

# The Role of Epistemic Emotions During Engagement with Online Information Encounters

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**Abstract:** This exploratory case study aimed to understand to what extent epistemic emotions are connected to effortful engagement when young adults were incidentally exposed to textual information snippets on a simulated social media timeline. Using discourse analysis, we draw on think-aloud data from fifteen young adults, to identify participants' emotional reactions to different textual snippets and to examine when these might prompt effortful engagement, as indicated by reliance on epistemic beliefs, source evaluation, evidence evaluation or science literacy. Our findings provide two important insights. We found that during online information encounters, frustration, curiosity and confusion were co-occurring with effortful engagement and were triggered, in particular, by posts that included negative words. We also found that epistemic engagement occurred even when boredom was verbalized first and was followed by frustration or confusion. We discuss the implications of this work for informal and formal learning environments.

## Introduction

The COVID-19 pandemic, and the viral spread of misinformation through social media outlets, highlighted the importance of citizens' critical consumption of information in online social networking spaces, such as Twitter or Facebook. Amidst an information-saturated environment, snippets of information are constantly vying for people's attention on social media. Given growing concerns about people's ability to critically reason with information when the boundaries of accurate and inaccurate information are not always clear, evaluating information online has emerged as a pressing education challenge, which necessitates new approaches that facilitate learning (Chinn et al., 2020), especially for those outside formal education (Lee, 2018).

Our work is motivated by the belief that the learning sciences should increase efforts to understand social media as contexts where learning can potentially happen and investigate how the experiences in such spaces can be scaffolded to afford more opportunities for learning. These inquiries can also help us examine how we can prepare youth in formal educational settings so that they can develop skills to navigate the plethora of information confronting them in everyday social media use outside of formal educational settings. Recent efforts to conceptualize how informal learning happens during incidental exposure to information online (Greene et al. 2020), situate learning in people's routine online *information encounters*, a term we use to refer to the information that individuals are incidentally exposed to while navigating online spaces.

The data we report on are part of a larger study seeking to understand what influences epistemic engagement with misinformation on social media. During online information encounters, people's knowledge, skills and cognitive biases may limit one's ability to evaluate information using appropriate criteria or processes (Barzilai & Chinn, 2020). However, so can emotions (Martel et al., 2020). In prior work with a representative sample of 177 adults, we found that epistemic beliefs were statistically significant when examining sharing patterns on Twitter: participants who held more salient epistemic beliefs about science were less prone to share misinformation. We continue this work by reporting on efforts to understand the role of epistemic emotions during incidental encounters with online information on social media. In this context, we ask if epistemic emotions are manifested during such encounters, and whether they are connected to epistemic engagement.

## Theoretical framework

### Online information encounters, emotions and learning

Our work draws from research on informal learning on social media and the role of emotions in cognitive engagement. We next present the main arguments from the literature that informs our work. First, we seek to expand our conceptualization of learning to include learning from incidental exposure to information on social media. Even though social media platforms used for everyday communication were not structured with learning

in mind, it has been argued that they hold potential for informal learning (Greene et al., 2020; Greenhow et al., 2019; Tabak & Dubovi, 2021). According to Greene et al. (2020), merely coming across and noticing information online does not necessarily predicate engagement. Instead, they posit that noticing can result in automatic processing, which is unconscious, or deliberate information processing, which is effortful. Effortful activity directed at achieving epistemic aims, either individually or with others, can constitute engagement with information when it is supported by cognitive and motivational processes (Hendricks et al., 2020). This is in line with dual process models of cognition (Evans, 2008) though the place that emotion holds in this configuration is less clear (da Sousa, 2009). Second, we know that emotions play a role in whether individuals choose to process information more effortfully, with the literature supporting that reaching an impasse during information encounters is more likely to result in less engagement (D'Mello & Graesser, 2012), which could potentially lead to endorsing information that is inaccurate. Finally, a growing body of empirical research suggests that epistemic emotions, whose focus is the generation of knowledge (Pekrun & Stephens, 2012), can encourage effortful engagement with information (Vogl et al., 2020). However, less is known about the epistemic emotions that emerge during information processing, which have a knowledge-generating focus (Pekrun & Stephens, 2012), and their connection to learning during information encounters on social media.

### Epistemic engagement with online information

Hendriks et al. (2020) posit that *epistemic beliefs*, *source evaluation*, *evidence evaluation*, and *scientific literacy* can support effortful engagement with information. Building on the work of Chinn et al. (2014) effortful engagement with online information is grounded in epistemic practices. During online information encounters, individuals effortfully engage with information when they set epistemic aims, such as seeking knowledge; rely on epistemic criteria to evaluate the information at hand; and when they rely on processes and strategies that ensure their epistemic aims are achieved. To this end, *epistemic beliefs* can instigate effortful engagement which can lead to the achievement of epistemic aims (Barzilai & Zohar, 2016).

Epistemic engagement can also take the form of *source evaluation* when individuals assess the epistemic authority of the person behind the information. The use of scientific language may suggest expertise in a scientific topic (Thon & Jucks, 2017), but evaluating the underlying motives for posting a piece of information – whether to persuade or inform, or when the information is two- versus one-sided – also factors into how a source is evaluated. Evaluating information that comes into conflict with one's prior beliefs about a topic can also encourage more effortful engagement with information (Bråten et al., 2016).

Examining how and if knowledge claims are justified (*evidence evaluation*) can lead to achieving one's epistemic aims. Sinatra and Lombardi (2020) suggest that effortful engagement can stem from plausibility reappraisals, whereby individuals evaluate the connections between evidence and alternative explanations. The amount of evidence that is provided in support of a scientific claim also matters (Corner & Hahn, 2009), as does the type of evidence (Hornikx, 2008). When it comes to evidence, effortful engagement is also aided by *scientific literacy* and an awareness of the tentative nature of scientific knowledge claims. Public understanding of science may be bounded, and effortful engagement may be hindered by challenges in reasoning about processes in knowledge and knowing, as well as cognitive biases and misconceptions (Sinatra et al., 2014). During effortful engagement individuals consider how scientific endeavor produces reliable knowledge through epistemic processes (Duncan et al., 2018). By being mindful of the epistemic quality of the information they are incidentally exposed to, individuals' effortful engagement is intentional, guided by the goal to arrive at epistemic ends.

### Epistemic emotions and effortful engagement

How individuals experience epistemic emotions is also influenced by one's epistemic cognition (Chevrier et al., 2019). Seven epistemic emotions (*surprise*, *curiosity*, *confusion*, *enjoyment*, *anxiety*, *frustration* and *boredom*) have garnered the most empirical and theoretical attention (Muis et al., 2018). *Surprise* arises when information is appraised as novel and involves an incongruity between what one already expects or believes (Meyer et al., 1997); it can often precede confusion when the information encountered is assessed as incomprehensible. The level of surprise may also play a role in what epistemic emotions individuals experience during information appraisals. When the level of surprise is high, individuals are likely to experience curiosity or confusion, depending on the complexity of the information or task at hand. When new information cannot be integrated into existing mental schemata, an impasse is reached, and individuals may also experience *confusion*, which can trigger *frustration*, and eventually *boredom*, which leads to disengagement, if the impasse is not overcome through a thoughtful and reflective process. Overcoming the impasse through cognitive engagement can result in *enjoyment* (D'Mello & Graesser, 2012). On the other hand, *epistemic anxiety* can lead to more engagement since it alerts to important weaknesses in one's epistemic position (Hookway, 2011); the higher the stakes for not knowing, the greater the epistemic anxiety. Such occasions lead to greater engagement in order to gather more

evidence (Nagel, 2010). Similar engagement can result when experiencing *curiosity*, which emerges when one becomes aware of a gap between what they know and what they do not (Loewenstein, 1994) and this can influence whether individuals engage with information in a deliberate and intentional manner. However, experiencing curiosity alone may not be enough to ensure that more effortful engagement occurs. Muis et al. (2018) found that curiosity positively predicted a more reflective stance towards information, but the type of textual information (expository or refutational) played a role in this. Prior work by D’Mello and Graesser (2012) has examined the interplay between emotions and engagement — which the authors conceptualized as being in a state of concentrated flow — during complex learning, but what happens during incidental online encounters, where individuals may often be predisposed to approach information with goals other than learning, is less clear.

## Methods

### Participants and Procedure

Participants were recruited through an open call posted in a Facebook group with 123 members. Fifteen respondents (12 females), ages 20-28 years old, opted to participate in the study. All participants reported using at least two, and as many as seven, social media platforms in their daily routines.

We chose to focus on health as a topic, and specifically on COVID-19. Think-alouds were used to capture participants’ reactions as they viewed social media posts using a simulated Twitter timeline. Due to COVID-19, all interview sessions took place online using a video conferencing software. As this study was part of a larger effort examining socio-technical approaches to mitigating online misinformation, all participants viewed the same set of stimuli, which consisted of two baseline posts, without credibility labels, and then six other social media posts that included credibility labels. Posts were a mix of accurate or misinformative posts; four accurate posts were retrieved from news organizations such as The New York Times, and official health organizations such as the World Health Organization and the US Center For Disease Control, while four misinformative posts were retrieved from the International Fact Checking Network (IFCN) Coronavirus Alliance database.

Each participant was asked to share their screen and to externalize their thoughts as they were deciding on whether to take an action (i.e., “like” a social media post). The interviewer first shared the link to the two baseline posts and asked participants to externalize their thoughts. The aim of this task was to familiarize participants with the think-aloud method, but also provide a baseline for comparison for emotions experienced when viewing information with credibility labels. Participants were then presented with the simulated COVID-19-related social media posts on Twitter and were asked to explain whether they would “like” any of the posts. To avoid priming the participants’ information evaluation processes, they were not informed of the presence of the credibility labels during the think-aloud. The average duration of each think-aloud session was 14 minutes.

### Data Coding and Analysis

All sessions were recorded and transcribed verbatim; they were coded in NVivo, using a coding scheme for epistemic emotions by Chevrier et al. (2019) capturing the seven epistemic emotions that have received the most attention in the literature (Table 1). Data coding occurred in iterative cycles; part of the data were coded by two researchers, then discussed to resolve discrepancies, and the process was repeated. We coded emotion only when it concerned information relating to the social media posts. To answer our research questions, we also analyzed the data using a second coding scheme to capture epistemic engagement by Hendriks et al. (2020): *epistemic beliefs*, *source evaluation*, *evaluation of evidence* and *scientific literacy*. To identify the emotions connected with most epistemic engagement, we examined the coding intersections between the verbalized epistemic emotions and the epistemic engagement episodes, and how these varied across each of the eight social media posts.

**Table 1**  
*Coding Scheme For Epistemic Emotions*

| Epistemic emotion | Description           | Example  |
|-------------------|-----------------------|--|
| Surprise          | Astonished, amazed    | [reads post aloud] ‘ <i>Experts warn that protective face masks can reduce oxygen flow to the blood by 20%. What?</i> ’ P9   |
| Enjoyment         | Excited, enthusiastic | “ <i>OK, it’s pretty great, I mean... any person that gets a Nobel, I mean. I see an emphasis on the fact that it’s women, which tells me that it’s not common for a woman to get a Nobel prize in Chemistry. And it makes it even greater.</i> ” P3 |
| Curiosity         | Interested, intrigued | “ <i>But I’m also, like, just wondering...where. What is this COVID-alert? Like, who is this account? Like, is it a health</i>   |

|             |                         |   |
|-------------|-------------------------|---|
| Confusion   | Puzzled, muddled        | <i>organization? Is it just someone compiling loads of information and putting it out there as a sort of COVID account?" P1</i><br><i>"[reads post aloud] 'Belgian study proves hydroxychloroquine is effective against COVID-19. Specifically, it can help prevent breathing problems.' Yeah, I mean, I don't even... hydro-chloro-qui... I don't know what that is." P9</i> |
| Frustration | Irritated, dissatisfied | <i>"So it makes me feel like someone who wrote it is a bit unreliable and doesn't actually have a clear thing... or a clear understanding of what they are trying to say. And I'm not sure what kind of point... what is the goal of this tweet?" P11</i>   |
| Anxiety     | Worried, nervous        | <i>"I wouldn't like it because then I would also spread panic, without knowing if this statement is true or false, if it can help. Not panic... but to spread this misinformation that, you know, take this thing [hydroxychloroquine] to get better, which might be false, might be true." P13</i>   |
| Boredom     | Dull, monotonous        | <i>"To be honest, if this was on my feed, I probably wouldn't read it. But... I'd probably, like, click on the Covid Alert and click unfollow." P19</i>   |

## Findings

This study investigated the extent to which epistemic emotions manifested during incidental information encounters and if these were connected to epistemic engagement. To do this we coded for epistemic emotions and epistemic engagement. All participants expressed epistemic emotions, but these varied across different posts and participants. This suggests that the topic and individual characteristics matter when experiencing epistemic emotions during information encounters. Boredom was the emotion that was most frequently experienced, which is perhaps not surprising considering that the simulated timeline was not customized or curated to match each participant's interests and motivations. However, our findings suggest that even when boredom was the first emotion verbalized during a post, this did not always lead to disengagement. Participants who transitioned to other emotions following boredom, were able to effortfully engage in assessing information reliability. Frustration, confusion and curiosity also emerged as emotions experienced frequently, as did enjoyment. Epistemic anxiety and surprise were not experienced as much. Table 2 provides the frequencies for verbalized epistemic emotions.

**Table 2**  
*Frequencies Of Verbalized Epistemic Emotions*

|   | <b>Boredom</b> | <b>Frustration</b> | <b>Confusion</b> | <b>Curiosity</b> | <b>Enjoyment</b> | <b>Anxiety</b> | <b>Surprise</b> | <b>Total</b> |
|---|----------------|--------------------|------------------|------------------|------------------|----------------|-----------------|--------------|
| # | 40             | 32                 | 30               | 29               | 28               | 9              | 4               | 172          |

Participants effortfully engaged with information in combination with emotions such as frustration, curiosity, and confusion. Epistemic engagement mostly manifested as source and evidence evaluation. Participants questioned references to abstract sources (e.g., "US scientists"), expressed the desire to check the source, or questioned the lack of URLs to support the claims made in the tweets. These suggest that even though participants could only verbalize their intentions, their engagement was motivated by epistemic aims which could lead to learning. They sought to achieve these aims through follow-up actions, or by maintaining a critical stance towards the information they encountered.

Additionally, participants epistemically engaged with some social media posts more than others. Participants engaged more effortfully with the two media posts which included negative words such as "dangerous", "worse", "death", "kills", and verbalized emotions such as frustration, confusion, and curiosity during these information encounters. Most notable, however, was the post that received the highest count for verbalized boredom, which also received the most effortful engagement; we found that when boredom was experienced first and then other emotions occurred, it led to epistemic engagement. We next present the two main themes connecting the most frequently reported emotions with epistemic engagement.

### Theme 1: Frustration, curiosity and confusion were connected to epistemic engagement

Our examination of the coding intersections between the participants' verbalized epistemic emotions and epistemic engagement revealed that frustration was connected with most epistemic engagement episodes (30

coded episodes), followed by curiosity (27 coded episodes), and confusion (15 coded episodes). Frustration was sometimes predicated by confusion. However, frustration frequently served as a catalyst for participants to more consciously engage with the information epistemically, by calling into question the source of information or the evidence used to support the information claims in a post. For instance, in the excerpt below, P11 first experiences confusion, and then frustration, and it is during this emotional response that P11 pays closer attention to the epistemic qualities of the information at hand:

- (*Confusion*) I wouldn't like this tweet because I'm reading it and I don't really understand part of it, because it says that it's only very marginally worse, so the word only and very marginally – only and very contradict each other.
- (*Frustration*) So it makes me feel like someone who wrote it is a bit unreliable and doesn't actually have a clear thing... or a clear understanding of what they are trying to say [**source evaluation**]. And I'm not sure what kind of point... what is the goal of this tweet? [**source evaluation**].
- (*Confusion*) Because I'm not ... I can't understand if it's trying to get me more relaxed or if it's actually trying to make me more alarmed because the combination of "only very marginally" is confusing.

In the above excerpt, the participant more closely evaluates the source and questions the author's intent. The participant is responding to a post comparing the COVID-19 death rate to that of the flu, and which included negative words such "death", "kills", "worse". The emotional reactions to this post suggest that the inclusion of such words may have triggered emotions such as frustration among participants, as they were trying to make sense of the information at hand. Participants responded similarly to a post characterizing the COVID-19 vaccine as "dangerous"; the use of this negative word, possibly in conjunction with the controversial nature of the topic, prompted frustration alone, or frustration experienced with emotions such as curiosity and confusion. In both contexts, participants questioned the evidence in support of the claim. For instance, the excerpt below illustrates how frustration led to paying closer attention to the epistemic aspects of the information encountered.

- (*Frustration*) "It says about a big scientific study, but of course again it doesn't have some... it doesn't have some link, like, 'go here to see this study'. It's just a few words, just like I can write this tweet, with no knowledge [**evidence evaluation**]. Because it says here it's uncertain [reads the credibility label], it's not a very credible Twitter account. Again, personally I wouldn't spread this statement. Even if it's right or wrong. Not right or wrong, but if it's true. I wouldn't like, I wouldn't retweet or share, or even say it myself [**epistemic beliefs**]. And I'm one of those people who mostly think scientifically, not in conspiracies, and I would like more... the evidence of this study to believe it [**evidence evaluation**]." [P13]

In other instances, the use of the word "dangerous" led participants to experience curiosity because they were aware that the topic was controversial or held potential for misinformation, as illustrated by P6:

- (*Curiosity*) "For this one I might search for more information, because there are a lot of hoaxes about microchips, and that the COVID-19 vaccine is dangerous. So, I would search to find out more about why they are saying it's dangerous, and what is this study? Because it doesn't refer to it at all [**evidence evaluation**]."

However, the uncertainty surrounding the topic of vaccination, also played a role in how participants emotionally responded to this post. For instance, in the following excerpt, P5 verbalizes confusion about what to believe on the topic, and also expresses anxiety, albeit it, not epistemic anxiety, since it does not prompt increased engagement with the information, but a tendency to escape it:

- (*Confusion*) "I don't know about this one 'cause I heard that most vaccines, even though it might help with this specific virus or flu, or whatever, it can have some side effects in the future. So, yeah. It's kind of dangerous but we don't know about that because it didn't... we don't know the future, so it is uncertain [**epistemic beliefs**]. Like, it makes my mind go weird like with all of this information, because it does increase anxiety. 'Cause it does conquer our lives, unfortunately. And having a lot of information about it is not nice."

Frustration, curiosity and confusion were also expressed sequentially for individual social media posts, and the transition between different emotions during the online information encounters suggests that far from blocking engagement, frustration may be conducive to prompting more epistemic engagement. The following excerpt by P12 exemplifies epistemic engagement and highlights how frustration may serve to sustain engagement longer while assessing the quality of information claims online.

- (*Confusion*) “So, obviously the “Not Credible” has completely thrown me off [**source evaluation**].
- (*Curiosity*) “The Ioannidis study’... the fact that there’s a specific study makes me question... I would, obviously, again, go research this study. I want to see more towards what they actually... what variables they used to convey the study [**scientific literacy**]. I also believe that this is just a very generic statement. The fact that “it’s only marginally worse than the standard flu”, although I... a part of me initially agreed with this statement, I feel it’s also very limited. I feel there’s no proof towards this... there’s not credibility to this, within this statement.
- (*Frustration*) [...] I feel like this is a statement that is said... It’s my thought process is that this feels like this is a very unprofessional statement. The way it’s also written, I don’t know why [**source evaluation**]. I don’t know if there is hardly any...[pauses] I don’t know! I can’t think about this.
- (*Confusion*) I just feel like I wouldn’t like this statement. I feel like I’d validate... I definitely, again, this “not credible” source is throwing me off [**source evaluation**]. Definitely the fact that there is no... I feel also, when it comes to any statement that has statistics, I believe it more. Even though the first one, with the 20%...I don’t, because I feel like that’s too much of a perfect number [**evidence evaluation**].
- (*Frustration*) But it’s also this “it’s only very marginally worse than the standard flu virus that kills hundreds of sick and elderly every year.” It seems very unprofessionally written as well. I don’t know why [**source evaluation**].”

## Theme 2: Experiencing boredom first does not always preclude epistemic engagement

The post which received the highest count for verbalized boredom was also the one that received the most effortful engagement, as suggested by the source and evidence evaluation statements. When participants verbalized boredom first, and then transitioned from this state of disengagement to verbalize other emotions, epistemic engagement occurred. This was observed during the participants’ verbalizations relating to a social media post on research in relation to COVID-19 decontamination using UV light. When participants experienced only boredom, no epistemic engagement was observed. When boredom was followed by other emotions, such as confusion or frustration, participants engaged with the information epistemically. In the excerpt below by P5, the initial emotional response of boredom suggests disengagement, yet P5 is able to transition from boredom to epistemically engage with the information:

- (*Boredom*) “For me, it’s irrelevant to me, even though, like, Coronavirus is kind of, like, dictating our lives in a way. There’s too much information on the topic so I don’t know if I would want to follow it, just because I know cookies exist and more information about the virus would bombard me, so I think...
- (*Confusion*) it’s good information, but I wouldn’t like it. Cause I don’t know what to believe nowadays, like. ‘Cause there’s so much information going on about it, that I don’t know if it’s true or not. And I don’t know the username. [...] And there’s no picture in the username, so I don’t know if it’s a valid point or not, to believe [**source evaluation**]. So yeah, that’s it.
- (*Frustration*) And also, Coronavirus is not in capital letter, so it’s a bit unprofessional in my opinion [**source evaluation**].”

Another participant (P4) clearly expresses boredom based on the way the information is presented. However, this initial reaction does not prevent epistemic engagement, and in fact the transition from boredom to emotions that enable the participant to interrogate the information quality of the post is illustrated in the following example:

- (*Boredom*) “I don’t think I would click it because it’s not attracting me to be like, ‘Oh yes, like, I like this’. It’s something positive, obviously, because it’s concerning the pandemic, but it’s not something, I guess. It’s not worth, I guess, clicking the screen. It’s, I guess, good news, yay!

- Research! But that's it. It's not really saying who really made the breakthrough or something, it's just saying the statement about the research **[source evaluation]**. Yeah, I don't think I would click like. It's not saying anything else. It doesn't make me want to click the page.
- (Curiosity) Actually, I would click the page to find something more available about this statement, but I think it's a bit plain what the research is about. Like, "US scientists" – is it the university, is it private lab? If it is... **[evidence evaluation]**
- (Frustration) It's 'Latest News', OK. It doesn't sound like a scientific page because if it was a scientific page, a science-related page, I would assume it would mention more details about the research, but maybe it would be nice if they tagged maybe the page of the scientists that made the breakthrough **[source evaluation]**."

## Discussion

During online information encounters, the information individuals are incidentally exposed to can trigger emotions that can impact one's online actions; this has consequences in the context of misinformation. These encounters also hold serious implications for sustaining an engaged and informed citizenry online given that information that appears on social media is often emotionally appealing. In this exploratory study, we sought to gain further insights into the role of epistemic emotions when individuals assess the quality of information they encounter and whether these emotions are connected to effortful engagement with information. Our findings suggest that during online information encounters, frustration, confusion, and curiosity are connected to epistemic engagement. This connection was particularly observed for social media posts that used negative language and for controversial issues. In such posts, participants paid closer attention to the source of information, or requested more evidence to support the claims raised in the post, and sometimes verbalized intentions to take additional actions such as searching for information or checking the source. Our study design prevented participants from following up, which is a limitation; however, these verbalizations signify an intentionality towards achieving epistemic aims. Even when boredom was experienced first, epistemic engagement can occur if boredom transitions to confusion or curiosity. Further understanding the contexts in which experiencing boredom first in a sequence of emotions can preclude disengagement online merits further exploration.

We believe this exploratory study contributes to understanding how epistemic emotions may prompt epistemic engagement with information online. It also underlines the need for new instructional approaches in formal education that can promote epistemic engagement online by supporting students during their online information encounters in differentiating between evidence-based claims versus speculation. Additionally, epistemic engagement in this study mostly manifested through source and evidence evaluation, with fewer instances of epistemic beliefs and scientific literacy. How might instructional approaches to evaluating information quality online be reimagined to strengthen epistemic practices and scientific literacy? Information environments online are not usually designed for learning, and even constrain effortful engagement by design (Hendriks et al, 2020). In such spaces, how might scaffolds aid users outside formal education deepen their epistemic engagement? Understanding the role that emotions play during effortful engagement can also inform the design of authentic online environments that learners routinely navigate to access and retrieve information (Chinn et al., 2020). This may narrow the gap between formal and informal learning.

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