinformation research open the way to new directions for future research projects.

Theoretical framework

Misinformation, disinformation and fake news – terms and differences

Within the last few years, researchers distinguished three distinct terms to differentiate specific types of faulty or misleading information that is spread deliberately or unintentionally: misinformation, disinformation and fake news. According to van der Linden and Roozenbeek (2020), false or information can be differentiated into misinformation and disinformation. Misinformation includes any incorrect information, such as human error, misleading but not false articles, rumors without a specific news article source, and satire. A social media user might, for instance, share a fake item because they think it is factual, only to learn later that it is untrue after being given accurate information.

The distinguishing factor between disinformation and misinformation lies in the intent behind the dissemination of false information: disinformation is deliberately meant to deceive, whereas misinformation may be unintentional (Tucker et al., 2018). Although establishing intent

can be challenging, it is generally understood that organized efforts by political entities, whether domestic or foreign, to spread false information are typically classified as disinformation. In practical terms, the deliberate propagation of misinformation for deceptive purposes is what constitutes disinformation (Guess & Lyons, 2020). This may occur, for example, in the form of deep fakes, faulty statistics or biased claims regarding a specific topic.

False or misleading material that passes for news or journalism is referred to as fake news. It constitutes a form of disinformation that is intentionally false and potentially misleading to readers, as noted by Allcott and Gentzkow (2017). Furthermore, it "mimics news media content in form, but not in organizational process or intent" (Lazer et al., 2018, p. 1), and may feign expertise in certain topics such as climate change or vaccines. This term is frequently used to describe made-up tales or articles that are not rooted in reality, or largely biased, but are written to appear to be genuine news (Rochlin, 2017). Wardle (2017) divides fake news into seven types: satire or parody, misleading content, imposter content, fabricated content, false connection, false context, and manipulated content. Among those, false connection and misleading content are most reminiscent of misinformation, whereas fabricated content falls clearly in the category of disinformation. Similarly, Tandoc et al. (2018) have classified fake news into six types based on two dimensions: level of facticity and intent to deceive. Propaganda, photo manipulation, and advertising contain a significant amount of factual information but have an intention to deceive readers. In contrast, news fabrication contains little factual information but still aims to deceive readers. News satire and news parody, on the other hand, do not intend to deceive readers and are therefore considered less problematic. In the current information environment fake news often focuses on political topics and spreads especially fast through social media (Pennycook & Rand, 2020; Vosoughi et al., 2018) where it

can be used to disseminate false information or to gain revenue off of advertising (Braun & Eklund, 2019; Bakir & McStay, 2018).

In conclusion, misinformation is defined as false or inaccurate information, that is disseminated without intent to mislead, while disinformation is defined as false or misleading information that is disseminated with the intent to mislead or manipulate people, and fake news is defined as false or inaccurate information that is disseminated under the guise of news journalism. While it is nearly impossible to establish intent behind the dissemination of false information in most cases, the material that was used in the two studies described in the later chapters originated from well-established disinformation sites known for spreading fake news. Thus, the term of fake news will be used for the remainder of this overview.

Individual factors of vulnerability towards fake news

There are several explanations as to why fake news continues to be a relevant problem. Overall, the reason as to why people fall for fake news can be seen as a problem of handling online information. This can either happen in a competent manner, i.e., through high degrees of media and information literacy or in problematic ways, i.e., impeded by biases or flawed reasoning.

Cognitive biases

Early explanatory approaches theorized that humans are simply flawed when dealing with dubious information due to a variety of cognitive biases. Arguably the most prominent one is the *confirmation bias*, which states that people tend to both seek and interpret evidence that reinforces their pre-existing beliefs and attitudes (Nickerson, 1998). Unfortunately, this is also true in the case of fake news. Research by Hameleers (2022) suggests that misinformation, regardless of its truthfulness, is assessed as more convincing and correct when it aligns with pre-

existing beliefs. This only gets exacerbated by filtered and personalized access to information due to search algorithms, leading to so-called selective exposure (Spohr, 2017). Additionally, prior exposure to fake news can also increase the perceived accuracy of those news articles (Pennycook et al., 2018). This illusory truth effect (Newman et al., 2020) is unfortunately quite robust, even when accurate knowledge about a given topic may be available (Fazio et al., 2015). Furthermore, differences in cognitive ability or style, i.e., intuitive vs. analytical thinking, seem to not moderate this effect (De keersmaecker et al., 2020).

Reasoning

Another, more recent explanation puts reasoning or a lack thereof at the forefront. In their 2018 study Pennycook and Rand found news consumers who fall for fake news to be "lazy, not biased", meaning that people rarely invest the time and cognitive effort to properly evaluate news sources they encounter when scrolling through their daily social media feed. The authors concluded that analytic thinkers would invest the extra cognitive effort and therefore succeed where intuitive thinkers failed. Their study was replicated in different contexts, such as in recent work by Faragó and colleagues (2023) who found similar effects in Hungary, concluding that analytic thinking led to higher accuracy in truth discernment. Similar results have also been found in Ukraine in regards to pro-Kremlin disinformation (Erlich et al., 2023). The authors found that people who engaged in analytical thinking were more likely to accurately rate true and false news accordingly, despite their political preferences. All these findings support the classical reasoning theory (Pennycook & Rand, 2020; 2018) which states that not utilizing one's mental capabilities (e.g., by not thinking at all) is the culprit behind news consumers falling for fake news. However, it is important to note that most these studies use the Cognitive Reflection Test (CRT) (Frederick, 2005) in order to measure analytic thinking. The CRT has been criticized in

the past for being confounded with several other constructs, especially numeracy (e.g., Thomson & Oppenheimer, 2016; Campitelli & Gerrans, 2014).

Lack of media literacy

Besides individual cognitive factors, specific competencies when dealing with digital media – or a lack thereof – also play an important role in the wake of fake news and online misinformation. In recent studies, different terms came up, such as news literacy (Bonnet & Rosenbaum, 2020; Klurfeld & Schneider, 2014), digital media literacy (Moore & Hancock, 2022; Buckingham, 2015), or fake news literacy (Jones-Jang et al., 2021). All of those fall under the broad umbrella of media literacy, which has been an important area of research for decades growing ever more relevant with the increasingly participatory media landscape (e.g., Koltay, 2011). The common denominator among these studies is media literacy, being found as necessary to assess the reliability of news sources and articles – be they true or false. People falling for fake news could thus be explained by insufficient media literacy, especially in regard to news media. Media literacy has been defined as the ability to access, comprehend, assess, and produce media (Aufderheide, 1993), the latter of which is not as important in regards to fake news. It encompasses the knowledge and abilities required to comprehend and interact with the many media types people come into contact with on a daily basis. This ability to navigate the complex and ever-changing media landscape and critically engage with the information that is offered to them – especially online – is a crucial life skill in today's society. With the arrival of digital media, some scholars are urging for a greater focus on the participatory characteristics of digital media. For instance, Buckingham (2015) emphasizes the symbolic, emotional, and persuasive dimensions of digital media that are often not as present in classic media formats. In a somewhat similar vein, news media literacy refers to a set of abilities and understanding that

news consumers require in order to navigate the online information landscape in a thoughtful and analytical manner (Hameleers, 2022; Ashley et al., 2017).

Some elements of this definition are shared with yet another competence – information literacy, which is defined as the ability to find, assess, and use information effectively and responsibly (ACRL, 2000). When compared to media literacy that was originally developed for print and audiovisual media, information literacy has been formulated and evolved to suit digital environments. According to Livingstone et al. (2008), information literacy puts special emphasis on the ability to navigate and locate reliable information. In general, it is a combination of skills and talents that enable people to successfully identify, locate, assess, and use information relevant for their current needs, e.g., deciding whether to get vaccinated against a new virus or not. Thus, it is a necessary life skill that allows people to make educated decisions, be active and informed citizens, and to participate in today's society.

Several studies (e.g., Faragó et al., 2023; Guess et al., 2020b) have been proponents of media literacy as a way of combatting fake news. While some recent works (e.g., Jones-Jang et al., 2021) have found information literacy to be superior when dealing with misleading and faulty information, the evidence as of yet is non-conclusive. However, what remains almost certain, is that literacy – be it (digital) media, information or news literacy – is necessary to deal with the ongoing flood of fake news. For the two studies featured in this overview paper, the classic definition of media literacy was used, as it holds the firmest position in educational research. In terms of fake news, this means a dichotomic approach that media literacy includes accurately identifying true and false news respectively. However, recent research, for instance by Carita Kiili and colleagues (2023), understand information as something used in problem-solving that can be searched for and applied to different situations. Thus, media and information literacy

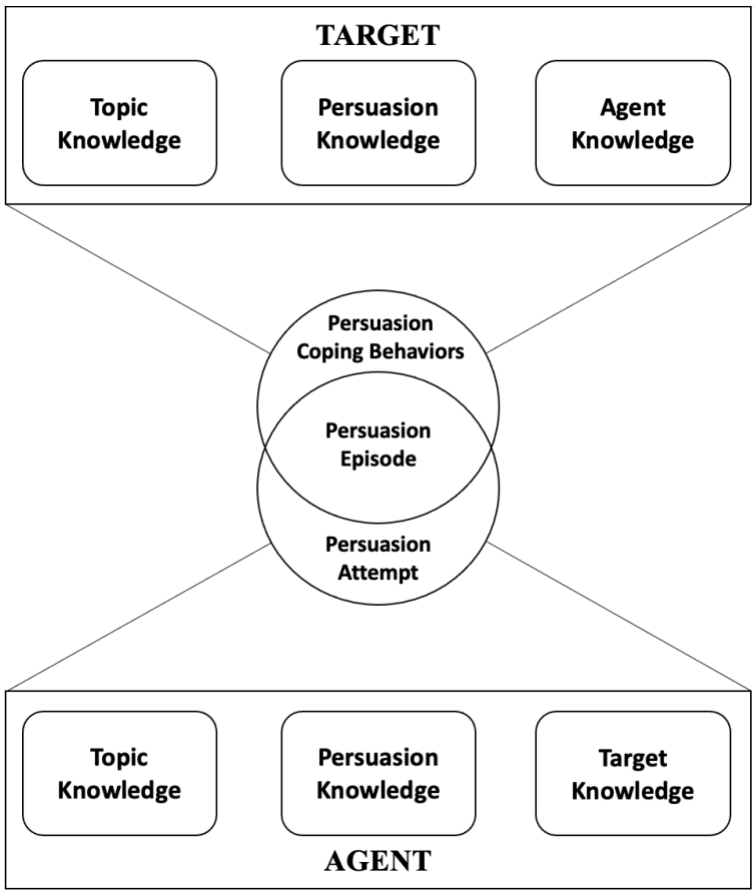
may have to encompass more than just judging information as either true or false. Additionally, the overall value of (online) information in regard to problem-solving needs to be assessed.

Persuasion knowledge model

As to the reason why a certain degree of media literacy is important in the context of fake news, one can look towards the Persuasion Knowledge Model (PKM). It is a paradigm for understanding the underlying conditions under which persuasive communications, such as fake news, are processed by humans (Friestad & Wright, 1994).

Figure 1:

Persuasion Knowledge Model (own depiction modeled after Friestad & Wright, 1994, p. 2)



Originally developed and used for marketing and public relations research (e.g., Tutaj & Van Reijmersdal, 2012) the PKM can also be used to explain how persuasive messages in the form of fake news deceive news consumers.

As seen in Figure 1, The PKM is based on the interplay between a persuasion agent, i.e., an individual or group who is behind any given persuasion attempt, and their target, both of which possess different types of knowledge about the other. *Topic knowledge,* held by both the persuasion agent and target, is the understanding that people have of the subject matter or problem that the persuasive piece of information relates to. This includes their familiarity with the subject and their knowledge of the important ideas around it. For instance, someone with extensive understanding of a particular medical disease, such as Covid-19, would be able to assess medical facts concerning that ailment with greater objectivity than someone with limited knowledge of it. People are more inclined to accept information that fits with their pre-existing knowledge and understanding of a subject, i.e., confirmation bias (Nickerson, 1998), thus this kind of knowledge is crucial when dealing with persuasive information. However, and this is where the problem with fake news arises, most people are not experts in every field, e.g., medicine or climate sciences. Moreover, Kiili and colleagues (2023) found that genre knowledge, i.e., knowledge about forms, conventions and contents of texts that are appropriate in a specific situation, also plays a major role when people evaluate the credibility of messages. This type of knowledge however only increases through experience when readers participate in different communicative activities. This in turn leaves those individuals with less experience regarding the consumption of online news at an increased risk of falling for persuasion. In order to bypass this disadvantage, news consumers must rely on persuasion and agent knowledge, which can be conveyed through educational programs.

Agent knowledge refers to the target's understanding of the source of the information they are analyzing, i.e., its' beliefs about the traits, competencies, and goals of a persuasion agent. This comprises the source's reliability, trustworthiness, and expertise. People are more likely to

trust information that comes from genuine and trustworthy sources (Ismagilova et al., 2020). For example, if someone gets information from a recognized news outlet, they are more likely to trust and accept it than if they get it from an unknown or untrustworthy source. This important role of source credibility has been emphasized in prior research (e.g., Pornpitakpan, 2004).

Target knowledge on the other hand encompasses everything the persuading agent may know about their specific target audience. This knowledge may for example be gained through harvested personal data, such as in the case of the Cambridge Analytica scandal, where millions of Facebook profiles were systematically analyzed in order to target users with personalized political advertisements (Cadwalladr & Graham-Harrison, 2018). Given that online news media sites nowadays usually include commentary sections, fake news mongers could also use their recipients own statements to gain further insights into their target audience.

Finally, *persuasion knowledge* refers to people's understanding of the methods and tactics used to influence or persuade others. Again, both the persuasion agent and target hold a – mostly different – degree of this kind of knowledge. It includes understanding about various persuasion strategies, such as framing (Scheufele, 1999; Entman, 1993), e.g., through emotional appeals, or other common tactics used by disinformation agents, such as impersonation of public figures or companies (Mac et al., 2022; Goga et al., 2015). Someone with a higher level of persuasion knowledge, for example, would be able to understand when a message is framed in such a way as to elicit an emotional response to convince them and would be less likely to be affected by it. In the context of advertising, consumers are fairly capable of using this knowledge (Kirmani & Campbell, 2004). However, in regards to fake news, it is unclear whether average internet users are familiar with common persuasive strategies.

In addition to the main components of the PKM, there are three further factors that determine a target's understanding of persuasion: cognitive ability, experience, and motivation (Shrum et al., 2013). Cognitive ability is fairly self-explanatory. Experience relates to the prior exposure to persuasion tactics and how people dealt with those (Friestad & Wright, 1994). In their original model, the authors state that persuasion knowledge increases through familiarity with the used tactics and may be fully automatized given enough encounters with persuasive content. Finally, motivation, i.e., whether a target is even considering the use of persuasion knowledge, can be heightened by a target's lack of familiarity with the persuading agent or previous observation of similar persuasive tactics in a different context. Conversely, motivation can be diminished by difficulty in identifying the persuading agent (Shrum et al., 2013). In the context of fake news, for instance, the lack of a specific source of a claim, may lead to the target not utilizing any persuasion knowledge at all.

Furthermore, it is important to note that depending on the subject or situation, people can have varying levels of topic, persuasion or agent knowledge, so that being more knowledgeable in one area does not automatically make someone more resistant to false information in general. For instance, an epidemiologist – while an expert on contagious diseases – may still be vulnerable when faced with fake news regarding the specifics of new forms of vaccinations. Given that topic and genre knowledge are highly subjective and mostly experience-based it stands to reason that one should aim to foster persuasion or agent knowledge when designing educational interventions. In Study 2 persuasion knowledge in the form of framing was conveyed within a university course.

The Role of Framing

One common persuasive strategy that has been used for decades – especially in journalism and public affairs – is framing (Scheufele, 1999). According to Entman (1993) "to frame is to select some aspects of a perceived reality and make them more salient in a communicating text, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation" (p. 52). To visualize this definition, one could imagine a painting of which only a small piece is visible and highlighted – one the artist specifically wants his audience to focus on (Tewksbury & Scheufele, 2019). It is a general technique used by all kinds of news outlets, however especially dangerous when used in the context of misleading or false information by nefarious actors.

The theoretical basis of the framing theory lies partially in sociology and psychology (Tewksbury & Scheufele, 2019; Pan & Kosicki, 1993). Goffman (1974) states that humans engage in active classification, organization, and interpretation of their life experiences to derive meaning from them. These interpretive schemata, referred to as frames, allow individuals to effectively locate, perceive, identify, and label information. Similarly, Kahnemann and Tversky (1984) introduced the idea of reference dependency claiming that perception is always reference-dependent, i.e., the way in which a particular piece of information is understood can vary significantly based on the interpretive schema that an individual employs. Scheufele (2008) further added that various interpretive schemas can be triggered by framing the same message in distinct ways. These schemata of interpretation are what framing by outside actors aim to utilize in order to persuade their audience. In order to achieve this, frames are constructed with syntactical and rhetoric structures in mind (Pan & Kosicki 1993). The choice of words and

phrases can greatly affect how a message is perceived, and can be used to evoke specific emotions and attitudes.

Certain communicators, e.g., politicians, bloggers, political satirists or editorial writers, intentionally use framing as a strategic tool to influence outcomes by persuading target audiences to adopt interpretations that align with their interests or objectives (Druckman, 2001; Entman et al., 2004). Individuals or groups that deliberately disseminate fake news also fall into this category. Conversely, other communicators, particularly reporters and news editors in established news media, tend to use framing as a natural part of their work, without any intention of promoting a particular policy or political agenda (Entman et al., 2004). To summarize, framing refers to the way in which information is presented to an audience, and the context in which it is presented. It is the process by which communicators, consciously or unconsciously, select and present certain aspects of reality to influence the way others perceive it.

In the context of fake news framing is used by presenting partial misleading or fabricated information in a way that supports a particular point of view or agenda. Using emotional appeals, such as children in need or danger, is a common and well-established framing device (e.g., Kepplinger, 2012; Gross & D'Ambrosio, 2004). Especially in the context of fake news, emotions play an important role (Bakir & McStay, 2018) and emotional framing situations where people get harmed, such as accidents, can lead to different emotional outcomes, such as anger or sadness (e.g., Kim & Cameron, 2011; Kühne & Schemer, 2015; Kühne 2014). Thus, *emotional framing* refers to the way in which information or a message is presented to evoke a specific emotional response in the audience (Lee & Chen, 2021; Kühne, 2014). This can be done through the use of language, imagery, and other means to elicit positive or negative emotions and shape the way the

audience perceives and interprets the message. particular issue, such as immigration or crime, in order to gain support for certain policies or candidates.

Semantic framing (Harmon & Muenchen, 2009) constitutes another subtle but powerful form of persuasion that involves the use of language to shape the way an audience interprets and understands a message. For example, using words like "investment" or "growth" to describe a policy or program can create a sense of optimism and progress, whereas using words like "cost" or "burden" can create a sense of negativity and resistance. In some cases, even replacing one single word in a message is enough to sway news consumers opinion (Simon & Jerit, 2007).

Finally, a third very successful strategy in the framing handbook is appealing to the audiences set of values (e.g., Schemer et al., 2012). This *value framing* (Chong & Druckman, 2007) refers to the way in which a message is presented in terms of the values or beliefs it represents. This can be done through the use of language, imagery, and other means to align a message with the audience's values and beliefs. Value framing is often used in political campaigns, where candidates or political parties will align their message with the values and beliefs of their target audience in order to gain support (Domke et al., 1998). These different framing strategies are explored in more detail in Study 1. Altogether, while framing may not be as potent in inciting specific behavior, it still heavily influences attitudes (Amsalem & Zoizner, 2022) and can be a powerful tool for persuasion. In the context of the PKM, framing and knowledge about framing falls clearly under persuasion knowledge which can and should be improved upon in order to make news consumers less vulnerable to fake news.

Interventions against fake news

There are a variety of different approaches to counteract fake news and its influence on internet users across the world. Overall, three categories of interventions can be differentiated:

truth-evaluation techniques, which are mainly concerned with topic knowledge, approaches based on inoculation theory, which mostly aim to foster persuasion knowledge, and media literacy education, which encompasses both agent and persuasion knowledge. Nonetheless, all of these come with their own advantages and drawbacks.

Truth evaluation techniques (fact-checking, lateral reading)

Probably the most common approach of dealing with false or misleading information is *fact-checking*. Walter and colleagues (2020) define fact-checking as "the practice of systematically publishing assessments of the validity of claims made by public officials and institutions with an explicit attempt to identify whether a claim is factual" (p. 2). This definition strays from the original purpose of fact-checking as a mechanism of quality control for news journalism, ensuring that all information any given medium publishes would be factual (Graves et al., 2016). Overall, fact-checking can be seen as a multi-step process that involves identifying a claim, tracing it back to its source, and comparing it with facts from reliable sources (Graves, 2018; 2016). In the first step, the facts are identified and traced to their original source, for example through the usage of databases or internet search engines. This allows the credibility of the source to be assessed and any manipulation of the facts and numbers to be ruled out. The second step involves checking the facts themselves. To do this, unbiased and reliable sources should be consulted. However, determining whether a source is independent and reliable can be challenging. Here, factors such as funding or previous jobs of the authors can be used to gauge their views on a topic. In cases where unbiased sources are not available, fact-checkers can triangulate the truth by using two partisan sources from the political spectrum, a more conservative and a more progressive source. This can help identify overlapping information and lead closer to the truth. Although machines can assist with tasks such as reverse image searches

to identify picture manipulation, fact-checking is a highly complex operation that can only really be completed by humans (Graves, 2018). As a result, an increasing number of professional fact-checkers and organizations, such as Snopes, FactCheck.org, and PolitiFact have developed in recent years to grade statements, primarily using truth scales or labels. For instance, over thirty independent fact-checking organizations have appeared all across Europe (Graves & Cherubini, 2018), which shows the increasing importance of their work.

Unfortunately, due to the immense effort required to properly conduct it, fact-checking suffers from not being scalable (Pennycook & Rand, 2021). This leads to a significant amount of fake news that does not get checked at all. In addition, warnings tend to be reserved for obviously false news and not for news coverage that is highly misleading or biased, but still based on actual events. Another issue arises in form of the "implied truth effect" (Pennycook et al., 2020) which states that news stories without any warning can be perceived as trustworthy and true, despite not being fact-checked at all. Moreover, given how quickly material is shared online, fact-checking might not be able to keep up and might miss people who have already ingested erroneous information (Pennycook & Rand, 2021). Finally, fact-checks oftentimes do not reach their intended target audience that would need them the most (Guess et al., 2020a). On a more positive note, the long-debated backfire effect, which states that corrections might lead to a person increasing their beliefs in fake news could not be found in recent research (Lewandowsky et al, 2020; Swire-Thompson et al., 2020). However, while fact-checking is an important tool in the overall kit of dealing with false information, it is rarely sufficient on an individual level when one intends to evaluate the credibility of a given piece of dubious news.

Given the time investment, that professional fact-checking requires, researchers have come up with faster ways to evaluate the credibility of a piece of information. For instance,

Caulfield (2019) provides a quick, four-step approach in the form of the SIFT model: stop reading the article, investigate the source, find better coverage, and trace information to the original context. A more in-depth approach is provided by Sam Wineburg and Sarah McGrew (2019) who evaluated the strategies professional fact-checkers utilize when they deal with dubious information. This method, dubbed *lateral reading,* builds upon fact-checking and aims to be a more context-independent strategy. It involves leaving a questionable website and consulting other digital sources to verify information. This approach differs from the common vertical reading, where individuals solely focus on the contents of a piece of news. A clear advantage of lateral reading is its independency of topic knowledge. One does not need to be an expert in infectious diseases to invalidate a false claim about a pandemic. Instead, efficient and concise research, e.g., through lateral reading, into trusted sources can be enough to give a justified suspicion a dubious website may not be trustworthy. In the long run, if lateral reading is conducted subsequently with various different fake news websites, an individual may build up enough agent knowledge to be able to dismiss claims from these sites right away. Focusing on source trustworthiness, which is at the core of lateral reading, is also one of the primary ways in which the key principles of the PKM can be used to refute misinformation. By improving agent knowledge through the continuous evaluation of different dubious sources, individuals can become more resilient towards future persuasion attempts. Research on the efficacy of lateral reading is also promising with several studies (e.g., Brodsky et al., 2021; Breakstone et al., 2021; Wineburg et al., 2022) showing positive results in different educational contexts. However, lateral reading is not a completely flawless strategy either. The method may be perfectly utilized by professional fact-checkers who have acquired a significant amount of agent knowledge by evaluating many untrustworthy sources over the course of their careers, an ordinary news

consumer however may lack the "footing" to gain significant benefits and could end up frustrated due to the still significant time investment.

Inoculation

Given that truth-evaluation techniques come with some severe downsides, some researchers have proposed a completely different strategy of protecting people from fake news. Akin to the immunity a human body can build against viruses after vaccination, the *inoculation* approach states that people can build an intuitive cognitive immunity against deception strategies (McGuire, 1964; McGuire & Papageorgis, 1961). This is accomplished by exposing individuals to a weaker version of the deceptive threat, such as fake news, in a secure environment, allowing them to build resistance against more powerful attacks. This process requires two essential components: a warning of an imminent threat and support to deal with the threat. The warning serves as a clear signal to exercise caution, while the support component involves providing resources and strategies to resist the persuasion attempt. In terms of the PKM, an effective inoculation would constitute an increase in persuasion knowledge, given that the inoculated individual gains an insight into persuasive strategies used by potential persuasion agents, such as fake news disseminators. In the context of fake news this means rather than debunking articles after they have been released, pre-bunking (Cook et al., 2017; Motta et al., 2021) through the use of inoculation can be employed to expose the strategies and tactics (Roozenbeek & van der Linden, 2019), used by fake news disseminators, such as framing, as well as to teach individuals how to identify flaws in their persuasion attempts (Cook et al., 2017). In future persuasion episodes they will then be better equipped to identify and reject the full-strength version of the false information.

The inoculation approach has been effectively implemented in various contexts, such as conspiracy theories (Banas & Miller, 2013), climate change (van der Linden et al., 2017), and genetically modified organisms (Wood, 2007). Inoculation theory has also been found to be an effective intervention against fake news in several studies, with individuals who have been inoculated against false information being better able to identify and reject it (e.g., Compton et al., 2021; Roozenbeek et al., 2022; Traberg et al., 2022; van der Linden & Roozenbeek, 2020).

However, it is important to note that while the inoculation approach is promising there are limitations to its effectiveness. For instance, the impact of inoculation appears to diminish significantly over time, necessitating regular renewal (Maertens et al., 2021). Pennycook and Rand (2021) bring up an additional downside of inoculation-based interventions in the willingness of individuals to participate in such interventions, which those who might need them the most often lack. Another and arguably even more problematic issue comes with a general and indiscriminate skepticism against all kinds of news that inoculation can induce (Clayton et al., 2020; Modirrousta-Galian & Seabrooke, 2023). For instance, in a re-analysis of the game "GoViral!" Basol and colleagues (2021) found that the game increased participants capability to accurately identify fake news while also decreasing their ability to spot true information. This could be due to participants of such interventions overestimating the presence of false or misleading information in their own media environment (Hameleers, 2022). Another constraint of the inoculation theory is its assumption that people are exposed to misinformation only once and that the counterarguments are presented before the misinformation. But in the context of fake news, people may be exposed to the same misinformation multiple times and from different sources, strengthening the illusory truth effect, hence, the inoculation may lose its effectiveness over time.

Media Literacy Education

Finally, resilience against fake news may be built through media literacy education (Corser et al., 2022; Dame Adjin-Tettey, 2022; Guess et al., 2020b). Arguably, both truth evaluation techniques (e.g., Wineburg et al., 2022) and inoculation-based interventions (e.g., Cook et al., 2017) can fall under this spectrum as well, however they are oftentimes not conducted in a formal educational setting, but through web-based applications or games. Educational programs designed to teach people media or information literacy skills often concentrate on enabling them to recognize the source of information (Wineburg et al., 2022), how to assess the reliability of sources (McGrew, 2020), and how to recognize common strategies used to propagate misinformation and fake news, such as Study 2. Media literacy education is seen as a necessary contribution to decrease the dissemination of misleading information by giving people the knowledge and abilities to spot misinformation and fake news (Friesem, 2019). For instance, through teaching students about different strategies fake news disseminators may utilize against them, such as in the "Bad News" game (Roozenbeek & van der Linden, 2019) persuasion knowledge in the sense of the PKM can be increased and utilized to combat misinformation. While researchers mostly agree on the importance of media literacy education, the supply of properly evaluated material ready to use for the curriculum is still quite rare. Some educators provide free-to-use and guided course material, such as the "Civic Online Reasoning" curriculum by the Stanford History Education group (2023). Similarly, the University of Washington offers a "Media Literacy Institute" (2022) for educators to gain media literacy skills and learn how to teach them to their students. The program is designed to support the teaching of all subjects by using media literacy as an engaging way to teach critical thinking and discernment skills. These programs, however, require teachers to specifically look for and

take the extra effort of implementing such courses into their regular teaching schedule. Furthermore, most teachers are no experts in regards to media literacy themselves and need a proper introduction before being able to convey it (Journell, 2019). To summarize, all approaches that aim to reduce the impact of fake news come with limitations and chances. Thus, a combined approach seems to be the optimal course (Hameleers, 2022; Clayton et al., 2020).

The present research

It is obvious that fake news poses a multifaceted problem with different possible avenues of approaching it. While individual cognitive factors, such as biases, are hard to circumvent, they may be mitigated by fostering analytical thinking and proper evaluation of a media landscape that is oftentimes riddled with persuasive messaging. This can be done by teaching truth-evaluation strategies such as fact-checking or through fostering media and information literacies which enable internet users to critically engage with persuasive content. Information literate individuals would ideally possess a significant amount of persuasion and agent knowledge, in order to recognize when to be suspicious of a given piece of information.

Although framing has been extensively studied as a persuasive strategy in communication research, research on how it is employed in misleading and completely false news is still scarce. Thus, Study 1 of this thesis aims to provide a deeper understanding of the fake news ecosystem by providing an analysis of several framing strategies and user reactions that were identified on a common fake news platform. Study 2, on the other hand, features a possible educational response to framing in the form of an undergraduate problem-based course on the persuasive strategy of framing. In conjunction, this thesis and the two studies aim to complement existing misinformation research with the introduction of framing and a way to approach this issue while outlining an agenda for future research.

Study 1

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Dialog in the echo chamber: Fake news framing predicts emotion, argumentation and dialogic social knowledge building in subsequent online discussions☆,☆☆,☆☆☆

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ABSTRACT

Disinformation currently floods the Internet worldwide and likely affects social knowledge building in online communities. Strategic framing in the form of emotional, value, and semantic framing is a common tool fake news producers use to more efficiently disseminate their content, yet these strategies have not been sufficiently examined, even less in relationship with the online dialog initiated by misinformation. In this exploratory study we aim to investigate the most relevant types of strategic framing and their role as predictors of news consumers' emotions, argumentation, and social knowledge building in the online dialog on a German alternative news site. Employing both manual and automated content analysis, we found significant relationships between framing in posted news articles and the subsequent online dialog. News framing predicted negative emotions in the online discussions and interfered with argumentation and social knowledge building. Conclusions pertain to digital information literacy interventions and further research on news framing.

1. Introduction

Fake news and misinformation pose a pervasive threat to the modern society as it undermines democracies and communication systems (McKay & Tenove, 2021). Fake news was defined as "fabricated information that mimics news media content in form but not in organizational process or intent" (Lazer et al., 2018, p. 1094) meaning that fake news production does not include journalistic quality management, in particular verification practices such as fact checking and the explicit differentiation between facts and authors' opinions (Tandoc, Thomas, & Bishop, 2021). As such, fake news falls under the broader umbrella of disinformation with the added feature of trying to imitate real news media. Disinformation can in turn be seen as a subtype of misinformation, i.e., faulty information such as inaccurate news media content, however with the added explicit intention to deceive recipients (Hameleers et al., 2021).

The Covid-19 pandemic brought with itself an accompanying "infodemic" of false and misleading information which impedes public efforts to combat health risks (Hua & Shaw, 2020). Researchers (e.g., Lewandowsky, Smillie, et al., 2020; Osborne et al., 2022; Pennycook & Rand, 2021) largely agree that susceptibility to fake news is a matter of information literacy. Hence, one of the general research questions in this field of increasing significance for society is: How can Internet users' information literacy be improved? Inoculation, i.e., providing a mental vaccine against disinformation through exemplary pieces of fake news and its strategies in a controlled and safe environment (Lewandowsky &

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Van Der Linden, 2021) is a prominent approach to information literacy interventions and provides news consumers with an insight into fake news authors' strategies and methods for misleading news recipients. One of these methods is strategic framing (Dan et al., 2020; Oswald, 2019), a powerful persuasion tool when used in news articles (Wasike, 2017). Strategic frames, as used by media organizations, politicians, or activists can be actively constructed to persuade news consumers (Druckman, 2011). In this sense, framing serves as a tool for influencing recipients' understanding of a given piece of information, which may be an act of collaborative meaning making or, in some contexts, a manipulation. Altogether, framing can convey disinformation. To properly design inoculation interventions, the nature of misinformation, i.e., its preferred uses of language such as stylistic devices need to be explored. This may be achieved through analysis of frames that can commonly be found in such content. In a further step, recipients can then be made aware of said strategies, for example in information literacy training.

Fake news and common misconceptions associated with it are frequently disseminated in social networks (Vosoughi et al., 2018). News framing amplifies this phenomenon by arresting attention, activating emotions and attitudes (Amsalem & Zoizner, 2022). This can foster a specific (biased) understanding of the news, and thus probably influences the way how the news is discussed. As online discussions hold a strong knowledge construction potential (Lai, 2015; Trausan-Matu et al., 2021; Wise & Chiu, 2011), discussing misinformation (while believing it is true) may create or foster long lasting misconceptions (Smith et al., 1994). The usage of specific strategic frames (e.g., Dan et al., 2020; Oswald, 2019) in a news article and confirmative chatter, such as in an echo chamber environment (Villa et al., 2021; Wang et al., 2022) in the comments might work together to distract audiences from the low argumentative quality of what is being said, and might thus encourage peripheral processing of dubious information. So far, there has been insufficient research on the connection between fake news framing and the quality of subsequent online discussions. Addressing this research gap, the following study is aimed at exploring the role of different types of strategic framing used in fake news articles as predictors for emotions, argumentation, and knowledge construction in the online discussions initiated by fake news content.

The remainder of this paper includes a theoretical framework explaining the key concepts of fake news, framing, and dialogism and establishing hypotheses, a description of the research methods and results, and a discussion of findings from which we draw theoretical and practical consequences focused on information literacy and how it can be trained.

2. Theoretical framework

2.1. Framing

Entman (1993, p. 52) defined framing as "select [ing] some aspects of a perceived reality and mak [ing] them more salient in a communicating text". Strategic frames specifically can be used to persuade news recipients of any given opinion or fact a medium may try to convey (Druckman, 2011) – be it accurate and based in objective reality, or false and misleading trying to push a specific agenda, such as perceived voter fraud.

There are many classifications of strategic framing (e.g., Dan et al., 2020; Oswald, 2019), not all of them relevant for disinformation. In first place, *emotional framing*, i.e., activating emotions in context, can attract recipients' attention by exploiting the negativity bias (Park, 2015). Moreover, it can elicit emotional responses (Amsalem & Zoizner, 2022), opinions (Lecheler et al., 2015), and even specific behavior (Kühne & Schemer, 2015). Outrage frames, for instance, can build a bridge between value and emotional framing by explicitly pointing out a violation of values through which a strong emotional reaction is then triggered (Oswald, 2019). When fake news disseminators make use of this strategy, they write about a given topic in such a way that recipients perceive it as offensive to themselves, e.g., immigrants stealing their jobs.

Value framing implicitly or explicitly includes norms and values important to the target audience (Andrews et al., 2017; Doherty & Stancliffe, 2017), For instance, news producers may appeal to recipients' sense of freedom by framing gun control or speed limit policies as significant cuts to their personal freedom. Such value frames can strengthen message credibility (Druckman & Lupia, 2016), which in turn is essential for effective disinformation. Value frames are oftentimes based on abstract constructs such as freedom, and thus strongly linked to symbolic language (Brewer, 2002; Wolf & Van Dooren, 2017), a subtype of semantic framing.

Semantic framing is used to activate specific associations and connotations regarding a certain topic (Burgers et al., 2016). It can be facilitated for example through target group-specific terms, which are often neologisms, i.e., lexical inventions (e.g., "Crooked Hillary" or the German "Lügenpresse" which roughly translates to "lying press"). Semantic framing is more effective on recipients who do not actively engage with politics or ideologies (Benjamin et al., 2017), which is particularly problematic as this target audience may be vulnerable due to a lack of prior political knowledge.

According to a meta-analysis by Amsalem and Zoizner (2022), framing has strong effects at emotional and attitudinal level. Therefore, we expect emotional and value framing to be the most frequent types of framing used in fake news media content. Nevertheless, as framing is a cognitive phenomenon related to semantic memory (Jones et al., 2015), we also expect semantic framing to be substantially represented in the corpus of analysis.

2.2. Emotions in fake news and subsequent discussions

Emotions not only influence recipients' behavior after consuming emotionally framed content (Amsalem & Zoizner, 2022; Horner et al., 2021; Valenzuela et al., 2017), they also play a significant part in recipients' ability to accurately recognize fake news (Martel et al., 2020). This is to say, recipients who can be triggered to react emotionally to a piece of content will also more likely believe it to be true, which may be due to intuitive information processing (Schwarz & Jalbert, 2020). Emotions contain a unique core relational theme, i.e., an "essential eliciting factor of each emotion" (Nabi, 2003, p. 227). For anger, this would be a perceived offense to oneself (Lazarus, 1991). This core relational theme in turn leads to an action tendency, which is again unique to each emotion. An action tendency is the likely behavioral response inspired by the emotion (Lazarus, 1991). Anger's action tendency, for example, is to attack (physically or verbally) the agent responsible for the offense (Lazarus, 1991). With fake news often featuring negative emotional language (Zollo et al., 2015), a specific consequence of emotionally framed content can be predominantly negative discussions in response to the original content. Due to framing effects (Amsalem & Zoizner, 2022), negative emotions would be much more prevalent than positive emotions in online discussions initiated by fake news.

2.3. Analytic information processing in fake news and subsequent discussions

The nature of information processing and how persuasion attempts may exploit it has been investigated in various ways. Prominent models include the elaboration-likelihood model (Petty & Cacioppo, 1986) and the heuristic systematic model (Chaiken & Ledgerwood, 2011). A common denominator amongst these are the two distinct information processing pathways: one intuitive and based on heuristics, the other analytical. Akin to persuasive information, online news can be similarly processed: intuitively through "gut instinct" (Schwarz & Jalbert, 2020) or analytically by applying verification practices. When trying to persuade potential readers of their disinformation, fake news disseminators would thus most likely aim to promote intuitive processing

(Schwarz & Jalbert, 2020) via the peripheral route (Petty & Cacioppo, 1986). Pennycook and Rand (2021) corroborate this in recent research suggesting that news recipients tend to rely on heuristic-based processing of (dis-)information, which impairs the news evaluation accuracy.

However, these models are limited to individual cognitive processes and do not take into account the social aspects. Another avenue of analytic information processing may be through argumentation in a social setting, such as online dialog. To construct a proper argument, one needs a somewhat solid grasp of the theme at hand in order to draw conclusions from facts by providing an explanation of the link between the facts and the conclusions. As established by Toulmin (1958), the main argumentation elements are the conclusion (claim), the facts (datum), and the logical link or justification (warrant). In contrast to the intuitive approach, the occurrence of all three elements could indicate an analytical way of interacting with news content. Moreover, social cues such as likes or comments can further influence credibility judgments of news content (Haim et al., 2018). Thus, persuasion attempts regarding fake news content may not only occur in the original news article, but also in the online dialog occurring in the comment sections under those articles, where the development or propagation of faulty knowledge can be promoted, as well. Whereas argumentation in online environments has been intensively studied (e.g., Clark & Sampson, 2008; Krauthoff et al., 2016), the online dialog initiated by disinformation is insufficiently explored and will be investigated in this study.

2.4. Dialogic knowledge construction in fake news and subsequent discussions

Given that persuasion is an attempt to influence knowledge building, sometimes in a skewed manner promoting misconceptions, and that argumentation may mediate the process, the social interaction prompted by disinformation appears to be central. Dialogism (Trausan-Matu et al., 2021) may be an effective lens to examine online social interaction. The dialogism considers that any language-based act is multivocal, involving several voices that interanimate toward knowledge construction. Voices are seen in a generalized way as ideas or positions that influence the other voices. Interanimation occurs generated by convergences and divergences among voices, similarly to centrifugal and centripetal forces (Bakhtin, 1981; Trausan-Matu et al., 2021). Participants in a collaborating group may generate more than a voice, sometimes in a ventriloquist act with the deliberate aim of others believing they were uttered by another participant (Trausan-Matu, 2016). From the dialogism perspective, fake news may be seen as voices using pragmatic (Austin, 1962; Watzlawick et al., 1967) and rhetorical (Jurafsky & Martin, 2009) means, including framing, in order to enhance their influence on the dialog and subsequent knowledge construction.

Interanimation includes moments of convergence and divergence, voices carrying information can appear and disappear (Trausan-Matu et al., 2021), thus performing a knowledge construction activity corresponding to the constructivist perspective on learning. More details correspond to the cognitive perspective: New information contained, for instance, in online news (no matter if truthful or fake) are integrated into the contents of the long-term memory as new concepts. The cognitive integration implies creating logical connections between new and previous knowledge. Cognitive dissonance can be solved by adapting the new information to the previous memory contents (assimilation) or vice versa (accommodation). The easy way is to avoid conflicting information, which results in confirmation bias (Nickerson, 1998). In combination with social technology and filter bubbles (Pariser, 2016), people group together confirming each other's views, a phenomenon known as echo chamber (Lewandowsky, Smillie, et al., 2020; Villa et al., 2021; Wang et al., 2022). In terms of dialogism, echo chambers are associated with the lack of divergent voices, which can also result from the majority suppressing these after a moment of divergence (Flaxman et al., 2016).

2.5. Framing as a predictor of emotions, argumentation, and dialogic knowledge construction in online discussions initiated by fake news

As strongly framed news or political content appears to be a major persuasion instrument (Dan et al., 2020; Oswald, 2019), specific types of framing (i.e., emotional, value, and semantic) may trigger reactions to this content. More specifically, emotional and value framing are prime candidates to elicit emotional reactions in news recipients. These can become manifest in the online dialog accompanying disinformation, where recipients react to the original content piece and may engage in (flawed) dialogic knowledge construction and promote echo chambers (Villa et al., 2021).

Furthermore, news consumers emotionally primed by specific framing will likely rely more on intuition and heuristics (Schwarz & Jalbert, 2020) when evaluating news content. This, in turn, is prone to personal biases, leading to a skewed processing and interpretation of already false claims. In echo chamber environments, opinions are strongly convergent with participants agreeing with each another and reinforcing their preexisting – and sometimes false – beliefs. The dialogic knowledge construction in such a setting will likely feature low argumentative quality (e.g., Krauthoff et al., 2016) and mainly consist of confirmative chatter. In this sense, our research question asks:

To what extent does framing predict emotions, argumentation, and dialogic knowledge building in the online dialog initiated by articles posted on a fake news site?

3. Method

3.1. Research design

Corresponding to the explorative research questions stated above, this study was built upon a qualitative, descriptive observational research design (Rosenbaum, 2010) with manual and automated content analysis. The quantitative content analysis results were subsequently part of a correlative design.

3.1.1. Corpus of analysis

For the analysis, we investigated several dubious German websites listed in the fake news dataset "GermanFakeNC" (Vogel & Jiang, 2019) and ended up choosing a news site in blog format whose head author has been known to disseminate disinformation regarding the Covid-19 pandemic. A first screening of this site revealed right-wing populist content on political and social topics. Keeping in mind Hameleers et al.'s (2021) definition of disinformation, we agreed that the news contained inaccurate, unreliable, partisan information cultivating political cynicism and distrust, and attacking political opponents, mainly the current government. The target group of this site – as can also be seen in the discussion sections of the articles – consists mainly of recipients being highly critical of the health and safety measures to combat the pandemic, such as the German "Querdenker" movement. It is of note that we were unable to prove intentionality of fake news in our given corpus – one criterium of classifying disinformation (e.g., Chadwick & Stanyer, 2022) – so that the term misinformation will be used for the remainder of this study. Given the topic relevance, we focused on articles addressing the Covid-19 pandemic and the subsequent vaccination campaign, which were much debated in the German misinformation scene. From these, we chose a sample of 29 articles in German posted in March 2021 that prompted the most extensive online discussions, i.e., a total of 1468 comments posted by individuals using 197 different pseudonyms. The unit of analysis was – depending on the research focus – the articles themselves or the individual comments under those articles.

3.1.2. Manual content analysis

Basic content analysis (Drisko & Maschi, 2015; Weber, 1990) in the format of a frequency analysis (Mayring, 2004) was performed manually

to find occurrences of news framing in the posted articles, and expressions of emotion and argumentation in the subsequent online discussions.

We analyzed the news article contents to extract three categories of framing. The specific themes of the articles included scepsis towards the Covid-19 vaccines, privacy concerns regarding contact tracing, perceived excessiveness of measures against the virus, and racist assumptions about the virus' origins. As we could not find any specific and detailed category systems concerning (fake) news framing, we began by developing our own. We first based our category system on Oswald's (2019) strategic framing types of emotional, value, and semantic framing due to their expected importance in terms of fake news content. Building upon these rather broad categories, we then inductively added specific sub-categories (e.g., anger for emotional, honesty for value, and metaphor for semantic framing) by closely analyzing eight articles out of our entire corpus. During this first coding cycle, it turned that we need more sub-categories, such as anger framing. For instance, the outrage frame was added for cases in which recipients should also feel a sense of astonishment in addition to anger. Anger frames were coded when the content was meant to elicit a feeling of rage, for example by spinning a given topic as a personal offense to the reader. The compassion frame was coded when the content was supposed to make the recipient feel sorry in regard to a certain topic, e.g., children being vaccinated against their will. Honesty/dishonesty frames were coded in cases where the content alluded to a certain group, e.g., free journalists outside the mainstream media who voiced concerns regarding Covid-19 measures and should be trusted by the audience. Justice/injustice frames in turn were coded when the authors wrote about such groups being "suppressed" by the established media or political system, e.g., being excluded from official press events. Trust/distrust frames were coded in cases where public institutions, health professionals or politicians would be attacked for "hyperbolizing" the consequences of the pandemic and following some hidden agenda. A detailed overview of the codes and the corresponding categories which were subsequently used for the entire corpus can be seen in Table 1.

To investigate whether the proposed frames in the articles had the expected effect, we analyzed the comments initiated by the sampled articles concerning expressed emotions based on the following codes: anger, fear, other negative emotions, and positive emotions. We did not distinguish positive emotions in more detail due to the mostly negative nature of fake news and the small number of positive emotions expressed (Lewandowsky, Smillie, et al., 2020). We distinguished anger and fear, as both can be strong behavioral drivers for disseminating (false) information (e.g., Berger, 2011; Berger & Milkman, 2012; Erisen, 2020; Stieglitz & Dang-Xuan, 2013) and are thus particularly relevant in a high-risk environment such as a global pandemic. A detailed overview of the category system is provided in Table 2.

We analyzed the comments initiated by the sampled articles concerning argumentation elements (Toulmin, 1958). Hard facts (data), justifications (warrants) and conclusions (claims) were the codes we used to analyze the argumentation found in comments. Furthermore, we also distinguished between complete and incomplete argumentation sequences, whereas we only identified a complete sequence as such if all three elements were coded. Notably, we did not evaluate the argumentation validity. Table 3 shows an overview of the category system.

Each frame occurrence was counted individually, so that a single article could include multiple instances of, for example, anger framing. The frames as shown in Table 1 were coded only in the original articles, whereas all other codes (as seen in Tables 2 and 3) were coded in the comments. Specific examples from the material can be seen as anchor examples in Tables 1–3. The unit of analysis could be entire sentences, paragraphs, or partial sentences. Furthermore, a single unit of analysis could be coded multiple times with different codes such as outrage frame and rhetorical question together. We used consensual coding (Hill, 2012; Hill et al., 1997) where two of this paper's authors, one of which was not involved in the creation of the category system (e.g., Lacy

Table 1
Category system used to code instances of framing in articles.

Framing in article contents		
Emotional framing: Specific focus on the activation of emotions		
Frames	**Frame description**	**Anchor examples**
Anger	Emotionalized statements/ phrasing aiming to trigger a feeling of anger in the reader. Author's own (negative) emotions are openly shown	"This is weighing human lives against each other."
Compassion	Emotionalized statements/ phrasing aiming to trigger a feeling of compassion in the reader	"And the psychological damage to many students and parents is already very great."
Outrage	Emotionalized statements/ phrasing aiming to trigger outrage in the reader. Author's own emotions remain unclear	"Apparently Merkel considers the federal government an institution that can restrict basic rights for parts of the population (or the whole) at will and give them back as it pleases."
Value framing: Use of values important to the target group		
Honesty and dishonesty	The statement/phrasing is emphasizing the value of honesty or a lack thereof	"The chancellor has instructed her justice minister to lay the legal groundwork to stop air travel – whether to Mallorca or elsewhere – as soon as possible. Revenge for the blown Easter holiday?"
Justice and injustice	The statement/phrasing is emphasizing the value of justice or injustice	"Gone are the days when ministers, prime ministers or even chancellors (Brandt) were asked to face consequences for mistakes or took them on their own initiative."
Trust and distrust	The statement/phrasing is emphasizing the value of trust or some form of deception as the contrary pole	"This has been trained for many years: Bear humbly when you are taken much. Be grateful when you are given back some of it."
Semantic framing: Use of specific terms or stylistic devices intended to associate the statement with other communication contents or features		
Defamation/ slander/ disparagement	Statements about the side portrayed as "the opponent" that are intended to denigrate/defame them.	"Well, the wackos just don't die out!"
Group specific terms	Words or phrases commonly used in specific communities	"Do we remain a democracy, or does Corona become the long-sought tool, alongside climate change, to lead the way to socialist-style totalitarianism via a political religion."
Hyperbole	Strong exaggeration	"But that would only be possible if everyone is patient for a few more weeks, because (for what feels like the hundredth time) the hardest time is now ahead."
Irony	Statement obviously suggesting the opposite of the overt message	"The chancellor has never apologized publicly for anything, because she has done everything right so far."
Lettering	Typographical option within a text to mark/optically emphasize individual text parts by e.g., capitalization, bold marked, multiplied punctuation marks	**"ARE LIMITS TO CROWD SIZES RACIST?"**
Metaphor	Stylistic means to make the statement/image appear more extreme, describing a person or object by referring to something that is	"The Federal Republic of Germany is stumbling into a constitutional crisis."

(*continued on next page*)

Table 1 (*continued*)

Framing in article contents		
Emotional framing: Specific focus on the activation of emotions		
	considered to have similar characteristics	
Neologism	A new word or expression, or a new meaning for an existing word	"Vaccination Narrative"
Repetition	Words or word pairs are repeated to emphasize importance	"If it came to light that there were so many people in Germany who didn't understand German"
Rhetorical question	A bogus question aimed to emphasize a statement rather than to elicit an answer	"Is that how he makes fiscal policy, too?"

Table 2
Category system used to code emotions in comments.

Emotions in Comments		
Positive emotion	Literal expression of positive emotions, use of emotionally charged terms, emoticons, punctuation, emotionalized expression	"I'm looking forward to it."
Negative emotion: Literal expression of negative emotions, use of emotionally charged terms, emoticons, punctuation, emotionalized expression		
Anger	Negative emotion in the form of anger	"Back then, in our school class, people would have just said, what a dumbass!"
Fear	Negative emotion in the form of fear	"Image of total hysteria; now I'm starting to get scared (not because of Covid)."
Other negative emotion	Negative emotion in the form of e. g., sadness or disgust	"His statements on the legitimacy of the lockdown are also treasonous."

et al., 2015), categorized individual units of content; in case of disagreement, a third coauthor decided which individual code should be applied. Cohen's kappa of our initial coding agreement was slight to fair (0.05–0.25) (Landis & Koch, 1977). Following this initial disparity, we discussed the coding process in more detail and ended up with consensus (Cohen's Kappa = 1.0) after 2 more cycles of coding and discussion. The finalized categories for the coding process are provided in Tables 1–3.

3.1.3. Automated content analysis

In addition to the manual content analysis we used the opensource framework ReaderBench version 0.10.58 (https://readerbench.com; https://pypi.org/project/rbpy-rb/; Dascalu et al., 2015) to automatically assess social knowledge building in the online community dialog. ReaderBench builds upon dialogism (Bakhtin, 1981; Trausan-Matu et al., 2021) and the dialogistic, quantitative assessment of social knowledge building comprises measures of semantic similarities between voices that describe the dialog cohesion and are summarized in a so-called cohesion network analysis (CNA) graph. Here, each element in the conversation (the article itself, each comment, and all corresponding sentences) is a node and each similarity relationship between the nodes is an edge. For this study, the edges were computed pretraining word2vec embeddings on the German Wikipedia (Yamada et al., 2020; https://wikipedia2vec.github.io/wikipedia2vec/pretrained/). Analog to social network analysis (SNA; Borgatti et al., 2009), ReaderBench calculates various centrality indices of the discussion contributions.

In this study, we used each node's (i.e., comment's) CNA degree centrality as a first indicator of social knowledge building. Degree centrality is generally defined as the sum of edges connecting a node with others. More specifically, this sum synthesizes the "past" activity (i.e., comments and discussion) that leads to an individual comment (indegree centrality for previous nodes and outdegree for the current node)

Table 3
Category system used to identify argumentation elements in the comments.

Argumentation elements in the comments		
Hard fact (Datum)	Date/fact/knowledge from which conclusion can be drawn	"Our young people can then invest the time they have gained in procuring food and other necessary goods on their own. In doing so, they can certainly learn a lot from those who haven't lived here that long."
Justification/proof (warrant)	A justification, connecting the data and the claim/ explaining or justifying the connection	"Since there will always be new mutations, as with the flu, I would suggest doing away with schools altogether, as well as kindergartens and universities."
Conclusion (claim)	A conclusion drawn from the data, often stating an additional point, new knowledge or represents view on the topic the commentator wants to persuade others of	"This also helps Germans adapt more quickly and thoroughly to the level of the new citizens, so there is no longer a need to lament "social inequality.""
Complete argumentation sequence	Data, warrant, and claim coded in conjunction with each other	[Facts:] Schools were closed, nevertheless caseloads increased. The daycares were closed, nevertheless the case numbers increased. Home improvement stores were closed, yet caseloads increased. Restaurants were closed, nevertheless the case numbers increased. There is an assembly ban, masks are compulsory, movement radius is restricted, contact prohibited, and many others, it cannot be because of it, if still the case numbers rise. [Claim:] The public local and long-distance travel has not been stopped so far, maybe it's because of that. [Warrant:] It doesn't make sense to close the schools if the public transport is contaminated in such a way that EVERYONE who uses it must be infected. There has been nothing done so far, [Claim repeated:] you have to start there, then the number of infections decreases!

and the "future" activity that originates from a specific comment (outdegree centrality for future comments and indegree for the specific comment). Degree centrality was calculated for an entire discussion as mean value of the individual participant centrality. In order to keep this presentation as simple as possible, and as the study findings were roughly the same for all available CNA centrality indicators, in the following we only report the CNA outdegree centrality provided by ReaderBench. In echo chambers (Villa et al., 2021), per definition, participants repeat prefabricated information, so that we expected the indegree and outdegree indices to be approximately equal, in other words, the voices prior to a particular contribution to be more or less the same as the voices following it.

As a further indicator of social knowledge building, we assessed single comments using the CNA contribution scores that measure the degree to which individual comments add new information to the overarching discussion, i.e., how far a specific comment summarizes information and advances knowledge building. For this, a filtered

version of the CNA graph was constructed, which included only the semantic links with a value higher than the mean plus standard deviation of the semantic similarity values of the links between elements on the same level in the hierarchy. The contribution score was computed by applying the modified TextRank algorithm (Mihalcea & Tarau, 2004) on the filtered graph, which measures the probability of ending up in a given node in the graph, while performing a random walk with semantic similarities seen as transition probabilities between two nodes. Thus, contribution scores measure how well a single comment is connected to all other contributions (voices) in the conversation. The contribution scores are normalized per discussion, meaning that the sum of scores for the initial article and all follow-up comments equals 1; as such, given the length and importance of the initial posting, as well as the large number of comments, we expected the values for the contributions scores to be very small in their absolute value. In echo chambers (Villa et al., 2021), we expected one piece of information to be posed in the initial article, then all comments to equally feature scores close to the value one divided by the number of comments, with a small standard deviation.

CNA overcomes inherent limitations of the traditional SNA by considering semantic similarities between comments, rather than observing who is talking with whom (which is not always possible), and by including implicit, rather than only explicit interactions between participants. The CNA graph is a complex internal data representation used in ReaderBench for further calculations, rather than standard output with a clear meaning from a psychological perspective. In order to keep this contribution as simple as possible and within reasonable length limits, we refrain from providing a graphical representation of the CNA graph.

3.1.4. Statistical analyses

To address our research question, we conducted multiple regression analyses on the data gained from both content analyses. Depending on the analysis goal, the unit of analysis was either the entire discussion initiated by a posted article (when assessing CNA centrality in the discussion and testing for framing elements in the posted article as predictors) or the comment (when assessing emotions and argumentation within comments or contribution scores, and testing for framing elements in the posted article as predictors).

Due to the many framing categories and subcategories considered as predictors that we chose not to aggregate, we utilized a hierarchical regression analysis (Gelman & Hill, 2006). It started with emotional framing that we expected to be the strongest predictors of emotions, argumentation elements, and knowledge building in the comment section (Amsalem & Zoizner, 2022).

In the results of the automated content analysis, the contribution scores distribution outliers were removed; these were frequent zero values in the CNA graph generated by comments unrelated to the overall discussion. All results of the automated dialog analysis were transformed logarithmically, thus all variables displayed a nearly normal distribution with light left and right tails (as indicated by the Q-Q plots; Das & Imon, 2016), and the assumptions of the regression analysis were met. For all statistical calculations we used IBM SPSS Statistics version 28.

4. Results

4.1. Descriptive statistics

In total, we analyzed 29 different postings with an average of $M = 50.62$ comments each ($SD = 12.89$). At most, a maximum of 94 comments were written under a given post, with the minimum number being 30. Furthermore, 197 individual pseudonyms wrote on average $M = 7.25$ comments ($SD = 12.18$). Comments were not distributed equally in regards to their origin. For example, one pseudonym wrote 90 comments throughout the discussion sections, whereas many others only wrote a single one.

With this study, we first aimed to investigate the occurrence frequency of three types of strategic framing (emotional, value, and semantic). In the 29 analyzed postings, framing occurred 637 times, from which 384 times as semantic framing (78 group-specific terms, 71 times lettering, 67 metaphors, 60 times irony/sarcasm, 41 times hyperbole, 28 defamations, 19 neologisms, 13 rhetorical questions, 7 repetitions), 155 times as emotional framing (85 anger, 63 outrage, 7 call for compassion), and 98 times as value framing (65 trust, 19 honesty, 14 justice). On average we found $M = 22.00$ instances of framing per article ($SD = 13.44$). At most, a maximum of 48 instances of framing occurred in a singular article, with the minimum number being 3.

Additionally, we investigated emotional reactions towards the fake news content. Expressions of negative emotions were found in more than half of the comments (888 from 1468), among which anger (577 occurrences) and fear (85) were the most frequent. Other negative emotions made up the remaining 226 occurrences. Positive emotions on the other hand were much less frequent (11 occurrences from 1468).

Furthermore, we investigated argumentation in the online dialog under the fake news articles. Elements of argumentation were relatively frequent, such that we found 1465 data, 712 warrants, and 959 claims. However, we found only 148 complete argumentation structures in total.

Adding to the analysis of argumentation structure, we also aimed to assess social knowledge building in the online dialog initiated by fake news content. While the analyzed news postings initiated on average $M = 50.6$ comments per posting ($SD = 12.9$) from $M = 27.1$ ($SD = 7.7$) participants, the CNA indegree was $M = 1.87$ ($SD = 3.86$), the CNA outdegree $M = 1.64$ ($SD = 3,73$), and the contribution scores had $M = 0.0167$ ($SD = 0.0134$). Regarding article framing as a predictor of emotions, argumentation sequences, and social knowledge building, we present the main results in Table 4.

4.2. Article framing as a predictor of emotions in the comments

Finally, we examined the relationship between framing and the aforementioned variables. We first correlated all types of framing with one another to test for multicollinearity; the highest correlation was outrage-anger framing with $\beta = .47$ (<0.70), excluding the multicollinearity hypothesis. Further on, we found that emotional framing, especially anger, significantly predicted negative emotions, in particular anger, expressed in the subsequent online dialog (for details, see Table 5). Emotional framing alone explained a moderate amount of variance (adj. $R^2 = 0.30$) when predicting negative emotions in comments as well as anger specifically (adj. $R^2 = 0.34$). After including both value and semantic framing into this hierarchical regression, emotional framing (anger, $\beta = 0.53$, $p < .050$) positively predicted negative emotions. Furthermore, anger in the comments specifically was positively predicted by emotional framing (anger, $\beta = 0.51$, $p < .050$) and semantic framing (lettering, $\beta = 0.56$, $p < .050$). However, semantic framing in the form of defamation also negatively predicted anger in the comments ($\beta = -0.49$, $p < .050$). In terms of negative emotions in total, the regression was significant when including only emotional and value framing ($F(29, 6) = 1.81$, $p < .050$) and explained a moderate amount of variance (adj. $R^2 = 0.29$). For anger specifically the regression was significant when including all three types of framing ($F(29, 15) = 2.64$, $p < .050$) and explained a large amount of variance (adj. $R^2 = 0.46$).

4.3. Article framing as a predictor of argumentation elements in the comments

Framing also significantly predicted argumentation elements in the comments (for details, see Table 5). Emotional framing alone explained a moderate amount of variance in the frequency of warrants (adj. $R^2 = 0.36$), such that anger negatively predicted the frequency of warrants in comments ($\beta = -0.49$, $p < .010$). This regression was significant ($F(29, 3) = 6.14$, $p < .010$). Furthermore, the frequency of claims in the

Table 4
Findings overview.

Criterion variables: Comment features		Predictors: Strategic framing in posted articles	Regression coefficients
Negative emotions	Anger (in comments) F (29, 15) = 2.64, p < .050, adj. R^2 = .46	Emotional framing	Anger (in posted articles) β = .51, p < .050
		Semantic framing	Defamation, β = −.49, p < .050
			Lettering β = .56, p < .050
Argumentation	Warrants F (29, 3) = 6.14, p < .010, adj. R^2 = .36	Emotional framing	Anger β = −.49, p < .010
	Claims F (29, 15) = 5.06, p < .010	Semantic framing	Defamation β = −.60, p < .010
	Complete argumentation sequences F (29, 3) = 6.00, p < .010, adj. R^2 = .35	Emotional framing	Anger β = −.54, p < .010
Social knowledge building	Outdegree centrality F (345, 15) = 5.43, p < .001, adj. R^2 = .16	Emotional framing	Outrage β = −.21, p < .001
			Compassion β = .52, p < .001
		Semantic framing	Group-specific terms β = −2.01, p < .050
			Irony β = 2.25, p < .050
		Value framing	Honesty β = −.29, p < .001
			Trust β = −.22, p < .010
			Justice β = .30, p < .001
	Contribution scores (incomplete argumentation sequences) F (1320, 15) = 6.80, p < .001, adj. R^2 = .06	Semantic framing	Neologisms β = −.13, p < .010
			Metaphors β = −.10, p < .050
			Lettering β = .20, p < .001
	Contribution scores (complete argumentation sequences) F (148, 15) = 3,36, p < .001, adj. R^2 = .19	Semantic framing	Hyperbole β = −.56, p < .050
			Group-specific-terms β = −.45, p < .050
			Rhetorical questions β = −.41, p < .050
			Irony β = .70, p < .010

comments was negatively predicted by semantic framing (defamation, β = −0.60, p < .010). This regression was significant as well (F (29, 15) = 5.06, p < .010) and explained a large amount of variance (adj. R^2 = 0.70). It is also noteworthy that, when including only emotional and value framing in the model, trust frames strongly predicted the number of claims (β = 0.51, p < .010). However, this was not the case in the complete model with all types of framing included. In regard to the amount of complete argumentation sequences, emotional framing was a strong predictor while value and semantic framing did not play a major role (see Table 6 for details). Anger frames (β = −0.54, p < .010) negatively predicted the amount of complete argumentation sequences significantly (F (29, 3) = 6,00, p < .010) and explained a moderate amount of variance (adj. R^2 = 0.35). Interestingly, the occurrence frequency of data in the comments were not significantly predicted by either type of framing at all.

Table 5
Framing as a predictor of negative emotions in general and anger specifically in comments (N = 1468).

	Negative emotions in total			Anger		
Variables	β	β	β	β	β	β
Emotional framing						
Anger	.372^{+}	.527*	.873^{+}	.427*	.511*	.706^{+}
Compassion	−.101	−.009	.063	−.004	.091	.151
Outrage	.344^{+}	.353	.348	.326	.331	.331
Value framing						
Honesty		−.172	−.300		−.265	−.108
Justice		.111	−.171		−.013	−.318
Trust		−.220	−.575		−.021	−.596
Semantic framing						
Defamation			−.117			−.485*
Group-specific terms			−.492			−.203
Hyperbole			.010			−.028
Irony			−.110			.084
Lettering			.456^{+}			.560*
Metaphors			.121			.153
Neologisms			−.125			−.138
Repetitions			.223			.130
Rhetorical questions			.537^{+}			.465
Regression statistics						
df	3	6	15	3	6	15
F	5.020	2.923	1.805	5.757	3.221	2.604
p	.007	.030	.146	.004	.020	.045
Adj. R^2	.301	.292	.301	.338	.322	.462

Note: ***p < .001; **p < .010; *p < .050; ^{+}p < .100.

4.4. Article framing as a predictor of social knowledge building in the comments

Regarding social knowledge construction, news framing significantly predicted outdegree centrality of the subsequent comments (see Table 7 for details). The hierarchical regression yielded stronger results, the more elements of framing we added. Emotional framing alone only explained a miniscule amount of variance when predicting outdegree centrality (adj. R^2 = 0.01). After adding value and semantic framing to the model, this regression explained a small to moderate amount of variance adj. (R^2 = 0.16). As for specific predictors, value framing was somewhat ambivalent, as honesty (β = −0.29, p < .001) and trust frames (β = −0.22, p < .010) negatively predicted outdegree centrality while justice frames positively predicted the same (β = 0.30, p < .001). Semantic framing similarly predicted degree centrality both positively (irony, β = 2.25, p < .050) and negatively (group-specific terms β = −2.01, p < .050). This regression was significant (F (345, 15) = 5.43, p < .001). Interestingly, emotional framing became a significant predictor in the complete model with outrage frames negatively predicting outdegree centrality (β = −0.21, p < .001) and compassion frames positively predicting the same (β = 0.52, p < .001).

We further distinguished between complete and incomplete argumentation sequences to investigate whether differences in the social knowledge building may appear (see Table 8, left column). For the 1320 comments with incomplete argumentation the complete regression model with all three types of framing included explained the most amount of variance (adj. R^2 = 0.22). Emotional (compassion, β = 0.53, p < .001), value (justice, β = 0.35, p < .001) and semantic (irony, β = 0.53, p < .050; defamation, β = 0.26, p < .050) framing strongly predicted the outdegree centrality in those comments with incomplete argumentation structures. This regression was significant, as well (F (1320, 15) = 6.32, p < .001). As for the 148 comments with complete argumentation sequences, we found somewhat different results (see Table 8, right column). Here, emotional framing (outrage, β = −4.14, p < .050) negatively predicted outdegree centrality, whereas value (justice, β = 1.15, p < .010) and semantic framing (rhetorical questions, β = 1.04, p < .050; neologisms, β = 0.45 p < .050) were positive predictors. This regression model was significant (F (148, 15) = 2.00, p < .050) and explained a small to moderate amount of variance (adj. R^2 = 0.18).

Table 6
Framing as a predictor of argumentation elements in the comments (N = 1468).

	Data			Warrants			Claims			Complete argumentation sequence		
Variables	β	β	β	β	β	β	β	β	β	β	β	β
Emotional framing												
Anger	−.245	−.122	−.032	−.494**	−.491*	−.626	.374^{+}	.255	.413	−.537**	−.493*	−.250
Compassion	−.061	−.062	−.082	−.319	−.362^{+}	−.411^{+}	.100	.096	.110	−.284	−.278	−.198
Outrage	.035	−.050	−.415	−.180	−.202	−.229	.271	.184	.224	−.139	−.119	−.187
Value framing												
Honesty		−.075	−.577^{+}		.113	.146		−.301*	−.043		.066	.014
Justice		.287	.631*		.093	.316		−.118	−.238		.048	.254
Trust		−.100	.460		−.042	.312		.511**	.068		−.147	−.200
Semantic framing												
Defamation			.737*			.100			−.598**			−.142
Group-specific terms			.484			.568			.082			.106
Hyperbole			.079			−.124			.031			.112
Irony			−.853^{+}			−.345			.001			−.234
Lettering			−.429			−.324			.380*			−.286
Metaphors			−.049			−.130			.106			.230
Neologisms			.469^{+}			.323			−.074			.245
Repetitions			−.332			−.314			−.031			.107
Rhetorical questions			.245			−.233			.146			−.083
Regression statistics												
df	3	6	15	3	6	15	3	6	15	3	6	15
F	.456	.574	1.554	6.137	2.974	1.906	3.724	6.174	5.061	5.969	2.909	1.630
p	.716	.747	.215	.003	.028	.125	.024	<.001	.003	.003	.030	.191
Adj. R^2	−.062	−.100	.229	.355	.297	.327	.226	.526	.685	.347	.290	.252

Note: ***$p < .001$; **$p < .010$; *$p < .050$; $^{+}p < .100$.

Table 7
Framing as a predictor of outdegree centrality of comments (N = 345).

Variables	β	β	β
Emotional framing			
Anger	−.071	.337***	.343
Compassion	.091	.318***	.517***
Outrage	.077	−.075	−.214***
Value framing			
Honesty		−.292***	−.392*
Justice		.297***	.308***
Trust		−.220**	−.102
Semantic framing			
Defamation			1.624
Group-specific terms			−2.014*
Hyperbole			−1.098
Irony			2.253*
Lettering			−.631
Metaphors			1.228
Neologisms			1.836^{+}
Repetitions			−.639
Rhetorical questions			−.387
Regression statistics			
df	3	6	15
F	2.479	9.702	5.425
p	<.061	<.001	<.001
Adj. R^2	.013	.136	.162

Note: ***$p < .001$; **$p < .010$; *$p < .050$; $^{+}p < .100$.

Results for indegree centrality were very small and the explained variance had only negligible practical significance.

Finally, we investigated how news framing would predict the contribution scores index in the subsequent comments. Again, we looked at complete and incomplete argumentation sequences separately (see Table 9). For the 1320 comments containing incomplete argumentation structures, we found framing to be only a weak predictor of the contribution scores. The complete model with all types of framing included explained only 6% of variance. Semantic framing was ambivalent with lettering being a positive predictor ($\beta = 0.20$, $p < .001$) and metaphors ($\beta = -0.10$, $p < .050$) and neologisms ($\beta = -0.13$, $p < .010$) being negative ones. This regression was significant (F (1320, 15) = 6.80, $p < .001$). On the other hand, for the 148 comments with complete argumentation sequences, value and semantic framing played a much larger role with respect to the contribution scores, albeit a quite ambivalent one yet again. Honesty frames ($\beta = 0.56$, $p < .010$) were a strong positive predictor, whereas justice frames ($\beta = -0.48$, $p < .010$) negatively predicted the contribution scores. Similarly, for semantic framing rhetorical questions ($\beta = -0.41$, $p < .050$), group-specific-terms ($\beta = -0.45$, $p < .050$) and hyperbole ($\beta = -0.56$, $p < .050$) were strong negative predictors whereas irony ($\beta = 0.70$, $p < .010$) positively

Table 8
Framing as a Predictor of Outdegree Centrality and Knowledge Building (N = 277 comments with incomplete and N = 68 comments with complete argumentation).

	CNA Outdegree (incomplete argumentation)			CNA Outdegree (complete argumentation)		
Variables	β	β	β	β	β	β
Emotional framing						
Anger	−.059	.390***	.162	.430*	.573*	.513
Compassion	.113^{+}	.363***	.532***	.081	.164	−.998
Outrage	.115^{+}	−.091	−.200^{+}	−.422*	−.337	−4.144*
Value framing						
Honesty		−.303***	−.288		−.238	.028
Justice		.385***	.345***		.124	1.153**
Trust		−.195**	.016		−.098	.498
Semantic framing						
Defamation			.256*			.603
Group-specific terms			−.231			1.670
Hyperbole			−.267^{+}			.387
Irony			.529*			.376
Lettering			−.092			−.557
Metaphors			−.012			.333
Neologisms			.152^{+}			.453*
Repetitions			−.175^{+}			.234
Rhetorical questions			−.097			1.041*
Regression statistics						
df	3	6	15	3	6	15
F	3.346	11.142	6.315	1.655	1.150	1.995
p	.020	<.001	<.001	.186	.345	.034
Adj. R^2	.025	.181	.224	.028	.013	.182

Note: ***$p < .001$; **$p < .010$; *$p < .050$; $^{+}p < .100$.

Table 9
Framing as a Predictor of Contribution Scores (N = 1314 comments with incomplete and N = 148 comments with complete argumentation).

	Contribution scores (incomplete argumentation)			Contribution scores (complete argumentation)		
Variables	β	β	β	β	β	β
Emotional framing						
Anger	.123***	.030	.028	.097	.114	−.144
Compassion	.092**	.020	−.033	−.066	−.080	.133
Outrage	−.027	−.028	−.028	.141	.025	.308
Value framing						
Honesty		.129***	.112*		.164	.561**
Justice		−.053^{+}	−.080^{+}		−.072	−.481**
Trust		.102**	.016		.097	.129
Semantic framing						
Defamation			−.004			−.024
Group-specific terms			−.009			−.449*
Hyperbole			.098^{+}			−.555*
Irony			−.015			.702**
Lettering			.203***			.202
Metaphors			−.095*			−.189^{+}
Neologisms			−.128**			−.163
Repetitions			−.010			.085
Rhetorical questions			.065			−.413*
Regression statistics						
df	3	6	15	3	6	15
F	7.473	8.875	6.793	2.615	2.288	3.359
p	<.001	<.001	<.001	.053	.039	<.001
Adj. R^2	.015	.035	.062	.032	.050	.194

Note: ***$p < .001$; **$p < .010$; *$p < .050$; $^{+}p < .100$.

predicted the contribution scores. The complete regression model was significant (F (148, 15) = 3,36, $p < .001$) and explained a small to moderate amount of variance (adj. $R^2 = 0.19$).

5. Discussion

In this study we aimed to explore the relationship between misinformation content framing (Oswald, 2019) and the subsequent online dialog in terms of emotions, argumentation, and social knowledge building (Trausan-Matu et al., 2021). Our manual and automated content analysis yielded the following results.

5.1. Types of framing

We began our study with an overview of the amount and variety of frames used in misinformation. We found semantic framing to be the most prevalent in our corpus of analysis. Interestingly, group-specific terms represented the most frequent frame type in this category, followed by distinct lettering, as semantic framing is often used as a tool to facilitate other types of framing (Oswald, 2019). Furthermore, emotional framing occurred more often than value framing, with anger, outrage, and trust frames being most common. This finding is in line with prior research that found fake news content to be preponderantly negative and emotional in nature (e.g., Zollo et al., 2015). In sum, our results suggest that some fake news disseminators in Germany actively utilize a wide range of framing techniques to skew discussions and likely to propagate misconceptions.

5.2. Emotions in online discussions

We also investigated the occurrence frequency of emotions in online discussions triggered by misinformation. We found that negative emotions, mainly anger, substantially outweighed positive ones. Given that (negative) emotions can affect consumers' perceptions of online news (Kümpel & Unkel, 2020) and their credibility assessment accuracy (Martel et al., 2020), and increase the news sharing in social networks (Duffy et al., 2020; Valenzuela et al., 2017), this finding, while not surprising, is concerning. Emotional news framing may promote the dissemination of false claims, and this effect may be mediated by consumers' emotional reactions in online discussions, thus creating a complicity between fake news producers and consumers.

5.3. Argumentation in online discussions

Our third research question addressed argumentation in online discussions as a form of potentially analytic (mis-)information processing. While single argumentation elements were very frequent, complete argumentation sequences occurred seldom, i.e., in roughly 10% of the comments. We mostly found single data and claims, i.e., "hard facts" and conclusions, whereas warrants, i.e., the supporting logical links between the two were rare. In line with prior studies (e.g., Krauthoff et al., 2016), argumentation in online news discussions oftentimes is incomplete, which in turn may impede the argumentation quality and rationality. At the same time, the quality of argumentation plays an important role in the evaluation of online sources trustworthiness (Marttunen et al., 2021). As comments are an important social cue for credibility evaluation (Haim et al., 2018), the low comment quality in terms of argumentation could also further influence news consumers skewed judgment of online sources and foster misconceptions.

5.4. Knowledge building in online discussions

Our fourth research question aimed at an insight in discussion participants' engagement in social knowledge building. We utilized two indicators provided by the automated content analysis. Degree centrality measures similarities between comments along the discussion, such that outdegree quantifies similarities to prior, and indegree to following comments. In the analyzed corpus, in- and outdegree centrality were very close to each other and contribution scores were very low. This suggests a dialog environment dominated by a single voice, initially represented a possible echo chamber (Villa et al., 2021), which is in line with previous literature (Cinelli et al., 2021; Flaxman et al., 2016).

5.5. Framing as predictor of emotions, argumentation, and knowledge building

Our fifth and final research question addressed news framing as a predictor of emotions, argumentation, and knowledge building in subsequent online discussions. Unsurprisingly, emotional and semantic framing in the posted articles predicted negative emotions in the comments. This provides further evidence for the relationship between framing and news consumers' emotional state (Amsalem & Zoizner, 2022). More specifically, anger frames and distinct lettering were strong positive predictors of negative emotions, especially anger, in the discussions. In other words, the frames successfully fulfilled their purpose.

Further on, distinct lettering appeared as a strong framing method. In combination with brief and simple main text, distinct lettering of news headlines is a well-known mass communication feature aimed at arresting readers' attention (Horne & Adali, 2017). In learning environments, signaling research also showed that simple visual cues can help draw attention towards relevant information, therefore they were used for scaffolding (Schneider et al., 2018). Misinformation producers seem to apply the same principle as semantic framing.

Unexpectedly, defamation frames negatively predicted anger in the comments. This may be due to the very homogenous opinion-scape of the comment sections, where a well-established group communicates using its own in-group language, already filled with defamations and group-specific terms, e.g., "Crooked Hillary" (Fong et al., 2021). Positive emotions hardly ever occurred, so that it made little sense to assess the prediction in that regard.

Framing elements also predicted argumentation in the discussions, such that defamation and justice frames positively predicted the occurrence of data in the discussions. However, it is noteworthy that we found an abundance of argumentation data in general (1465 data in 1468 comments), making an accurate explanation of this result substantially difficult. Furthermore, trust frames and distinct lettering positively predicted claims, while defamation and honesty frames negatively predicted the same. This could imply that frames of "big scandals" through particular lettering and a notion of distrust in established figures or governments encourage recipients to draw conclusions of their own and express those more openly.

Complete argumentation structures were seldom. However, emotional framing in the form of anger frames negatively predicted complete argumentation structures and the occurrence of warrants. Given that warrants can be seen as the logical bridge between a hard fact and a conclusion (Toulmin, 1958), the presence of warrants may indicate an in-depth understanding of a phenomenon. This could in turn imply that anger frames – if successful – may impede recipients' argument construction. The large number of incomplete argumentation structures may also suggest a generally more superficial and intuitive information processing (Schwarz & Jalbert, 2020).

With respect to knowledge construction, we found all framing types to predict outdegree centrality; however, framing went both ways in this case. Semantic framing (irony and, to a smaller degree, neologisms), emotional framing (compassion), and value framing (justice) positively predicted outdegree. At the same time, group-specific terms, honesty and outrage frames negatively predicted the same. Given that outdegree centrality of a given comment is an indicator of its semantic similarity to the previous comments along the discussion, this may allude to an overarching echo chamber (Villa et al., 2021), where most to all comments are homogenously skewed into a particular direction. In all of this, the completeness of argumentation structures moderated the relationships between article framing and knowledge construction, such that in comments with complete argumentation structures the effects of emotional framing (outrage, compassion) and semantic framing (irony) were diminished while the effects of value framing (calls for justice) and semantic framing (rhetorical questions) were amplified. This may indicate that individuals who go through the process of creating a complete argumentation sequence are influenced more by frames that call for justice and put in the effort to back up their arguments properly. Notably, however, complete argumentation sequences were extremely rare in our corpus.

Furthermore, value and semantic framing in articles predicted knowledge construction (contribution scores) in discussions—especially in those where complete argumentation structures occurred. More specifically, irony and calls for honesty were positive predictors in these cases, which could be a sign that a handful of users were "in on the joke" and further explained their own ideas, whereas most news consumers were influenced by hyperbole and group-specific terms, which in turn reduced their contribution to the discussion.

Altogether, emotional news framing in our corpus was positively associated with (mainly negative) emotions and knowledge construction, and negatively associated with argumentation in subsequent discussions. This in line with prior research suggesting that framing is capable of eliciting strong emotional reactions in recipients (Amsalem & Zoizner, 2022). At the same time, our results imply that emotional framing can hinder proper argumentation in the sense of Toulmin (1958). Both value and semantic framing were ambivalent in that different types of frames proved to be either positive or negative predictors for emotions, argumentation structure and knowledge construction in the comments.

6. Implications for educational practice, publishers, and social media companies

The relationships we identified in this study may advance information literacy training approaches. In line with more general interventions against misinformation, the direction appears twofold. On the one hand, preventive measures such as inoculation attempt to foster information literacy and aim to combat fake news effects by making framing techniques visible to the news consumers (e.g., Basol et al., 2020; Lewandowsky & Van Der Linden, 2021; Roozenbeek & Van der Linden, 2019; Scheibenzuber et al., 2021). Our findings contribute to this class of applications by providing more detail on framing, so that the inoculation can focus on the strongest framing techniques.

On the other hand, a novel approach could be to infiltrate online discussions on fake news sites. Recent research found the dreaded backfire effect when trying to correct misinformation to not be as problematic as formerly thought (Lewandowsky, Cook, et al., 2020). Reframing or counter-framing interventions in the discussions (Benford, 1993; Stieglitz & Dang-Xuan, 2013) might be more effective. Additionally, legitimate news sites may need to participate in this effort as well, through content moderation or counter-framing of stories being published by disinformation distributors. In the light of our findings, it might also be effective to sprinkle accurate and complete argumentation structures, which contribute more to knowledge construction, in order to provide heterogenous opinions and break open the echo chamber. Combinations of reframing or counter-framing and simple argumentation could reduce the required effort, so that such interventions might be done by intelligent bots, rather than by humans (Rode et al., 2021).

On the side of social media companies, dubious websites that spread disinformation and fake news need to be consequently flagged and fact-checked to avoid sceptic users of falling into a disinformation rabbit-hole. Furthermore, recent studies (e.g., Pennycook et al., 2021) have shown accuracy prompts, i.e., regularly reminding users to think about the trustworthiness of a giving piece of information, can in fact reduce the susceptibility of falling for fake news. Such simple and easily scalable interventions combined with preventative measures such as inoculation trainings (e.g., Lewandowsky & Van Der Linden, 2021) may well be key in the ongoing battle against disinformation.

7. Limitations and consequences for research

The presented findings are not without limitations. First, although we found emotional framing to be a strong predictor of negative emotions in ensuing discussions, we cannot say for certain whether the utilized frames triggered this anger or the discussion participants were already angry in the first place and thus decided to consume content that would reflect their current emotional state and post a comment – in a way a form of mood management (Zillmann, 1988). To clarify this relationship, a controlled experimental setting with measurements in real-time is necessary.

Second, our corpus of analysis stems from a single alternative news site and included solely content referencing the Covid-19 pandemic. Although this site provides a wealth of typical right-wing misinformation content, any generalization of our results to other misinformation sites and framing methods must be done with particular care. Future research should aim to include not only a greater extent of such sites, but also a broader variety of topics, to investigate whether the categories we used for our study hold true for different subject areas, as well. To this end, machine learning algorithms could be trained on our corpus to analyze further online discussions.

Third, while we found ample evidence of framing correlated with the occurrence of different types of argumentation elements (data, warrants, claims), we did not check this argumentation for validity. Future research should also examine the quality of this argumentation. The substantial effort required for this might be limited by utilizing machine learning.

Fourth, while we did analyze the contents of the articles to compile our category system for the frames, we did not include the articles' specific topics as a variable of analysis. Given that all of them focused on the overarching theme of Covid-19, this may not be an issue;

nonetheless, the topic of each individual article may be a confounding variable that should be considered in future studies.

A fifth limitation concerns the authors of the analyzed comments. We cannot say whether the 197 nicknames we found were single persons or if some participants had written under more than one guise, which may interfere with the statistical analysis. Further dialog analysis, possibly based on natural language processing, might provide a clearer picture.

Sixth, a comparison with established media formats may be necessary to ensure that the instances of framing we identified are indicative of fake news content. While prior research has already focused on some of these facets (e.g., Horne & Adali, 2017), a broader analysis featuring several different sites – including both real and fake news platforms – would be required to make a more generalizable statement.

Finally, the suggestion that our object of research was an echo chamber was only based on the deduced meaning of automated content analysis indicators performed by ReaderBench (Dascalu et al., 2015, 2018). Whereas ReaderBench may provide an identification method at least comparable with previous approaches (Villa et al., 2021), additional research is needed to find commonalities between various definitions and establish an overarching understanding of the phenomenon.

In this study, we developed multiple category systems to analyze fake news content and subsequent discussions. Additionally, we conducted a first pilot analysis of 29 fake news articles and 1468 comments combining both manual and automated content analysis. While we only focused on a single website, this work provides the groundwork for future studies aiming to investigate similar sites.

Credit author statement

Christian Scheibenzuber: Conceptualization, Writing- Original draft preparation, Methodology, Visualization, Writing - Reviewing & Editing. Laurentiu-Marian Neagu: Data curation, Methodology. Stefan Ruseti: Data curation, Methodology. Benedikt Artmann: Data curation, Methodology. Carolin Bartsch: Data curation, Methodology. Montgomery Kubick: Data Curation, Methodology. Mihai Dascalu: Methodology. Stefan Trausan-Matu: Methodology. Nic. Nistor: Conceptualization, Supervision, Writing- Reviewing and Editing.

Data availability

Data will be made available on request.

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Study 2

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Designing for fake news literacy training: A problem-based undergraduate online-course

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ABSTRACT

In the wake of the Covid-19 pandemic, most universities had to switch to "emergency online learning". At the same time, academics were in search of means to combat "the infodemic", a wave of misinformation rolling over the world, affecting social and political life, and undermining efforts to deal with the pandemic. In the framework of emergency online learning, we propose an educational sciences undergraduate online course addressing fake news illiteracy by giving students an insight into the form and effects of fake news with a focus on framing. The course was built upon current fake news research and the problem-based learning approach. The research questions addressed students' perceptions of critical design elements, their fake news credibility test performance, and their academic achievement. A total of $N = 102$ undergraduate students participated in the course. Among various design elements, students indicated that online communication and feedback was most appealing. On the other hand, for future course iterations, they suggested improvements to the task descriptions. Fake news credibility decreased significantly ($F(1, 36) = 62.64$, $p < 0.000$, partial $\eta^2 = 0.64$) and final course papers were on average good to very good, indicating strong academic achievement. The study suggests that problem-based online courses can be appropriate learning environments, even in the context of "emergency online learning" and, furthermore, that they can serve as an instrument for combating fake news illiteracy.

1. Introduction

Education faced at least two major challenges in the year 2020: emergency online learning (Murphy, 2020) and an infodemic (Hua & Shaw, 2020), a wave of misinformation rolling over the world in the form of fake news. The restrictions of social contact aimed at limiting contagion during the Covid-19 pandemic called for *emergency online learning*, which is the focus of this special issue. In the past three decades, educational researchers have been experimenting with online learning (e.g., Nistor, 2003; Nistor & Neubauer, 2010), but it was not expected that it would be adopted on such a large scale in traditional universities. Due to the pandemic, much of the academic environment had to switch from face-to-face to online learning practically overnight, the challenge at hand being that both many educators and many students were not fully able to deal with online learning. In particular, although students might previously have acquired some cognitive scripts for online collaboration (Fischer et al., 2013), these may not have been enough to enable them to handle study programs that were completely online. Students had to self-regulate their learning processes (Greene & Azevedo, 2010), coordinate their activities in multiple online courses, and successfully apply learning strategies such as time management (Broadbent & Poon, 2018).

The *infodemic* made Germany the prime target in Europe for misinformation campaigns (EUvsDiSiNFO, 2021). In times of crisis, and particularly during the Covid-19 pandemic, fake news exacerbates the intrinsic danger of the ongoing crisis: On the one hand, various actors are fighting to convey views on how to deal with the crisis. On the other hand, fake news and the associated uncertainty, fear, and a higher need for information, make the confused population less responsive to the crisis management, therefore increasing risks (Hua & Shaw, 2020). Accepting and sharing fake news results in misconceptions and false beliefs about the world (Marsh & Stanley, 2020), i.e., fragmented and inaccurate conceptions at individual level, or deficient comprehension of complex situations. This leads to negative consequences for society, politics and the economy. With the ever-growing quantity of information available, and few reliable possibilities to accurately evaluate its

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Table 1
Overview of fake news cognitive processing, supportive factors, intervention goals and approaches.

Cognitive processing	Supportive factors	Intervention goals	Intervention approaches
Reception	Interests General perception features ("eye catchers") Negativity bias Illusory truth Emotional framing	Awareness of perception features and biases Scepsis towards emotional content	Inoculation
Information acceptance	Truth bias Cultural identity Bullshit receptivity Confirmation bias Value framing	Awareness of biases and cultural identity Reduction of intuitive truth evaluation Promotion of analytical truth evaluation Scepsis towards value framing	Inoculation Fact checking • Information literacy • Source evaluation • Lateral reading
Cognitive integration	Confirmation bias Selective exposure Filter bubbles Naïve realism Semantic framing	Awareness of biases and filter bubbles Prevention of creation and perpetuation of misconceptions Correction of misconceptions and adapt existing beliefs Scepsis towards semantic framing	Inoculation Conceptual change
Sharing	Echo chambers Filter bubbles	Awareness of filter bubbles and echo chambers Restraint of recipient's willingness to share fake news	Inoculation • News credibility warnings Fact-checking • Source evaluation training

truth value, we have arrived in a so-called post-truth era (Peters, 2017). This state of affairs is problematic for society as it hinders citizens from basing judgments and attitudes on valid information, and thus compromises the democratic decision-making process (Allcott & Gentzkow, 2017). Combatting fake news is an important contemporary goal of research in fields like computer science, mass communication, psychology, and education, a goal which is even more important in times of crisis.

Against this background and in the context of emergency online learning, we propose an educational intervention designed as a problem-based online course to address susceptibility to fake news. The paper is focused on instructional design built upon current fake news research, resulting in a pilot course subjected to a first assessment of student perceptions, academic achievement, and fake news credibility performance. After this introduction, the remainder of the paper includes a literature review focusing on the cognitive processing of fake news, fake news design, and interventions against fake news, as well as the instructional design of problem-based online courses. The second section of the paper includes the research questions and methods, the presentation of results, discussion and conclusions.

2. Theoretical framework

2.1. Fake news

For the purpose of this study, we define fake news as "news articles that are intentionally and verifiably false, and could mislead readers" (Allcott & Gentzkow, 2017, p. 213). In addition, fake news "mimic[s] news media content in form but not in organizational process or intent" (Lazer et al., 2018, p. 1049). Fake news features a variety of different content from many aspects of life, from which conspiracy theories are a prominent recurring topic and therefore dangerous (Lewandowsky et al., 2017), as they can harm public discourse and interaction. In many cases, however, fake news is simply "bullshit" (Pennycook & Rand, 2020) in the sense defined by Harry G. Frankfurt, i.e., the authors do not care if the contents of the communication are true or not as long as somebody reads it and believes it (Frankfurt, 2009).

2.2. Cognitive processes associated with fake news

Currently, there are several approaches explaining why humans are so vulnerable to fake news. In the following, we attempt to provide a synthesis of these explanations from a cognitive perspective that can be subsequently used as a ground for educational interventions. Accordingly, we propose that the cognitive processing of fake news comprises four components: reception, information acceptance, cognitive integration, and sharing (see Table 1). To the best of our knowledge, this model integrates the most relevant fake news research findings published so far.

(1) *Reception.* At the onset, misinformation may captivate the attention of internet users who may, for various reasons, be interested in the topic. Negativity bias makes humans focus more on negative information, and thus on the majority of fake news (Jaffé & Greifeneder, 2020; Park, 2015). Repeated statements are more easily processed and deemed more credible than completely novel ones, leading to the illusory truth effect (Fazio et al., 2015; Hasher et al., 1977). Together, these two categories of effects provide fake news with a simple entry point to recipients' cognition.
(2) *Information acceptance.* Once fake news has found its way into cognition, individuals evaluate the truth value of information, in order to decide whether to accept and integrate the information in their knowledge network. This can be done analytically, e.g., by fact checking; it can be done intuitively, e.g., by stating that the information "feels true" (Schwarz & Jalbert, 2020), or the information can be accepted without any particular evaluation (Pennycook & Rand, 2019). Truth evaluation, especially when done intuitively, can be biased in several ways. Humans are not very good at identifying deception (DePaulo et al., 1997; Rubin & Conroy, 2012), i.e., we tend to believe others and perceive information we receive from them as reliable (truth bias – e.g. van Swol, 2014). Cultural identity can make certain concepts more fluent than others, and thus more truthlike (Oyserman & Dawson, 2020). Pennycook and Rand (2020) describe "bullshit receptivity" as a personality trait of people falling prey to fake news (Pennycook & Rand, 2020). Moreover, information that fits the pre-existing knowledge and attitudes is more easily accepted and integrated, which promotes the confirmation bias: humans specifically look for, and accept information that fits into their worldview, their previous attitudes and opinions (Nickerson, 1998). Cognitive dissonance (Festinger, 1957) is a prominent way of explaining the confirmation bias. In order to avoid or reduce cognitive dissonance, new and dissonant information may get dismissed as biased, untrustworthy or simply false, whereas consonant information may be accepted and integrated in the pre-existing knowledge (McGrath, 2017; Weeks et al., 2017).
(3) *Cognitive integration.* If the integrated information or its semantic relationship to other concepts is missing or false, misconceptions develop (diSessa, 2018; Smith et al., 1994). Due to confirmation

bias, these misconceptions can be consolidated by selective exposure to information, i.e., by actively searching for new pieces of information conforming to existing misconceptions, assimilating these and thus building larger flawed knowledge structures (Weeks et al., 2017), leading individuals to viewing their perspective of the world as the only valid one and to dismiss alternative information as irrational, ill-informed, or biased (Ross & Ward, 1996; Weeks et al., 2017). This is a cognitive state described as naïve realism (Cheek et al., 2020). Algorithms recommending customized content based on Internet users' previous history limit experiences in the digital world to spaces conforming to the existing worldviews, the so-called filter bubbles (Pariser, 2016), an ideal place for naïve realism and confirmation biases.

(4) *Sharing.* Leaving the individual level and looking at fake news from a socio-technical perspective, misinformation is frequently shared among Internet users, above all on social media platforms. This is done for various reasons, such as (dis-) informing others and influencing their decisions (Oyersman & Dawson, 2020), harming them (Maftei & Grigore, 2020), or is simply unreflected (Pennycook & Rand, 2019). Filter bubbles, at their extreme, can turn to echo chambers where a naïve reality is maintained among like-minded Internet users sharing the same information and confirming each other's beliefs (Nguyen, 2020).

A synthesis of the above-mentioned deficits that hinder critical thinking about fake news leads to what is termed fake news illiteracy in this paper. In contrast to media literacy (Potter, 2018), which would provide a preemptive safeguard against misinformation, fake news illiteracy fuels flawed evaluation of news and misinformation processing, and results in change resistant misconceptions.

2.3. Fake news design

Like most mass media content, fake news needs to be designed so that it can be more easily received, accepted, cognitively integrated, and shared. This is mainly done by adapting it to consumers' individual characteristics, taking – we assume – the cognitive processes addressed above into consideration. *Designing for reception* would thus exploit the negativity and truth bias, and the illusory truth effect. The reception process is sustained by the sheer mass of fake news, and by Internet user profiling, so that they can be targeted either as individuals or as filter bubbles inhabitant groups (Cadwalladr & Graham-Harrison, 2018; Vosoughi et al., 2018). Emotional and value framing (Oswald, 2019) can address news consumers' negativity bias, activate negative emotions such as anger, and thus captivate attention. *Designing for acceptance* can be based on the illusory truth effect and confirmation bias, and comprise bombarding individuals or filter bubble inhabitants with similar or consistent fake news stories from different sources. Consistency between fake news stories reduces the cognitive dissonance and fosters the integration of misinformation (McGrath, 2017). Additionally, value framing can be done by appealing to users' existing beliefs (Oswald, 2019) or cultural identity (Oyersman & Dawson, 2020). *Designing for cognitive integration* may build upon illusory truth effects and perpetuate misconceptions by continuously addressing them, e.g., as Donald Trump and his followers did with their chant "lock her up", meaning Trump's opponent Hillary Clinton (Erichsen et al., 2020). Furthermore, semantic framing (Allcott & Gentzkow, 2017; Oswald, 2019) can be used to implicitly address the theme in multiple contexts. As social network systems are among the preferred media for spreading fake news (Allcott & Gentzkow, 2017; Lazer et al., 2018), *designing for sharing* implies formatting the news to fit social network platforms. Again, user profiling (Cadwalladr & Graham-Harrison, 2018) and filter bubbles (Pariser, 2016) build a strong infrastructure that brings together like-minded Internet users, creating environments where fake news is more efficiently disseminated.

As framing appears to be a powerful mass communication method that we have mentioned above in several places, we would like to close the fake news design subsection with some further clarification. The framing theory (Scheufele, 1999) is based on Goffman's (1974) frame theory, Rumelhart's (1980) cognitive schemata, and Tuchman's (1978) reality construction in mass media. "To frame is to select some aspects of a perceived reality and make them more salient in a communicating text, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation for the item described" (Entman, 1993, p. 52). Oswald (2019) identifies three linguistic framing instruments that are most commonly used in political communication: value, emotional, and semantic framing. Value framing is the use of norms and values important for the targeted audience and activated no matter whether they are relevant for the news content or not. Emotional framing means the intentional activation of certain emotions, such as anger, through corresponding language. Semantic framing associates news content with a certain connotation by using specific terms.

2.4. Counteracting fake news

The same four processes addressed above (see also Table 1) are relevant when counteracting fake news. At *reception level,* news recipients need to be warded against emotional framing and the impacts of negativity bias. Approaches based on inoculation theory provide one way of fostering such healthy scepticism towards emotional content. These were initially developed during the Cold War as a means to counteract propaganda (McGuire, 1964; Papageorgis & McGuire, 1961). Inoculation in the context of fake news refers to building up a defense against persuasion or deception attempts by exposure to fake news in a controlled and safe environment. In this way, online news recipients are provided with an insight into fake news composition, techniques, and effects (Basol et al., 2020; Van der Linden et al., 2017).

At *information acceptance* level, recipients should become suspicious of value framing techniques, to prevent them from simply evaluating truth in an intuitive manner, or not evaluating it at all. Again, inoculation as described above may be a promising approach in dealing with this issue (Basol et al., 2020). The illusory truth effects could be potentially lessened by informing news consumers about them, and by exposing consumers to personal experience of value framing and commonly used strategies (Osborne, 2018; Revez & Corujo, 2021), for example by reverse engineering news stories (Osborne, 2018). Getting news recipients to rely less on their intuition and more on analytical information processing also appears promising (Roozenbeek & van der Linden, 2019). Inoculation can take place through serious games, such as the "Bad News" game, developed by Roozenbeek and van der Linden (2019). Empirical results with a large sample size of very diverse internet users showed that inoculating players with information about fake news design has a small to moderate effect on the perceived reliability of news (Roozenbeek & van der Linden, 2019). Scheibenzuber & Nistor (2019) were able to replicate the positive effects on subjective learning success and motivation, but the causal comparison between the "Bad News" game and a text-based presentation of the same information did not yield any statistically significant effects.

Information literacy increases the likelihood of debunking fake news, although its positive effects appear rather limited (Jones-Jang et al., 2021). Nevertheless, librarian practice includes disseminating information about fake news and information literacy campaigns, particularly aimed at raising the awareness of the need to evaluate information, and source evaluation training (Osborne, 2018; Revez & Corujo, 2021). An example of carefully designed and evaluated source evaluation training is the lateral reading technique deployed by McGrew (2020) with high school students who could thus improve their ability to select reliable news sites.

Acceptance is not only relevant for the cognitive processing of online news; it can also be critical for interventions against fake news. At

reception level, an intervention might not be framed in a way which frequent fake news recipients are familiar with. At acceptance level, the cognitive dissonance created by the intervention poses a significant threat to recipients' intervention acceptance. Even more so at cognitive integration level, where we deal with change-resistant misconceptions. Finally, at sharing level, the social bubble inhabited by news consumers may disapprove and even reject the person involved in an intervention against fake news. Consequently, interventions need to be not only functional in terms of reducing fake news illiteracy but also designed in a way that appeals to participants and keeps them engaged.

At *cognitive integration* level, the creation and perpetuation of misconceptions (Chi, 2013) needs to be addressed. Simply warning recipients of semantic framing may not be sufficient (Lazer et al., 2018). However, incorporating new information to correct misconceptions in somebody's worldviews seems to require higher cognitive abilities (De keersmaecker & Roets, 2017). "Detecting and escaping from echo chambers will require a radical restructuring of a member's relationship to their epistemic past" (Nguyen, 2020, p. 143). In other words, conceptual change, including belief revision, mental model transformation, and categorical shift (Chi, 2013) may be necessary and appropriate. Conceptual change has been extensively researched in the last decades, although it has hardly ever been related to fake news.

At *sharing* level, credibility indicators based on automated or human-made fact checking, and corresponding warning labels can reduce the fake news consumers' sharing intent (Chung & Kim, 2020; Yaqub et al., 2020). As the perceived information quality predicts news sharing (Koohikamali & Sidorova, 2017), interventions fostering a more accurate evaluation of information sources may indirectly influence the fake news sharing behavior.

Altogether, this brief literature overview suggests that educational interventions aimed at information literacy – fake news literacy, as discussed in this paper – aim at self-evaluation of knowledge and skills (prominently including the various cognitive biases), knowledge construction and reorganization, and knowledge and skills transfer, in order to enable adequate cognitive processing of online news. Interventions are built on inoculation more often than fact checking. The number of intervention studies in the context of formal education is limited.

2.5. Problem-based learning and fake news literacy

As shown in the previous section, educational interventions geared towards fake news literacy aim at individuals' self-evaluation of knowledge and skills, knowledge construction and reorganization, and transfer of knowledge and skills in order to enable adequate handling of online news. Problem-based learning appears to be a particularly promising way of targeting these intervention goals (see also Table 1) in the context of formal education in a semester-long course at the university. Based on a constructivist approach, problem-based learning embeds student learning into real-life problems that students try to solve collaboratively in groups (e.g., Barrows & Tamblyn, 1980; Hmelo-Silver, 2004). Problem-based learning environments have been shown to support the development of conceptual knowledge and skills in different domains (e.g., Dolmans et al., 2016; Ferreira & Trudel, 2012; Gijbels et al., 2005; Loyens et al., 2015; Şendağ & Ferhan Odabaşı, 2009; Yew et al., 2016). In line with the intervention goals listed above, we hence suggest a problem-based learning environment for constructing and reorganizing as well as flexibly applying (i.e., transferring) conceptual knowledge of characteristics and mechanisms of framing. This conceptual knowledge is key to understanding fake news processing (reception, acceptance, and integration) and practicing related skills. We see these related skills in a broader context, including the skill to perform a literature search or qualitative content analysis as well as critically reflecting on cognitive processes (self-evaluation). In the following section, we go through the problem-based learning process and highlight why the different steps in this process might be particularly advantageous to fake news literacy.

At the beginning of the problem-based learning cycle, students are confronted with a problem scenario that has to be analyzed in order to formulate and evaluate possible solutions. By design, students' existing knowledge is not sufficient for them to come up with a satisfactory solution to the problem at hand. The insight that a given problem cannot be solved by referring to one's pre-existing knowledge stimulates active knowledge construction and reorganization. Related prior knowledge is activated and motivation increases (Sinatra & Pintrich, 2003). Failing to solve the problem can be productive in this context by revealing the limits of the students' existing knowledge and hence initiating conceptual change (see Chinn & Brewer, 1993; Kapur, 2014; Sanchez et al., 2009). At the beginning of a course promoting fake news literacy, students can be instructed to think up answers to the question how and why fake news might trick news recipients before they receive any information on the topic.

After having identified knowledge deficits, students engage in self-regulated learning to acquire the knowledge necessary to address the problem (e.g., Broadbent & Poon, 2015). Designing for fake news literacy course will help students to develop conceptual knowledge about framing techniques including emotional, value and semantic framing and their application in fake news. They are hence instructed to describe different forms of framing based on literature on fake news and framing and to derive a coding system to detect these design elements in actual fake news articles. In the process, they practice their literature search skills as well as the research method of qualitative content analysis.

A next step in the problem-based learning process involves the application of the newly acquired knowledge to the problem and the evaluation of the solution. In a course to increase fake news literacy, this could be implemented by having the students apply their coding systems to a number of real fake news items. In the process, students might discover gaps in their own knowledge. The process supports the development of knowledge that can be activated and flexibly applied in a variety of fake news contexts. (e.g., Gick & Holyoak, 1983; Goldwater & Schalk, 2016).

The next step of the problem-based learning cycle also promotes transfer. If the problem solution is evaluated positively, learners are asked to transfer their ideas to new situations, which further promotes their ability to conceptualize. In the context of a course on fake news literacy, the conceptual knowledge of characteristics and mechanisms of framing acquired during the previous steps can be used by the learners to design an intervention or training on the effects of framing. Likewise, the coding system used to detect and describe framing that was tested on a given corpus of fake news can be applied and adapted to a new corpus covering another topic. Problem-based learning promotes knowledge transfer and is therefore particularly relevant to fake news literacy.

If no problem solution is reached, however, students have to repeat the problem-based learning cycle – or parts of it – thereby practicing monitoring and critically reflecting their own thinking processes (e.g., Barrows & Tamblyn, 1980; Hmelo-Silver, 2004). Being able to reflect on one's own cognitive processes and biases can be seen as an integral part of fake news literacy.

To sum up, confronted with the problem of identifying and understanding the mechanisms behind fake news design (i.e. framing), students collaboratively engage with the conceptual content knowledge on framing and, at the same time, practice evaluation skills, such as literature search and qualitative content analysis as well as self-monitoring (e.g., Gallagher, 1997; Hmelo-Silver, 2004; Polanco et al., 2004).

2.6. Designing a problem-based course

The effectiveness of problem-based learning largely depends on the right balance between students' prior content knowledge and problem solving, collaboration and self-regulated learning skills, on the one hand, and instructional support, on the other hand (e.g., Kalyuga et al., 2001; Roelle & Berthold, 2013). Different types of instructional support – or instructional design elements – can be considered to avoid overload

and help students to learn despite the complexities of the problem-based learning environment. While instructional support can be provided both in an analogue and digital environment, online problem-based learning implies specific affordances, opportunities, and difficulties.

Authentic problem description. The problem scenario should be described in sufficient detail and based on authentic materials that can include interactive media elements (links to webpages, videos or images) to contextualize the problem. The problem should be broken up into separate parts that can be addressed one by one to help students structure the work process. In a problem-based learning curriculum, small groups of students may be confronted with weekly problems they are trying to solve supported by the teacher (Keppell et al., 2001).

Problem-solving resources. Particularly when students are not familiar with the learning domain, instructional guidance encompassing worked out examples, instructional videos, or question prompts can effectively scaffold the problem-solving process (e.g., Hmelo-Silver et al., 2007; Kim et al., 2018; Schmidt et al., 2007). Instructor feedback during the problem-solving process could be a helpful resource for students to calibrate their self-regulated learning activities in a given time (e.g., Mamun et al., 2020). Finally, access to all information, material, and resources necessary to address the problem should be guaranteed. In online settings, learning management systems can be considered a valuable resource to organize and streamline the problem-based learning cycle and, in particular, the provision of problem-solving resources. These systems structure the problem-based learning process (e.g., weekly updates, learning organized around problems or assignments), handle access to course materials, incorporate communication technologies (announcements, feedback, wikis, or discussion boards) and computer assisted learning modules, link to webpages, and permit embedding diverse media content (Petrovic & Kennedy, 2005; Tosun & Taşkesenligil, 2011).

Communication and collaboration resources. Deliberately stimulating interactive activities such as group discussions or peer review that allow social knowledge construction can increase student engagement (Olsen et al., 2020; Swan, 2002). Instructor questions or question prompts provide guidance and structure for group work and discussions (e.g., Garrison & Akyol, 2013; Lee et al., 2017). Discussion boards, etherpads, or wikis, which represent a platform for synchronous collaboration, facilitate collaborative learning and are promising resources in online problem-based learning environments (e.g., Duncan et al., 2013; Zheng et al., 2015).

While the presentation of authentic problems and the learning resources supply may profit from the digital format, social interactions, both among students and with faculty, can be considered one of the biggest challenges (e.g., Delen & Liew, 2016; Olsen et al., 2020; Tsai & Chiang, 2013). Potentially, computer-mediated communication can be as productive for collaborative learning as face-to-face communication; however, the former requires specific communication and collaboration skills or, in current terms of cognitive psychology, collaboration scripts (Fischer et al., 2013; Radkowitsch et al., 2020). A lack of such skills may increase the working time (Broadbent & Poon, 2015; Straus & McGrath, 1994; Valkenburg et al., 2016), and time resources can become scarce if all the courses on a student's study schedule are online. Consequently, the collaboration quality and the learning outcome can be affected.

3. Research questions

The literature review provided above outlines the cognitive processing of fake news and the corresponding interventions, concluding that a problem-based online course aimed at improving fake news literacy is necessary, and suggesting how it could be designed. We have developed an initial pilot course along these lines. Subsequently, in the empirical section of this study, we have addressed two basic areas of interest in order to obtain first indications as to how far the pilot course meets its objectives.

Firstly, we have searched for insight into how our students experience the actual course design, particularly the online implementation of the authentic problem description, the problem-solving resources, and the communication and collaboration resources. This was expected to point out major design flaws and suggest potential improvements for future course iterations, keeping in mind that participants with different study experience (e.g., freshmen vs. junior students) may have different learning needs and thus perceive different design elements as particularly helpful or unhelpful. Hence the first research question:

RQ 1: (a) Which instructional design elements did the participants find particularly appealing (or unappealing) and functional (or dysfunctional), and (b) why? (c) If unappealing or dysfunctional, how could these elements be improved?

Secondly, we looked at the learning outcome. Being highly student-centered, the success of problem-based learning has been generally shown to depend on learners' prior knowledge and cognitive skills, thus on their study experience. Therefore, we differentiated, similarly to RQ1, our learning outcome research questions according to participants' study experience (e.g., freshmen vs. junior students). The learning outcome related to fake news literacy was students' ability to apply conceptual knowledge and evaluation skills to detect fake news, assuming that junior students may perform better than freshmen. Hence the second research question:

RQ 2: What is students' pre-post performance change in a fake news literacy test? What is the difference between freshmen and junior students?

The academic learning outcome was that participants learn in a self-regulated and collaborative manner, and synthesize the acquired knowledge in a final course paper. In analogy to the previous research question, the difference in performance between freshmen and junior students is also considered in the third research question:

RQ 3: What is students' academic achievement as reflected in the final course paper? What is the difference between freshmen and junior students?

4. Research methods

4.1. Research design

The research questions were examined in the field, i.e., within the current emergency online learning situation. The first question was qualitative, the second and third were quantitative. RQ 1 was addressed in online breakout groups and additionally through content analysis of open questionnaire data and email communication with students. For organizational and ethical reasons, a classic evaluation design with treatment and reference groups was not possible. Therefore, RQ 2 was approached using a pre-post-test design including within- and between-subject analysis, and RQ 3 by descriptive statistics and quantitative group comparison.

4.2. Population and sample

The course was part of the study program at the Faculty for Psychology and Educational Sciences of a German state university with more than 50,000 students in 18 faculties. The participants, $N = 101$ in total, were undergraduates studying educational sciences either as a major or as a minor. The course was taken by both $n_1 = 62$ freshmen (51 female, 11 male) and $n_2 = 39$ junior students (36 female, 3 male). Freshmen took this course in the second semester of their undergraduate study and were thus less familiar with scientific problem-solving and collaborative and self-regulated learning, as compared to their junior counterparts, who took the course in their fifth semester. From their first year of study, the junior students were somewhat familiar with single online courses or course modules, however, not with an entire study program being carried out online.

To answer RQ 2, a repeated measures within-between ANOVA with

two datapoints was conducted. At the end of the term, 97 participants had completed the course, from which 38 provided valid and complete datasets in both pre- and post-test. A post-hoc power analysis indicated that a sample size of N = 38 is sufficient to detect a medium effect (f = 0.25) with an α error probability of 0.05 and power 1 - β = 0.85, greater than the acceptable minimum of 0.80 and deemed appropriate for a pilot study in the field (G*Power 3.1; Faul et al., 2009).

4.3. Course description

4.3.1. Course goals

Courses aimed at four different learning goals. First, participants should either acquire, as in the case of freshman students, or foster existing literature research skills by searching for literature and getting an insight into fake news research with a focus on framing. Second, they should develop specific problem-solving skills by learning and applying qualitative content analysis methods. Specifically, they should develop a coding system for framing and identifying the occurrences of different framing methods. They should not only become familiar with a new research method, but also gain insights into some of the strategies commonly found in fake news and thus decrease fake news illiteracy. Third, they should acquire collaboration skills by practicing online collaboration in small groups and using the wiki-tool provided by moodle to keep records of their progress. Fourth, they should critically reflect their own research progress throughout the term and synthesize the results in an empirical research report submitted as a course paper. For the paper, the instructors suggested the title "Fake News Framing: Developing and Applying a Coding Scheme for Content Analysis".

4.3.2. Instructional design

Overall, the online course was problem-based. With respect to the subject matter, the course relied on the inoculation approach (Basol et al., 2020; Van der Linden et al., 2017) with a focus on framing (Entman, 1993; Scheufele, 1999). The specific instructional design elements were shaped as follows.

Authentic problem description. Participants worked with the problem of online fake news, currently well-known to the students from the international political discourse, and displaying even higher relevance in the context of the Covid-19 pandemic (Hua & Shaw, 2020). To increase the authenticity of the learning environment, only current fake news on migration from several German, Swiss or Austrian alternative news sites (Vogel & Jiang, 2019) was used as learning material. Migration is a pervasive topic due to the European refugee crisis from the mid 2010s, thus highly authentic. Authenticity was further addressed by the task in which the students later in the term independently searched for fake news on Covid-19, and selected from this the material for the second content analysis.

Problem solving resources. One of the key resources in the course was current research literature on the general definitions and different types of fake news, their effects and form as described through the framing approach. Due to Covid-19 restrictions on-campus libraries were not available to the students and their entire literature research had to be conducted online. Additionally, a "crash-course" on qualitative content analysis with further, more in-depth literature recommendations was compiled and provided by the instructors. It mainly contained a step-by-step tutorial, the bare minimum to get a grasp on the method.

Furthermore, students worked with current fake news articles from the publicly available German Fake News Corpus (Vogel & Jiang, 2019), or GermanFakeNC, a corpus of ~490 manually fact-checked fake news articles from German, Austrian and Swiss alternative news sites. Instructors had selected 20 articles from this corpus with a thematic focus on migration to provide a coherent sample for the participants. Additional research material in the form of fake news articles on Covid-19, used in a second content analysis later in the course, were searched for by the participants themselves. Due to the difficulty of finding adequately fact-checked fake news the minimum amount that had to be collected for analysis was set to 10 articles with a strong recommendation of searching for more. Finally, participants received a set of guidelines for their course paper, including formalities, such as the usage of APA version 7 formatting, as well as a model structure which students should adhere to when writing their final assignment.

Communication and collaboration resources. The course management was based on moodle (v. 3.6), and freshmen and junior students had two separate courses. Both were built with the same data structure and contents. The courses opened with a short welcoming text, the course overview and the schedule. The courses had a weekly structure consisting of task descriptions and associated learning resources. At the start of the course, only the welcoming text, the course overview, and the first task were visible. Throughout the term, the next sections were made visible and became available for students after each task completion, i.e., at the start of the next one. Each course section included a written task description, corresponding resources and, if necessary, assignment submission links for completed tasks.

The communication between instructors and students was mostly asynchronous and handled via moodle through weekly assignments as well as notifications that students received through their campus email every Monday morning. Alongside this regular and steady communication of tasks and new contents, participants communicated directly with instructors through email or the moodle messaging feature. Close to the end of the term, two synchronous meetings, one about the course paper, the other for more general questions, were held using the video conferencing tool zoom (v. 5.0.2, zoom.us). Upon assignment completion, students received feedback from the instructors via email. For communication between participants, the use of zoom was recommended at the beginning of the term. The breakout group discussions held within the last two term weeks also used zoom and its breakout sessions function to provide participants with separate spaces for group discussions.

4.3.3. Course schedule

Week 1 opened with a general introduction to the course featuring the organizational structure and the instruction to autonomously form work groups of three to five students using the moodle etherpad feature. In *Week 2,* students explored and started to use the moodle wiki feature. Furthermore, participants set, discussed and documented their individual learning goals in the wiki. *Week 3* featured the "crash-course" on qualitative content analysis. From *Week 4* to *Week 8,* students conducted the required literature review, collecting the search results in their groups' wiki. Furthermore, the participants proposed a coding system to analyze the fake news from GermanFakeNC. This analysis began in *Week 6* and ended with the submission of the coding system in *Week 8*. In *Week 9* students wrote and handed in a short non-formal concept paper (max. 2 pages) on possible intervention methods to combat fake news illiteracy, as deduced from the results from the first content analysis. W*eeks 10* to *13* featured the second content analysis, this time based on Covid-19 fake news found by the participants on the Internet, and on their coding system now adapted to the requirements of the new contents. The students began coding the new material in *Week 12* alongside their work on the course paper, which was due in *Week 15* (Fig. 1).

4.4. Qualitative data collection

To address RQ 1, the appeal and functionality of our instructional design elements as seen by the students, we conducted discussions in breakout groups. This was inspired by the focus group method that comprises discussions in an informal setting with the goal of identifying participants' personal experiences with the object of research (McLafferty, 2004; Morgan, 1997). The participants were invited to join one of two online discussions in zoom, for freshmen and for junior students respectively. In total, there were five breakout groups, three for the freshmen and two for the junior courses with four students in each group, all female. Prior to the sessions, the participants received an

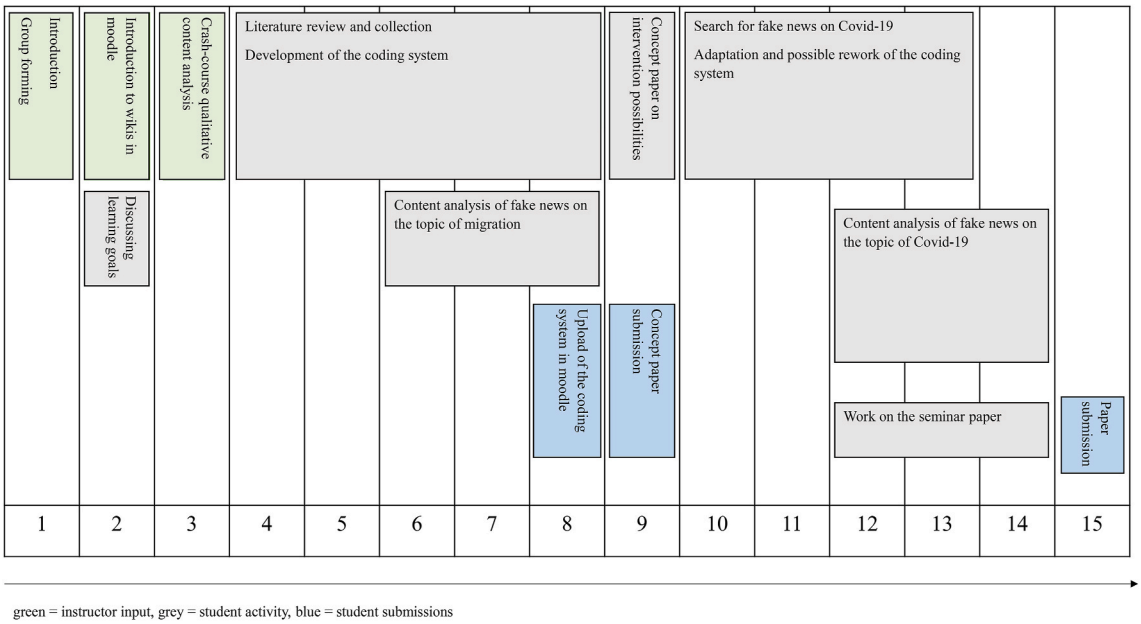

Fig. 1. Course overview.

Table 2
Assessment criteria of the course papers.

	Chapter	Criteria	Maximum points
1.	Problem statement	Coherent and evidence-based problem statement	10
2.	Theoretical background	Coherent and logical presentation of the current state of fake news research with a focus on framing	20
3.	Methodology	Complete, adequate and accurate presentation of the research method (qualitative content analysis)	5
		Quality of the category systems for migration and Covid-19 respectively	5
4.	Results	Complete and accurate presentation of results	20
5.	Discussion	Summary of relevant results linked with research literature	10
		Credible and literature-based interpretation of results	10
6.	Implications	Stating logical consequences for research	5
		Stating logical consequences for practice	5
7.	Formal aspects	Use of adequate and recent literature	5
		Correct use of academic language	3
		Correct use of template and formatting (APA-7)	2
	Total		100

overview of the recommended discussion steps, as follows: (1) In a plenary brainstorming session, the participants collected points for the student feedback about the course design. (2) In separate breakout rooms, they formulated three feedback statements on the most important design elements of the course, rating them as positive or negative. If the rating was negative, improvements were suggested. (3) The participants returned to the main zoom room and each group presented their statements for a last discussion with the entire group in order to clarify uncertainties, if any, and finally the statements were submitted for the course evaluation. In addition, the participants occasionally provided feedback on the course design and suggested improvements via email during the term. The feedback was recorded and subjected to a thematic content analysis. In both the focused feedback and in email statements, subthemes subordinated to the design elements named above (authentic problem description, problem solving resources, and communication and collaboration resources) were identified, and the corresponding statements were summarized (Creswell, 2007).

4.5. Quantitative variables and measures

RQ 2 entails a single dependent variable, i.e., performance in a test on fake news credibility, measured by showing the participants a set of ten screenshots of online fake news, all taken from the GermanFakeNC (Vogel & Jiang, 2019). A completely different set of ten news article screenshots was used for the post-test questionnaire. All articles were taken from news sources the participants had not worked with during the course. For each screenshot, participants were asked to rate the credibility of the featured content on a seven-point Likert-scale from 1 = absolutely not credible to 7 = absolutely credible. The sum score was used for all calculations (ranging from 10 to 70), with a higher score implying a higher degree of fake news illiteracy. So far, there is no validated test for fake news credibility. However, the assessment method adopted here has been shown to work well in prior research on fake news (e.g., Roozenbeek & van der Linden, 2019). The reliability estimates yielded in our pretest (Cronbach's $\alpha = 0.83$) and posttest ($\alpha = 0.87$) indicate good internal consistency.

For RQ3, we operationalized academic achievement as a single multidimensional dependent variable describing the quality of the course paper with the suggested title "Fake News Framing: Developing and Applying a Coding Scheme for Content Analysis." The papers were recommended to be structured as shown in Table 2, and were developed step by step as described above in the course schedule. To develop the papers, the students had to apply the skills named above in the course goals, i.e. literature research, collaborative learning, and problem-solving skills. Paper grading was based on normative performance standards of what is expected from undergraduate students of educational sciences, taken from the syllabus. Scores for each criterion were: 1 point = criterion met, 0.5 points = criterion partially met, 0 points =

criterion not met. The total points awarded per chapter divided by the maximum number of points and multiplied by the weights indicated in Table 2 resulted in scores for each chapter. These weights were chosen in a way that reflected the importance of each given chapter, focusing on theoretical background and discussion to see whether participants had a solid grasp on the research literature, and results to gauge how well the participants were able to depict their findings in an academic manner. The maximum total score was 100. In order to provide an objective assessment, the papers were coded independently by two instructors to evaluate the objectivity of the rating system. Both instructors reached 100% agreement after brief discussions of less than 10 min each. The final grades were then calculated by transferring the total number of points to the German grading system (100–86 points = very good, 85–74 = good, 73–62 = satisfactory, 61–50 = sufficient, and <50 = insufficient).

4.6. Data collection and analysis

The course was offered during the summer term of 2020, from late April to early August, over 15 weeks. Data was collected during the first and last term week through online questionnaires in moodle using feedback forms. Each questionnaire had a lifecycle of one week. On Monday, the questionnaires were made visible and the participants were notified by email. Reminders were sent on Wednesday and Friday. On the following Monday, the questionnaires were made invisible again. After the end of term, the course papers were submitted and graded by two instructors. All survey responses were downloaded for analysis and matched using pseudonymized user IDs. Data was analyzed with IBM SPSS Version 26 computing descriptive statistics, repeated measures ANOVA, and Kruskal-Wallis test.

5. Findings

5.1. RQ1: group discussion results

Online learning environment. All five groups found online learning helpful and less stressful than face-to-face learning because they did not have to travel to the university campus. For students who do not live nearby, travel time may be 2 h or more every day. In general, time management was easier, as gaps in course timetables were no longer an issue. They explicitly suggested continuing online teaching and learning after the pandemic. Nevertheless, two groups (one freshmen, one junior) also noted the importance of face-to-face meetings for motivation and focused learning, as well as the social components of student life.

Goal setting. One freshmen group misunderstood the goal setting, in that they had expected to become fake news experts who would recognize fake news at a single glance. Consequently, they were disappointed to see that the work of an entire semester "only" resulted in a differentiated insight into fake news framing. They suggested that the instructors explain the seminar goals at the beginning of the term in a synchronous online meeting, to clarify the expected learning outcome.

Course overview. One freshmen group had perceived the course overview provided by the instructors at the beginning of the term as too generic and felt uncertain about how to proceed with the upcoming course work. They suggested a more specific course overview with weekly task descriptions in advance for the entire term.

Generic task descriptions. All participants, freshmen and juniors alike, felt that they could not always understand the task descriptions immediately and sufficiently. Some of them needed to think them through carefully, while others would have preferred the instructors to explain the tasks in detail in an online meeting. Furthermore, one junior group reported that they had to revise certain task results, mostly the analysis codes, after instructor feedback because they had not correctly understood the initial task description. This additional workload could have been avoided by providing models of completed tasks as worked out examples for the more complex tasks, as suggested by the participants.

Content analysis task description. For the participants who studied educational sciences as a major, content analysis was not included in any lecture on empirical research methods. Therefore, conducting a content analysis was new to them, sometimes a challenge. They found the "crash course" too abstract for them to be able to properly apply this method. They suggested that the instructors give an introduction to content analysis in an online meeting and provide more practical and worked out examples. Moreover, they had not realized that the requirements were low, in the sense of a first insight into qualitative research. Correspondingly, they suggested that the instructors be clearer about this at the beginning of the course. In spite of these difficulties, the participants emphasized a feeling of success stemming from their mostly self-regulated learning activities.

Learning resources. Both junior student groups found the literature recommendations too broad, resulting in an increased effort to identify relevant information from large handbooks of qualitative research methods. They suggested that the instructors focus their recommendations on specific book sections. Regarding the analysis material, one junior student group felt disgusted by certain fake news, and wished the instructors had provided a more pronounced explicit content warning.

Instructor communication and feedback. Three groups (two junior and one freshmen) highly appreciated the communication with the instructors, in particular the instructor feedback regarding the assignments. They perceived communication as timely, clear, constructive, and friendly. They felt their questions were taken seriously, thus they felt relieved and supported. Nevertheless, the participants suggested scheduling obligatory group meetings to discuss participants' questions.

Peer communication. One freshmen group had found the coordination and division of work within their work groups through online communication somewhat confusing and difficult due to the lack of physical presence. They suggested that the instructors schedule regular online meetings via zoom, at least at the beginning of the term. Complementary to the main zoom room, small group breakout sessions could simulate formal face-to-face meetings and support the coordination within groups.

Assessment. Two freshmen groups felt overwhelmed by the workload during the last four term weeks. This was because the university administration had changed the officially recommended assessment form during the term. As the social distancing and hygiene requirements did not allow large gatherings of students, the initially planned group presentations of results during the term with an additional multiple-choice exam at the end were replaced by a single course paper, a research report expected to be 25–30 pages long and written collaboratively in working groups. This was communicated in week 9, leading to a feeling of pressure to complete the assignment in the remaining 6 weeks of the term. For future online courses, everybody agreed that the assignments need to be clearly defined at the beginning of term. In addition, one freshmen group suggested a schedule with weekly assigned paper section submissions, which would distribute the workload throughout the term and thus reduce the workload at the end of term. However, the junior groups were fine with the actual schedule and would have felt under time pressure if they had had to work even more during the term writing assigned paper sections.

5.2. RQ 2: fake news credibility test performance

In spite of only $N = 38$ participants ($n_1 = 18$ Freshmen, $n_2 = 20$ Junior students) who had responded to the fake news credibility test in both data points, the data were normally distributed (Shapiro-Wilk-Test, $p = 0.64$ in pretest and $p = 0.21$ in posttest). This requirement being met, a repeated measures ANOVA was conducted. The test performance was significantly improved ($F(1, 36) = 62.64$, $p < 0.000$) both for freshmen ($M_{1pre} = 32.61$; $SD = 7.00$ vs. $M_{1post} = 21.67$; $SD = 8.73$) and for junior students ($M_{2pre} = 34.10$; $SD = 6.72$ vs. $M_{2post} = 22.15$; $SD = 7.24$)

Table 3
Comparison of course paper scores.

	Freshmen ($n = 58$)		Juniors ($n = 39$)		Kruskal-Wallis test results
Chapter	*M*	*SD*	*M*	*SD*	
1. Problem statement	8.62	2.25	9.49	1.54	$H(1) = 4.24$, $p = 0.04$
2. Theoretical background	15.60	3.87	17.56	3.60	$H(1) = 6.56$, $p = 0.10$
3. Methodology	8.94	0.92	8.89	1.10	$H(1) = 0.00$, $p = 0.98$
4. Results	16.90	5.98	20.00	0.00	$H(1) = 10.83$, $p = 0.001$
5. Discussion	15.92	2.50	15.90	5.32	$H(1) = 1.28$, $p = 0.26$
6. Implications	8.45	1.54	7.69	1.33	$H(1) = 6.52$, $p = 0.01$
7. Formal aspects	9.17	1.14	10.00	0.00	$H(1) = 22.27$, $p = 0.000$
Total	83.59	9.70	89.53	7.47	$H(1) = 7.54$, $p = 0.006$

resulting in a large effect with partial $\eta^2 = 0.64$. The effect of study experience on test performance was not significant ($p = 0.61$).

5.3. RQ 3: course paper assessment

Over both student groups, the average score on the course paper was $M = 85.98$ ($SD = 9.30$), thus very good or good. Junior students have received more points for their course papers (very good, $M = 89.53$, $SD = 7.47$) than freshmen (good, $M = 83.59$, $SD = 9.70$). Because the number of points awarded for the course papers was not normally distributed, a Kruskal-Wallis test was conducted to test this difference, resulting in $H(1) = 7.54$, $p = 0.006$. In more detail, in chapters 1, 2, and 4, as well as in formal aspects, junior students scored significantly higher than freshmen. However, in chapter 6 freshmen scored significantly higher than juniors. There was no significant difference in chapters 3 and 5. Detailed scores are provided in Table 3.

6. Discussion

The first aim of this study was to design an online undergraduate course to address fake news illiteracy. To achieve this, we started from a literature overview focused on the cognitive processing of fake news, the resulting fake news design, and interventions against fake news. Whereas all these, interventions included, were framed by the cognitive processing components fake news reception, information acceptance, cognitive integration, and sharing, the interventions against fake news were essentially inoculation and fact checking, the former mainly addressing the reception, acceptance and sharing levels, and the latter the sharing of fake news. Our intervention, the pilot online course, was built on inoculation, which was put into practice as students' in-depth insight into fake news framing. More specifically, the course participants started from the problem of fake news illiteracy, reviewed communication research literature about framing, developed a framing-centered coding schema, and finally applied this to analyze fake news contents. Thus, our online course was designed according to a problem-based approach.

The design aim of this study was complemented by a basic assessment of students' use of the pilot course learning and their learning outcome. More specifically, we examined students' perceptions of the learning environment (RQ 1), and recoded their suggestions for improvement. Further on, the learning outcome was operationalized as the pre-post change in a fake news credibility test (RQ 2), and the academic quality of the course papers submitted at term end (RQ 3).

In spite of a relatively turbulent transition from face-to-face learning with a few online elements to the exclusively online setting, students' perceptions of the pilot course (RQ 1) were predominantly positive. They especially valued the communication and collaboration resources, as well as problem-solving resources, due to which their collaborative problem-based learning was successful even in the completely remote setting. Given the value of social knowledge construction and its effects on student engagement (Olsen et al., 2020), it is promising to see that in an online course these benefits may also hold during the stressful periods of study during a pandemic. However, especially for freshmen who are not yet fully familiar with the university environment and have not yet developed online collaboration skills (Fischer et al., 2013), regularly scheduled meetings, as requested by one breakout group, appear necessary to ensure productive learning. Instructor input and feedback was highly appreciated by the course participants, which is in line with prior research that stresses the importance of guidance and structure, especially in cooperative learning situations (Garrison & Aykol, 2013; Lee et al., 2017). On a similar note, especially when dealing with new learning content, instructional guidance is a valuable resource for learners to organize and structure their self-regulated learning processes (Kim et al., 2018; Mamun et al., 2020). In remote teaching in general and specifically for asynchronous learning environments, this may be of the utmost importance to guarantee students' success. Additionally, despite promising results with regard to collaboration tools that support collaborative learning (e.g., Zheng et al., 2015), there was a notable absence of student feedback on the provided collaboration tool in form of the wiki in moodle. This may indicate that students did not see the need to utilize the tool to its fullest or simply that they had found it useful, but not so useful that they specifically praised it. In terms of the authentic problem description, the fundament of problem-based learning, we received the biggest array of reported insecurities and misunderstandings when faced with the weekly task at hand. Despite splitting tasks into bite-sized weekly pieces for students to work on (Keppell et al., 2001), our participants asked for more details and model examples of task descriptions in order to avoid confusion. This may be due to the asynchronous nature of our course which somewhat limited the opportunities to ask comprehension questions on account of the added hurdle of having to email the instructors. More generally, participants attributed their course success to the high degree of freedom in self-regulated learning, which originated from overcoming difficulties self-directedly and with a relatively low amount of instructional support. This is in line with research showing positive relationships between self-regulated learning and academic achievement (e.g., Abar & Loken, 2010; Greene & Azevedo, 2010; Mega et al., 2014).

Regarding participants' performance in the fake news credibility test (RQ 2), which was based on their conceptual knowledge gain regarding fake news and more specifically on their understanding of framing, we saw substantial improvements at the end of the course compared to the beginning. Test performance significantly improved in both freshmen and juniors with no significant effect of prior study experience. This is promising as it suggests that even at the entry level of higher education, such as for our freshmen, an intervention against fake news such as ours may yield significant results in reducing fake news illiteracy at reception and acceptance level. This increase in test performance is in line with prior research showing that the problem of fake news illiteracy can be addressed by online interventions based on the inoculation approach (e.g., Roozenbeek & van der Linden, 2019). Participants seemed to have developed cognitive skills at the reception and acceptance levels of fake news processing (Gijbels et al., 2005; Loyens et al., 2015; Walker & Leary, 2009) or, in more current terms, cognitive scripts (Fischer et al., 2013; Radkowitsch et al., 2020) that enabled them to more accurately recognize fake news by looking at their framing.

In terms of academic achievement and the conveyance of research

skills (RQ 3), the course can be seen as a success with participants passing with good to very good final grades, on average. Junior students scored significantly higher than freshmen, especially in the presentation of results and in overall formal aspects of the course paper. This difference could be explained by juniors' greater familiarity and experience with writing academic papers, which usually develops over the course of students' university careers (Lea & Street, 1998). Notably, we did not find this difference between juniors and freshmen students in the fake news literacy test.

6.1. Limitations

As this study is focused on instructional design driven by previous theories and empirical findings, the associated empirical study had explorative character and the validity of its findings displays some limitations. Our research design does not include reference groups, therefore it does not support causal conclusions. In other words, although substantial pre-post performance changes were found, we cannot claim that these were caused by the course or by its instructional design. Causal conclusions should be drawn in future research employing causal group comparisons, best under controlled laboratory conditions. In the long term, the course quality should be systematically improved by design-based research.

The setting and sample of our study are also limited. Conducting a field study, we have examined a single set of courses in the context of an emergency online semester with possible interdependencies with other courses, online lectures, or small research projects we could not control for. Our course design was tested only on a narrow sample of students of educational sciences, all of them willing to learn and very cooperative. It needs to be expanded to different contexts to provide representative results for a larger, more heterogenous set of students, and to people outside the academic world, who are probably more affected by fake news than university students. Additionally, the small sample size – due to attrition during the study – needs to be expanded in further research. A possible solution for this would be to use learning analytics methods such as log data analysis (e.g., Lerche & Kiel, 2018) to objectively assess students' activity without the need for them to take part in an additional study during the semester.

The basic data collection instruments may have introduced further limitations. The group discussions (RQ 1) were initiated by a few questions that were very generic and that may not have captured important aspects of the learning process. Further research should be based on more precise questions specifically directed to instructional design elements addressing the fake news cognitive processing. The fake news credibility test (RQ 2) does not give any insight into the associated cognitive processes, i.e., analytic or intuitive (Schwarz & Jalbert, 2020), or into participants' evaluation of the information quality (e.g., Hahnel et al., 2020). Social desirability may have also inflated the results. Assessing the quality of course papers (RQ 3) manifests all the advantages and disadvantages (Galla et al., 2019), hence this may not be the ideal measure of academic achievement and the acquisition of research skills.

6.2. Consequences for educational practice

Reflecting upon the overarching theme of this special issue, higher education teaching and learning in times of crisis, a few conclusions result. First, as long as the pandemic is still raging on and traditional teaching methods must be limited (Crawford et al., 2020; Murphy, 2020), our study suggests that a problem-based online course not only works even in an emergency online semester, but may also produce significant learning.

In terms of design improvements, the breakout group discussions yielded several possible improvements for future course iterations. In brief, task descriptions need to be as concise and clear as possible, and to include worked out examples and online meetings. Further improvements include a more specific course overview, featuring weekly task descriptions, and a clearly communicated goal-setting at the beginning of term to set expectations properly. Finally, aside from the well-received instructor communication and feedback, peer communication can be enhanced through the addition of regular and obligatory online plenary meetings. These improvements will be undertaken in further development of this course concept.

6.3. Consequences for educational research

The theory-driven instructional design was the focus of the study, but the resulting research agenda necessarily appears to be the most important part of this discussion. As outlined in our literature review, fake news research has been strongly developing in recent years, mainly positioned in computer science, communication, and social psychology. The fake news related educational research trails somewhat behind, but it is also developing.

Currently, two main research lines stand out, related to interventions based on inoculation and fact checking. In both areas, comprehensive literature reviews and meta-analyses focusing on fake news reception, acceptance, cognitive integration and sharing appear necessary and helpful. Inoculation research has a longer history and has therefore made more progress. Our study was also centered on inoculation. As suggested in the limitations section, the development and validation of measure instruments (including those based on learning analytics) that not only assess fake news credibility, but also give insight into the underlaying cognitive processing, would be fruitful for both lines of research. Laboratory and experimental research on the effects of various intervention design components on fake news processing may largely complement the findings currently available. This may also include both main and interaction effects of inoculation with fact checking, both of interventions with individual traits, and of interventions with various instructional designs. Fake news research should further involve more diverse participants, also including individuals with lower education degrees, higher exposure to fake news, and various political and religious orientation (Pennycook & Rand, 2020).

Research positioned at the cognitive integration level is particularly scarce. Interestingly, conceptual change has been extensively investigated during the last few decades (Amin & Levrini, 2018). However, there are hardly any studies of repairing misconceptions built around cognitively integrated fake news (e.g., Chi, 2013). For a start, this research topic could easily be carried out in the academic world.

Research on online learning, the overarching theme of this special issue, has been conducted at least since the early 1990s, and has become increasingly specialized. Our study calls for research on self-regulated learning skills (Kirschner et al., 2006; Nistor, Dascălu, & Trăușan-Matu, 2020; Pedrotti & Nistor, 2019). In this context, an investigation of students' learning strategies (Broadbent & Poon, 2015; Pedrotti & Nistor, 2019) would be of interest. Furthermore, online communication and collaboration scripts in group-based online courses are essential (Valkenburg et al., 2016). A more in-depth look at the degree of development of these in different student groups could suggest ways of fostering these skills and improving students' learning experience in future collaborative online learning environments.

Author contribution

Christian Scheibenzuber: Conceptualization, Data curation; Formal analysis, Investigation, Methodology, Resources Writing - Original Draft, Writing – review & editing, Visualization Sarah Hofer: Conceptualization, Writing – original draft; Writing – review & editing. Nicolae Nistor: Conceptualization, Supervision, Writing – original draft; Writing – review & editing

Declaration of competing interest

The authors have no conflict of interest.

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General discussion

Overall, this thesis aims to include framing theory into the ongoing academic discourse regarding fake news. In this context, the PKM serves as a framework to comprehend how persuasive messaging, such as news articles full of emotional, value and semantic frames, is processed by humans. In the following, findings from both studies in the context of the PKM will be discussed against the larger corpus of fake news research, followed by an outline for future search.

Implications from Study 1

Study one aimed to investigate the relationship between the framing of fake news content and subsequent online dialog in terms of emotions, argumentation, and social knowledge building. The results of this study suggest that fake news disseminators actively use a wide range of framing techniques, i.e., emotional, value and semantic framing, to skew discussions and propagate misleading information. Results indicate that emotional and semantic framing in posted news articles are predictors for negative emotions in the comments, meaning that these frames successfully completed their task of arousing potential readers. More specifically, negative emotions, particularly anger, substantially outweighed positive ones in online discussions triggered by misinformation, which could increase the sharing of false claims (Bakir & McStay, 2018). Moreover, after analyzing the discussion participants' engagement in regards to social knowledge building a dialog environment dominated by only a few voices became apparent, possibly indicating an echo chamber (Rhodes, 2022). While the role of framing has been researched for decades in propaganda and established media content (e.g., Amsalem & Zoizner, 2022) this study provides a first look into how the framing of fake news specifically can impact its consumers in terms of emotions and discussion amongst each other.

In terms of the PKM, these findings imply that fake news disseminators successfully use their persuasion knowledge, in the form of framing strategies – strategically or unknowingly – to persuade their target audience. This audience of news consumers seems not to hold the necessary degree of persuasion knowledge to spot and identify persuasive tactics used against them – or which is also plausible they simply do not care because the persuasive messages align with their own views and beliefs, i.e., confirmation bias (Moravec et al., 2018; Zhou & Shen, 2022). Accordingly, this distinction has to be investigated in future studies, as well as whether these results can be generalized in regards to the broader public, since this study only featured a very niche slice of online news consumers.

Implications from Study 2

Study two was conducted during the early stages of the Covid-19 pandemic and aimed to create an online asynchronous undergraduate course to address the problem of fake news through fostering media literacy with a problem-based approach. The course was designed using an inoculation approach (e.g., Traberg et al., 2022), which involved developing a framing-centered coding schema to analyze fake news content. Through intense engagement with different framing strategies in the controlled setting of a seminar course, students learned about typical approaches fake news disseminators use when trying to persuade news consumers of faulty and misleading information. Overall, the study suggests that media literacy in terms of knowledge about framing can be fostered through online courses. However, as this study was conducted in an undergraduate university course it is difficult to scale in its current form, similar to many other interventions against fake news, such as fact-checking (Pennycook & Rand, 2021).

In the context of the PKM, the findings of this study indicate that persuasion knowledge can also be gained by specifically teaching learners about persuasive strategies, such as framing,

and not only through actual authentic persuasion episodes. This is in line with previous research on promoting persuasion knowledge in regards to advertising (e.g., Nelson, 2016). However, simply nurturing persuasion knowledge might not be the silver-bullet needed to combat fake news. Results from a recent meta-analysis by Eisend and Tarrahi (2022) indicate that gaining persuasion knowledge does not necessarily result in consumers having complete control over persuasive influences. This suggests that even with the development of persuasion knowledge, news consumers may not fully comprehend all aspects of persuasion tactics and how they operate in an authentic environment, requiring more in-depth interventions. Thus, focusing on teaching persuasion knowledge may not be sufficient to counteract the influence of fake news. Additionally, agent knowledge may be fostered through teaching lateral reading (e.g., Wineburg et al., 2022). Through continued application of that method individuals may gain an ever-growing amount of expertise in evaluating sources and additionally naturally encounter several disseminators of fake news. This in turn would lead to an increase of agent knowledge, hindering future persuasion attempts. Ideally, a bilateral approach should be applied, teaching agent and persuasion knowledge simultaneously.

Overall, potential interventions based on the PKM, that foster persuasion or agent knowledge, might be conflicting with inoculation theory and lateral reading respectively. While each of these approaches has its own sense of purpose, they also come with their advantages and drawbacks. Inoculation-based interventions can be efficiently applied through games such as "Bad News" (van der Linden & Roozenbeek, 2020), but they carry the disadvantage of promoting indiscriminate skepticism towards all types of news - both fake and real (Modirrousta-Galian & Seabrooke, 2023). On the other hand, lateral reading has been shown to be an effective way of fostering information literacy when dealing with dubious sources (e.g., Wineburg et al.,

2022), but it requires significant time investment, which may deter internet users from using it in their day-to-day lives. The PKM provides a framework that combines knowledge from both inoculation-based approaches and lateral reading (persuasion and agent knowledge), and could be a unifying theoretical basis for future media and information literacy interventions that also take into account the role of framing in the propagation of fake news. However, it is largely unexplored in this context, leaving potential for future studies.

Agenda for future research

By including another perspective towards the continuous problem of fake news in the form of framing this thesis aims to broaden both the scope of potential interventions as well as propose an additional explanation in regards to the effects of consuming fake news content, mainly on emotions and subsequent discussions. From this point onward several directions for future research are possible.

Research on fake news framing

For instance, fake news should be compared to traditional reliable news media in regard to the framing strategies used. Are the results found in study one of this paper merely symptoms of a general usage of framing in all types of news media or specific to fake news content? Are there similarities and differences in regards to which frames are most commonly used? For such an analysis, the category system used in study one would provide an ideal starting point.

Furthermore, while Study 1 provides insights into the reactions towards fake news content, these are limited to a very specific target audience: frequent users of an otherwise quite obscure site. It is therefore of interest how other target groups perceive contents from such sites. Thus, lab-based studies with different comparison groups are conceivable. While the main target audience of pure fake news content is arguable difficult to reach for such investigations due to

their skepsis towards mainstream organizations like media or universities, "ordinary" people who may still be at risk of exposure to misleading and outright false information should be more open towards research. In terms of the effects of framing, eye-tracking studies (e.g., Ladeira et al., 2022; Ohme et al., 2022) may provide insights into which visual elements of a news article draw media users attention towards a topic.

Application of the PKM in fake news context

The main research direction from this thesis onward lies in the continued application of the PKM with the goal of designing educational interventions to counter framing in fake news content. Here, one clear gap in research arises: the PKM originally stems from marketing research and has not been integrated into educational science as of yet. Given that the main components of the model focus on different types of knowledge, i.e., topic, persuasion and agent/target knowledge, it is essential to gain an understanding of how this knowledge is represented within individuals. For instance, while Friestad and Wright (1994) state in their original model, that persuasion knowledge can be seen as a form of procedural knowledge that grows through expertise and familiarity with recurring persuasion episodes, the precise nature of this knowledge remains vague. Moreover, the authors suggest that persuasion knowledge is applied similarly to a cognitive schema (Rumelhart, 1984), involving various aspects such as directing consumers' attention towards specific elements of an advertising campaign or sales pitch, drawing inferences about the possible background conditions that led the agent to construct their persuasion attempt in a particular way, making predictions about the likely impact of the attempt on individuals, and assessing its overall effectiveness. This paints the persuasion target as an actively thinking individual reflecting on specific details of a persuasive message. However, as shown by prior research in the context of misinformation, information recipients are

oftentimes too lazy or not sufficiently cognitively engaged to evaluate online information in an effective manner (Pennycook & Rand, 2018). This in turn implies, that interventions designed to foster persuasion knowledge first and foremost need to enable persuasion targets to make use of their existing persuasion knowledge, for example by pointing out specific persuasive strategies commonly used by fake news disseminators, such as framing. Recent research suggests that accuracy prompts, i.e., instructing people to consider accuracy when evaluating news, can lead to better discernment of truthful and fake news (Pennycook et al., 2021). Similarly, teaching people about their own existing persuasion knowledge and having them actively engage with it when evaluating online news content could be a promising way of improving media and information literacy. However, this requires accurate ways of measuring persuasion knowledge in regard to fake news in the first place. While there are validated scales to measure the individual components of the PKM (e.g., Boerman et al., 2018; Ham et al., 2015), these focus on the original context of marketing and advertising and need to be translated into the context of fake news or online misinformation in general. Similarly, investigating and improving agent knowledge follows the same principle.

Following this, a series of clear and explicit steps for future research becomes evident. The first step is to either translate current scales into ones that can effectively measure persuasion knowledge or to create whole new scales. In a second step data on online users' existing persuasion knowledge on framing needs to be collected, ideally with a heterogenous group including different social and educational backgrounds. After gathering the data, the next step is to identify any gaps or restrictions in the consumers' knowledge. In a fourth step, once internet users' existing persuasion knowledge can be properly measured, targeted educational interventions to bolster lackluster knowledge can be developed. These could be designed

comparably to inoculation approaches (e.g., van der Linden & Roozenbeek, 2020) to improve internet users' persuasion knowledge by making common strategies of fake news disseminators visible. Lastly, in the fifth step, the intervention is carried out and its effectiveness is assessed using a knowledge test. For example, a pre-post-control-group-design with an additional delayed posttest could be used to discover whether the intervention carries any long-term effects.

To illustrate, after participating in such an intervention internet users would ideally be familiar with, for instance, a specific mediums' (agent knowledge) use of semantic framing in headlines (persuasion knowledge). When they encounter a suspicious of a piece of information that uses this style later on in their own information ecosystem, they would be suspicious of a instead of blindly falling for the persuasion strategy. However, one major challenge remains: these interventions can also lead to indiscriminate scepsis towards all kinds of information (Modirrousta-Galian & Seabrooke, 2023) which leads to less trust in reliable news media as well. Possibly, this balancing act needs to be supported by a renewed understanding of information literacy (Kiili et al., 2023) in order to design overarching interventions that tackle all different aspects of the multifaceted problem that is fake news.

Conclusion

This thesis presents some of the overarching theories around the phenomenon of misinformation as well as two studies on the role of framing in the propagation of fake news and one intervention against it. As such, it introduces another perspective of online misinformation as well as a potential remedy for this issue.

This examination of the impact framing has on the reaction of news consumers, both emotional and discursive, has revealed that the way in which online information is presented can have a significant influence on how it is received and interpreted by audiences. Through the

framing analysis, it is apparent that different frames – emotional, value-based and semantic – can shape the narrative around an issue, influencing readers' opinion and potentially exacerbating divisions within society. Furthermore, study two highlights the importance of media literacy in combating the spread of fake news through promoting persuasion knowledge. By educating individuals on the various framing techniques used to manipulate information they can be empowered to make informed decisions and resist the influence of persuasive frames. Overall, this analysis suggests that the role of framing in the propagation of fake news is complex and multifaceted, and requires a comprehensive approach that uses not only one single tool, such as inoculation, but an entire toolbox of approaches from a multitude of disciplines.

To summarize, this thesis provides an additional perspective to this issue by integrating the persuasion knowledge model, more specifically framing, and its impact on internet users while proposing potential interventions and future research opportunities from the viewpoint of educational science. With fake news being one of the great challenges of modern times and educators, journalists, researchers, big tech companies, and governments continuing the search for effective ways to counteract it, this work can be one of the pieces that helps stem the tide of false and misleading information.

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