

What are you feeling right now? Moving beyond self-report as a method for measuring epistemic emotions

¿Qué estás sintiendo ahora mismo?
Superando el autorreporte como método de medición en emociones
epistémicas

O que você está sentindo neste exato momento?
Superando o auto-relato como método de medição das emoções
epistêmicas

Jazmín Coli¹

Bernardo Chocobar²

Israel Alegría³

María Rosa Lissi⁴

Christian Sebastián⁵

RESUMEN

Las emociones epistémicas son aquellas que emergen en el acto de conocer o frente al conocimiento (Vogl et al., 2020). En la literatura se ha identificado para cada emoción particular una función en el proceso de aprendizaje. Estas han sido observadas principalmente a través de cuestionarios de autorreporte. Si bien estos instrumentos constituyen un aporte, presentan también limitaciones que podrían afectar las comprensiones del constructo. Por ello, el objetivo de este artículo es ilustrar formas alternativas de operacionalizar las emociones epistémicas, específicamente en su medición. Se realizó una revisión bibliográfica de los instrumentos de medición existentes y se construyó un prototipo de libro de códigos utilizando como base la matriz de codificación de Henríquez (2022), la cual se modificó a partir del análisis de videos y de la literatura revisada. El prototipo

¹ Pontificia Universidad Católica de Chile. Escuela de Psicología. Orcid: <https://orcid.org/0009-0004-7900-6794>. E-mail: jacoli@uc.cl.

² Pontificia Universidad Católica de Chile. Escuela de Psicología. Orcid: <https://orcid.org/0009-0002-5067-8912>. E-mail: beka.chocobar@uc.cl.

³ Pontificia Universidad Católica de Chile. Escuela de Psicología. Orcid: <https://orcid.org/0009-0004-6750-1798>. E-mail: iaalegria@uc.cl.

⁴ Pontificia Universidad Católica de Chile. Escuela de Psicología. Orcid: <https://orcid.org/0000-0002-9740-6853>. E-mail: mlissi@uc.cl.

⁵ Pontificia Universidad Católica de Chile. Escuela de Psicología. Orcid: <https://orcid.org/0000-0001-5038-9227>. E-mail: csebasti@uc.cl.

permitió codificar las siete emociones epistémicas descritas en la literatura. Las emociones se pudieron codificar en función de quién la experimentó (emociones intraindividuales versus interindividuales), y de manera no excluyente (se pudo codificar emociones particulares, así como emociones coexistentes en un mismo segmento). Estos resultados permiten cuestionar las funciones tradicionalmente atribuidas a cada emoción epistémica, invitando a reflexionar sobre la relación bidireccional entre teoría y medición en la comprensión del fenómeno. Se discuten limitaciones y proyecciones del instrumento.

Palabras-clave: Emociones epistémicas; Instrumento de medición; Emociones en el aprendizaje; Argumentación; Procesos distribuidos.

ABSTRACT

Epistemic emotions are those that arise in the act of knowing or in response to knowledge (Vogl et al., 2020). Existing literature has identified a specific function for each particular emotion within the learning process. They have been observed primarily through self-report questionnaires. While these instruments have proven valuable, they also present limitations that could constrain our insight into the construct. Therefore, this article aims to illustrate alternative ways to operationalize epistemic emotions, specifically regarding their measurement. To this end, a literature review of current measurement instruments was conducted, and a prototype codebook was developed based on Henríquez's (2022) coding matrix, which was subsequently modified through video analysis and the reviewed literature. This prototype enabled the coding of the seven epistemic emotions described in the literature. These emotions were coded based on who experienced them (intraindividual versus interindividual emotions) and in a non-exclusive manner (allowing for the coding of both specific emotions and coexisting emotions within the same segment). These findings challenge the functions traditionally attributed to each epistemic emotion, inviting reflection on the bidirectional relationship between theory and measurement in understanding this phenomenon. Finally, the limitations and future avenues of the instrument are discussed.

Keywords: Epistemic emotions; Measurement instrument; Emoticons in learning; Argumentation; Distributed processes.

RESUMO

Emoções epistêmicas são aquelas que emergem no ato de conhecer ou em resposta ao conhecimento (Vogl et al., 2020). A literatura identificou uma função no processo de aprendizagem para cada emoção específica. Essas funções foram observadas principalmente por meio de questionários de autorrelato. Embora esses instrumentos sejam valiosos, eles também apresentam limitações que podem afetar nossa compreensão do construto. Portanto, o objetivo deste artigo é ilustrar maneiras alternativas de operacionalizar as emoções epistêmicas, especificamente em sua mensuração. Foi realizada uma revisão da literatura sobre instrumentos de mensuração existentes e um protótipo de livro de códigos foi desenvolvido utilizando a matriz de codificação de Henríquez (2022) como base. Essa matriz foi modificada com base na análise de vídeos e na literatura revisada. O protótipo permitiu a codificação das sete emoções epistêmicas descritas na literatura. As emoções puderam ser codificadas de acordo com quem as vivenciou (emoções intraindividuais versus interindividuais) e de forma não exclusiva (foi possível codificar tanto emoções individuais quanto emoções coexistentes no mesmo segmento). Esses resultados permitem questionar as funções tradicionalmente atribuídas a cada emoção epistêmica, suscitando reflexões sobre

a relação bidirecional entre teoria e mensuração na compreensão do fenômeno. Limitações e direções futuras do instrumento são discutidas.

Palavras-chave: Emoções epistêmicas; Instrumento de mensuração; Emoções na aprendizagem; Argumentação; Processos distribuídos.

1 Introduction

Epistemic emotions are those that arise in the act of knowing or in response to knowledge (Vogl *et al.*, 2020), which makes them particularly relevant when studying the learning process. Various research teams have observed their impact on academic achievement (Chevrier *et al.*, 2019; Di Leo *et al.*, 2019) and on engagement in complex academic tasks (Muis; Chevrier; Singh, 2018; Vogl *et al.*, 2020), as well as a close relationship with other constructs such as critical thinking and metacognitive feelings (Muis *et al.*, 2021; Nerantzaki; Efklides; Metallidou, 2021).

Although research in this area is relatively recent (López-Cassà; Bisquerra Alzina, 2023), the field of epistemic emotions has been established through theoretical models (Muis; Pekrun; *et al.*, 2015; Muis; Chevrier; Singh, 2018), measurement instruments (Pekrun *et al.*, 2016), and interventions for emotional regulation in learning contexts (Di Leo; Muis, 2020; Kohatsu *et al.*, 2025).

Despite these significant advances, some research teams argue that there is a noticeable tendency to conceive of emotions—both theoretically and empirically—as an epiphenomenon of learning, establishing mechanical and/or causal relationships that denaturalize affective processes (de Paula *et al.*, 2023; Haye; Carballo, 2017; Sánchez; Sebastián, 2024). This denaturalization has consequences not only for how the object of study is defined but also for its operationalization, insofar as the conceptualization of phenomena guides the design of interventions as well as the instruments used to measure them.

With these insights in mind, we believe it is pertinent to analyze the current ways in which epistemic emotions are operationalized—specifically through their measurement—in order to explore alternative ways of observing this construct. We propose that these alternative forms of measurement must take these theoretical and practical challenges into account from their initial design, in order to enable, in the best-case scenario, more comprehensive observations and interpretations of the emotions experienced during the learning process.

2 Background

Epistemic emotions have been defined as those that emerge in situations related to knowledge generation, particularly in situations where cognitive incongruence is experienced (Di Leo *et al.*, 2019; D'Mello; Graesser, 2012; Vogl *et al.*, 2020); that is, situations involving discrepancies between prior schemas and new information. Among researchers studying this field, there is relative agreement on seven epistemic emotions: surprise, curiosity, confusion, enjoyment, frustration, anxiety, and boredom (López-Cassà; Bisquerra Alzina, 2023).

Each of these emotions is thought to play a specific role in the learning process (Chevrier *et al.*, 2019; Di Leo *et al.*, 2019; D'Mello *et al.*, 2014; D'Mello and Graesser, 2012; Muis, Psaradellis, *et al.*, 2015; Vogl *et al.*, 2019). Researchers tend to agree that, when faced with a cognitive incongruity, the first emotion to arise is epistemic surprise; meanwhile, they associate the desire to understand or solve the task with epistemic curiosity. If the student manages to resolve the incongruity, then epistemic enjoyment emerges. On the other hand, epistemic frustration is related to the persistent failure to resolve an incongruity, positively correlating with epistemic anxiety, which in turn refers to doubt about one's own ability to solve the task. Both epistemic frustration and anxiety, if sustained over time, increase the likelihood that the student will disengage from the task—an action typically associated with epistemic boredom.

Meanwhile, there is a debate regarding the role of epistemic confusion. Some studies have found that students who experience epistemic confusion and then successfully complete the task perform better than those who completed the task but did not experience confusion (D'Mello *et al.*, 2014; Munzar *et al.*, 2021). However, in a recent study, a research team attempted to induce the experience and resolution of epistemic confusion following the guidelines of previous studies, but found no association with improved performance (Kohatsu *et al.*, 2025).

2.1 Measurement of Epistemic Emotions

Epistemic emotions have been measured predominantly through self-report instruments, generally in the form of questionnaires with Likert-type questions. The most widely used instrument for this purpose is the *Epistemically-Related Emotion Scales* (Pekrun *et*

al., 2016), a 21-item self-report Likert-type questionnaire that covers the seven epistemic emotions listed above. This instrument has been translated into other languages (Ahvanuiee; Kareshki; Yazdi, 2023; Balaž; Pavlin-Bernardić, 2022) and has undergone multiple psychometric analyses that attest to its importance in the field (Pekrun, 2016).

To a lesser extent, *think-aloud* procedures have also been used, in which prompts are provided to support the self-identification of emotions. For example, in the *Emote-aloud procedure* (D'Mello; Graesser, 2012), participants are presented with a list of seven emotions from which they select the one they are experiencing; and in the *Retrospective Self-Reported Affect Judgment Protocol* (Chipman *et al.*, 2006), video recordings of participants' faces were used so that, also using a list, they could self-report their emotions.

To a limited extent, some researchers have explored external measures of epistemic emotions through the analysis of texts produced by students (Ortega, 2022; Valdivia-Yábar, 2025) or through the observation of videos by third parties (Henríquez, 2022). However, of these studies, only one published a codebook, which includes indicators, physical cues, and counter-indicators for the seven epistemic emotions (Henríquez, 2022).

The existence and widespread use of self-report questionnaires to measure epistemic emotions can be explained by both practical and theoretical criteria. The former relates to their low cost and high adaptability to different situations. The latter refers to the fact that self-report questionnaires are capable of accessing subjects' internal processes, such as emotional experience, and that no other method is capable of providing such differentiated assessments of the various affective components of learning (Pekrun, 2016). Nevertheless, there are criticisms that need to be addressed.

2.2 Criticisms of Self-Report Instruments

Similar to epistemic emotions, in the field of epistemic cognition—beliefs about knowledge and knowing—most of the measurement instruments used are self-report questionnaires. In this field, Hyytinen; Postareff; Lindblom-Ylänne, (2020) discuss the relevance of these tools. First, they point to the inherent abstraction and complexity of epistemic cognition to highlight the possibility of a mismatch between participants' interpretations of the items and the assumptions and meanings intended by the research teams, which leads to a problem of reliability and validity for these instruments.

Along these lines, the authors point out that self-reports require considerable effort in self-reflection and abstraction on the part of participants in order to respond reliably. In this regard, participants with less developed levels of the construct are unlikely to be able to account for their internal processes, since metacognitive effort is characteristic of more developed levels (Hyytinen; Postareff; Lindblom-Ylänne, 2020).

Pekrun (2016) acknowledges similar problems in the field of epistemic emotions—which may stem from the proximity between the two constructs—and points out that it is necessary to explore ways to observe collective emotional dynamics in real time that take cultural diversity into account. He proposes refining self-report instruments and supplementing them with mixed methods.

2.3 Exploring Alternatives to Overcome Methodological Challenges

Hyytinen and colleagues (2020), in addition to clarifying the critique of self-report instruments, point to the need for authentic measurements—that is, those conducted in the context of a real epistemic task (as opposed to the hypothetical situations presented in self-report questionnaires). Along these lines, they propose the use of simultaneous strategies: external measurements triangulated with self-report measurements, in order to overcome the problems associated with the latter while acknowledging their benefits.

Based on these discussions, we believe that the critiques by Hyytinen and colleagues (2020) raise reasonable doubt as to whether current measurement instruments might be limiting the possibilities for observing epistemic emotions. If the way in which constructs are theoretically conceptualized and the way in which they are operationalized are mutually constitutive (theory guides the types of possible instruments, just as empirical results reshape theoretical understandings), it becomes necessary to question whether the ways in which we have measured epistemic emotions thus far are affecting or excluding possible findings and interpretations regarding affective phenomena in learning.

In this regard, we ask ourselves what observations will enable the development of measurement instruments whose initial design has been guided by the theoretical and practical critiques summarized above.

3 Method

This study is part of the first author's master's thesis and aims to illustrate alternatives to the current approaches for operationalizing epistemic emotions, specifically with regard to their measurement. In this sense, it is exploratory in nature and adopts a qualitative approach (Walker, 2017).

3.1 Study Design

The study consisted of three distinct phases: (a) development of a prototype for coding epistemic emotions, (b) implementation of a serious game-based intervention to elicit epistemic emotions, and (c) initial analysis of the intervention using the coding prototype.

3.1.1. Design of the coding prototype

First, we conducted a literature review to identify existing instruments for measuring epistemic emotions. This review included Scopus, Web of Science, and Google Scholar databases, as well as the repository of the Pontificia Universidad Católica de Chile. We used the keywords “epistemic emotion” AND “measurement,” “evaluation,” and their Spanish equivalents “emociones epistémicas” AND “medición” or “evaluación.” A summary of these instruments is shown in Table 1.

Based on the review, we decided to build our first prototype using Henríquez's (2022) code book as a foundation, which includes indicators for the seven epistemic emotions, physical cues for six emotions, and counter-indicators for two emotions. In addition, we incorporated descriptions and verbal indicators from other related studies found in the literature.

To test the first prototype (Appendix 1), we analyzed videos of argumentative instances from Fondecyt Project 1150859, which featured education students engaging in group discussions as part of a serious game activity. This initial testing involved the analysis of four 90-minute videos and aimed to assess the tool's ability to distinguish between epistemic emotions and to evaluate its user-friendliness. When discussing the individual codings, we observed that the codebook allowed us to identify and distinguish between epistemic emotions. At the same time, we noted difficulties in its use, which were discussed and addressed in a second prototype.

Specifically, for the second prototype (Appendix 2), we removed the information regarding when an epistemic emotion is expected to occur because, although the literature includes these notions, maintaining an expectation of an emotion's appearance risks skewing observations—for example, by conditioning the emergence of an emotion on the resolution of a conflict. In addition, we removed duplicate information from different sources (particularly physical and verbal cues) and reorganized that information to present it more concisely and facilitate analysis.

3.1.2. Intervention

Participants. We recruited six first-year students from the Elementary Education program at Pontificia Universidad Católica de Chile. The participants' ages ranged from 18 to 20; five of them identified as female, and one identified as non-binary. Throughout the study, we encouraged voluntary participation—primarily through the informed consent process—and ensured the protection of the participants' personal data.

Activity. We designed an argumentative activity in the form of a serious game consisting of four 90-minute sessions, with the objective of promoting the development of epistemic thinking through argumentation. The activity involved the forced justification of pedagogical positions and the analysis of those justifications. In practice, each participant was given a case in which an elementary school teacher made certain decisions while planning and conducting her classes. Once per round, the participants role-played and justified these decisions, even when they did not agree with them. In every case, the group sought to reach an agreement (by consensus) to classify the justifications presented into different levels of epistemic thinking (objectivist, multiplist, or evaluativist) regarding the teacher's planning. To scaffold the discussion, they used a table with descriptions of these levels, and the need for group consensus was emphasized.

The general structure of the activity remained the same throughout the four sessions; the only differences were in the specifics of the epistemic thinking levels table and the specifics of the pedagogical decisions the participants were required to justify (in the first two sessions, the participants explained why they included a particular activity in the class, but in the last two sessions, they had to justify complete lesson plans).

3.1.3. Analysis of Epistemic Emotions

After implementing the intervention, we conducted a partial analysis of the sessions, followed by an in-depth analysis of the second play session.

In the preliminary analysis, we individually identified potential segments to be included in the corpus (those where we could observe epistemic emotions) and generated new questions about the construct. We collectively compared these insights and, based on a new review of the literature and internal discussions, more precisely defined the corpus to be analyzed and made further modifications to the codebook. The third version of the prototype (Table 2) includes a summary of the indicators compared to the previous prototype, a refinement of the description of these indicators, and the inclusion of counter-indicators for the emotions of surprise, enjoyment, and confusion.

Based on the initial partial analysis, we selected one of the play sessions to conduct an individual analysis using the third prototype, in order to cross-validate our analyses once again and reach a consensus on the types of observations that this instrument has enabled to date. We began with the second session because it contained the most codable material for illustrating the observables. In the inter-coder triangulation, discrepancies were resolved by consensus: the coders discussed the issues until the entire group agreed on each coding. In this coding process, we established four criteria for coding epistemic emotions: (1) physical cues explicitly noted in the codebook; (2) verbal cues, since including what they were explicitly discussing allowed us to distinguish between emotions; (3) individual markers, which became necessary upon observing that the intensity of gestures and interactions varied greatly among participants and, therefore, we could not draw the same conclusions from superficially similar movements; and (4) previous emotional trajectory—that is, we considered in the analysis the emotions previously coded for the same subject, since, in the face of ambiguous segments, this allowed us to construct a narrative and historical coherence of the affective dynamics within the play session.

4 Results

The instrument developed to date is in the form of a codebook (see Table 2) and allows for the coding of the epistemic emotions of enjoyment, curiosity, surprise, confusion, frustration, anxiety, and boredom. It includes indicators for all emotions, detailed descriptions of those indicators, and counter-indicators for five emotions. The

corpus was selected based on the presence of emotions and the participants' focus of attention: all segments in which emotions could be observed were included in the analysis, provided that the action taking place was focused on epistemic thought (for example, arguing why a statement corresponds to one level of epistemic thought rather than another, or questioning what constitutes a valid source of knowledge). Consequently, segments where other constructs could be observed—such as social emotions (where the object of the emotion was the relationship with others)—were excluded from the corpus, as were segments where task-related emotions could be observed but did not pertain to the participants' understanding of epistemic thinking (such as initial confusion due to a lack of understanding of the task instructions).

The instrument made it possible to identify the seven epistemic emotions in the video recording. The current form of the codebook, like other measurement instruments, allowed us to identify the specific epistemic emotion experienced by a person at a given moment during the session; however, due to its current structure, it also allowed us to observe more than one emotion simultaneously in the same subject (which we refer to as coexisting emotions). Furthermore, the analysis revealed the possibility of coding emotions for more than one subject at a time when it was observed that the participants experienced the same emotion(s) while performing a joint action (for example, when they were trying to complete an idea among several participants). Figure 1 summarizes these coding possibilities:

Figure 1 - Matrix of Codable Emotions

	Intraindividual	Interindividual
Specific emotion	An emotion (surprise, curiosity, confusion, enjoyment, frustration, anxiety, or boredom) experienced by a person at a given moment	An emotion (surprise, curiosity, confusion, enjoyment, frustration, anxiety, or boredom) experienced by more than one person at the same time in response to the same object
Coexisting emotions	Combined emotions experienced by a person at a given moment	Combined emotions experienced by more than one person at the same time regarding the same object

Source: Authors' work

For this article, we selected segments to illustrate the four ways of observing epistemic emotions in the data (summarized in Figure 1), prioritizing the maximization of the number of individuals targeted by the codings and ensuring that each of the seven epistemic emotions was represented at least once. For the quadrant of specific intra-individual emotions, we illustrate the emotions of curiosity, surprise, anxiety, and boredom. From the quadrant of coexisting intra-individual emotions, we illustrate the emotions of frustration-enjoyment. From the specific inter-individual emotions, we present confusion. Finally, from the coexisting inter-individual emotions, we illustrate confusion-enjoyment.

4.1 Particular intra-individual emotions

- *Curiosity followed by epistemic surprise*

In this segment, the group had been discussing how to classify the hypothetical actions in the case for 25 minutes. During the last 3 minutes, Heidi⁶, supported by Karol, argued that the actions had been multiplicitist, while Ana and Amanda counterargued, without reaching an agreement. In this case, Ian is the subject of analysis:

Ian: *I have a question* (He looks at the researcher).

Researcher: *Yes, go ahead, go ahead.*

Ian: (Looks at his chart) *What do you mean by "based on what the right sources say"? What are the right sources? Do you mean the subject matter?*

Researcher: *Ask the actress.*

Ian: (Raises his eyebrows and his eyelids open wider than usual for a moment) *Oh, but isn't this about that?* (Points to the chart with his pencil) *Is it about the...?* (Points to his classmate with his pencil and smiles. Then, he falls silent without finishing his sentence, staring at the chart).

Here we see that the focus of attention is on the "correct sources," which is specific to the task; therefore, it meets the first criterion for being analyzed as an epistemic

⁶ All names are pseudonyms.

emotion. In this case, Ian poses an original question—one not dictated by the activity's rules—which aligns with the indicator of “exploratory behavior.” During those seconds, curiosity is coded.

Immediately, upon hearing the researcher's response, Ian raises his eyebrows and widens his eyes, meeting the indicator of “expression of surprise.” Along with that expression, the participant interrupts his own words and leaves his sentence unfinished, which aligns with the indicator of “abrupt break in the rhythm of actions.” Thus, by the end of this segment, all the indicators for coding epistemic surprise in Ian are met.

- *Epistemic Anxiety*

This segment occurs 5 minutes after the discussion of the second performance began. The discussion of the first performance lasted 50 minutes—much longer than expected—because the participants discussed their ideas in a more extensive manner. In this case, the subject of analysis is Sofia, who joined the group in this second session of the study; therefore, it was her first time playing:

Ana: *So, belief 2, about “how pedagogical decisions should be made.” I already labeled that as “objectivist” because it was based more on the issue of—*

Karol: *Yes, of correct answers, because she used the same book.*

Ana: *Exactly. That's one source.*

Amanda: *But that's not the only pedagogical decision.*

Heidi: *Of course.*

Karol: *Of course, but you, for example, are also checking their work, and by checking it, you're also making sure they're understanding the material.*

Ana: *Yes. If we focus on that point, I think it's more like that. On that point.*

Ian: *You become the correct source, as the teacher.*

Karol: *Yes, the book and you (Ana and Ian nod).*

Ana: *What do you think, Heidi?*

Heidi: *Yes, I think so, because “evaluativist” doesn't quite fit for me.*

Ana: *So... are we all in agreement?* (As she says this, one by one they turn toward Sofia, who had been looking down).

Sofia: Uhum... (She nods quickly with her lips pressed together and without saying a word, then smiles, and the group bursts into laughter. Sofia, in particular, begins to run her fingers through her hair from top to bottom, bringing her hand close to her forehead to cover her eyes, no longer smiling. She remains slightly hunched over the entire time.)

Since the discussion centered on the epistemic level of the case, it meets the criteria for inclusion in the corpus to be analyzed. In this instance, Sofia had gone the entire five minutes of discussion without speaking; she maintained a slightly hunched posture throughout, and her gaze shifted between her board, her hands, and the person speaking, fulfilling the indicator of “displaying restlessness or discomfort.” Both the way she nervously nods at Ana when asked if she agrees and the fact that this was Sofia’s first session—in contrast to a group that had already played one session—can be interpreted as a lack of certainty or insecurity regarding the task, fulfilling the second indicator of anxiety.

- *Epistemic Boredom*

In this segment, the group had been discussing a case for 30 minutes and was unable to reach an agreement. Karol and Amanda were trying to develop arguments to classify the case at a certain level of epistemic thinking, while the rest listened and offered brief comments. In particular, Ana, who had previously been part of the discussion, slowly begins to stop looking at her classmates; her gaze becomes unfocused, she sways in her seat, looks at her shoulder, and starts scratching it; this goes on for about a minute. Her slumped posture, as well as her attention being directed toward another object, are indicators of epistemic boredom.

4.2 Coexisting Intra-Individual Emotions

- *Frustration-Enjoyment*

The group had been trying to classify the teacher’s actions for 22 minutes. They had reached some tentative agreements, but still did not have a definitive answer. Amanda and Karol argued that the actions were evaluativist. However, Ian suggested that they might be objectivist, asking Ana (the actress for that round) for more details about the activities carried out in order to make a decision. In this case, the subject of analysis is Karol.

Ana: [The guide also] *was developmental because the developmental approach was based on being able to exchange answers with the children, not on the alternatives.*

Amanda: *This is “beliefs about how pedagogical decisions should be made.” Hmm... It could still be...* (She exchanges glances with Karol).

Karol: (Laughing) *Oh, I’m out of here!* (She raises her arm quickly as if to let go of or throw something, while leaning back in her seat and looking away, still laughing. The whole group laughs).

In this segment, it is evident that the focus is on the level of epistemic thinking they are attempting to classify, thereby meeting the first criterion for inclusion in the corpus. The phrase *“Ah, I’m out of here!”* is interpreted as an observable for the indicator “discomfort with the activity is expressed” because, although it could be interpreted as a joke, the person verbally indicates a desire to withdraw from the activity—in this case, the discussion. Likewise, the arm movement and stepping back are considered expansive body language described in the “troubled look” indicator. Thus, the criteria for coding frustration are met.

On the other hand, the same segment includes observables for the “joyful expression” indicator, evidenced by Karol’s laughter and her pretended departure from the discussion, which elicits laughter from the entire group. Thus, for the same segment and individual, enjoyment can also be coded.

4.3 Specific Interpersonal Emotions

- *Epistemic confusion*

In this segment, the group has just heard Ana’s performance. An unusual silence falls during the discussion.

Amanda: *It’s just that you talked so much that I’m a little lost.*

Ana: *That’s the point.*

Amanda: *I think she’s dragging out her explanation so we won’t have time to ask her questions* (Laughs).

Ana: *No, it’s because the words just come to me all at once.*

(The whole group falls silent for 10 seconds.)

Amanda: *Hm... it's just that... uh...* (She holds a pencil between her lips and looks at her chart.)

Karol: (Her lips are pursed; she leans slightly forward with one elbow resting on the table, holding a pencil.) *It's just that since it's a science class, it's kind of complicated, like...* (She smiles, nods, looks at Amanda, and presses her lips together.)

Amanda: *Well, of course...* (She raises her hand, palm up.)

Ian: (Looks down at his worksheet, leaning slightly forward, his head tilted slightly to one side, holding a pencil that he tilts toward his chest).

Despite the silences, as they look at their charts and wonder how to classify the performance, the criterion for this segment to be part of the corpus to be analyzed is met. Karol and Amanda verbally agree that it is difficult to classify the actions in that performance, both fulfilling the criterion “it is observed that the person does not understand something.” Likewise, both display signs of physical tension, and Karol has pursed lips; in this regard, both meet the indicator of “a troubled expression.” Thus, confusion is coded for both Amanda and Karol in the same segment and in relation to the same object.

4.4 Coexisting Interpersonal Emotions

- Confusion-Enjoyment

The group had been debating for more than 30 minutes to reach an agreement. Karol appears to be listening to the others, shifting her gaze between them and her board, while holding a pencil in her hand, which she wiggles or places over her mouth.

Ian: *It's just that I think it's more objectivist, because it has a guide, an individual element, and at first it's very general, and as it gets closer to the end, it kind of starts to focus on each one individually.*

Amanda: *That's more of a detail in the class, like me taking the time to say, “Okay, with you, this is wrong, this is wrong, this is right.” “You could read this again.”*

Ian: (Nods) *That's exactly why I think it's very general, because it's like a separate point—not a definitive part of the class—but more like, “Oh, I have this time now, so I'm going to do it.”* (Karol turns to look at Ian, nods, and bends her finger, indicating

she agrees.) *I find it very objectivist for that reason, because if it were multiplist, I feel like it would be the guide for us to reach out and help those who...*

Karol: *Aaaah, I get your point.*

Amanda: *The thing is, honestly, that's how classes were taught at my school—you'd do the activity, in this case the textbook, which is very general material but covers the content, even though it isn't tailored to each student. It's not designed for our specific class, but rather for the general student population nationwide. They do their work in the textbook, and then later, when I'm checking, I take the opportunity to give brief feedback to each student as I'm checking their work and marking their answers with X's.*

Ana: *But if we're talking about the approach toward students, it's more multiplist, because it focuses more on each individual.*

Ian: (He rests his chin on one hand while looking at his chart) *Yeah, I think it's more student-centered in that sense...* (He crosses his arms and stares at his chart with a serious expression).

Karol: (She looks at her chart for a moment longer.) *Now I've changed my mind.* (She turns to look at Ian; they both laugh, and Karol quickly tilts her head back. Then she looks back at her chart, still smiling.)

Ian: *But I think the other one is more objectivist, whereas the first one, I think, could be multiplist.*

The discussion presented allows us to conclude that Ian, Amanda, Karol, and Ana were involved in it, and thus it is considered part of the corpus to be coded. During this exchange, Karol initially agrees with Ian, but after Ana's intervention, Ian qualifies his position, and Karol indicates that she "changed" her stance. This back-and-forth in their classifications suggests that, at times, they were persuaded by arguments supporting two different perspectives, with both Ian and Karol meeting the indicator of "expressing that something is not understood." In addition, while they were talking, Karol made repetitive movements with her pencil, and Ian scratched his chin during the discussion. For both of them, this could be interpreted as involuntary repetitive movements, meeting the indicator of "troubled expression." With both indicators, the emotion of confusion is coded for both participants.

However, when the group tries to agree on a perspective, Karol points out her own indecision by indicating her change of stance and laughs it off. Both a smile and more energetic body movements are observed, compared to Karol's usual behavior during the conversation. Likewise, Ian laughs in response to Karol's exclamation, which constitutes an observable instance of the "joyful expression" indicator. Thus, it can also be argued that Karol and Ian experienced enjoyment at the same time.

5 Conclusion and Future Directions

The objective of this study was to illustrate alternative ways of observing epistemic emotions, with the aim of advancing toward measurement tools that enable interpretations beyond those possible through the use of self-report questionnaires. Based on Henríquez's (2022) matrix, a codebook was developed which, in its current version, allows for the coding of various epistemic emotions using video segments: surprise, curiosity, confusion, enjoyment, frustration, anxiety, and boredom. These can be coded non-exclusively (coding more than one emotion at a time if the indicators are met within the same segment) and across one or more subjects (intra- or inter-individual, respectively). These coding possibilities, illustrated in Table 1, include elements that we consider to be genuinely novel compared to the possibilities offered by self-report questionnaires.

First, we find the coding of emotions that do not align with the function assigned to them in the literature particularly interesting. In particular, enjoyment is associated with the resolution of a cognitive incongruity (Chevrier *et al.*, 2019; Di Leo *et al.*, 2019); however, in the case of Karol and Ian, we observed this emotion at moments when the participants were unable to resolve the incongruities.

Second, using those same examples, it was possible to simultaneously code emotions that are understood as contradictory—in the sense of *being mutually exclusive*—again due to the role assigned to them within the learning process. In Karol's case, we coded frustration and enjoyment at the same time, and for Karol and Ian together, we coded confusion and enjoyment simultaneously.

On this point, it is important to note that it was not possible to code contradictory emotions for all participants. In fact, we observed this phenomenon only in Karol and Ian. In other participants, however, we observed the combinations of frustration-confusion

and frustration-anxiety⁷ —emotions that we consider non-contradictory given the roles assigned to them and, therefore, more likely to be observed together.

The possibility of coding emotions in unexpected situations—or even when they coexist with emotions that are supposedly opposed—raises central questions in the field: Does each epistemic emotion play a specific role in learning? Are the situations in which we can observe each of the epistemic emotions predetermined by that role? If the answer to both questions is yes, then what's going on with Karol, who seems to enjoy an argument where there's no apparent solution? What happens when Ian smiles to himself upon realizing that he doesn't agree with the rest of the group (and is, moreover, in the minority)? Some authors offer insights that may help reframe our understanding (and thus the operationalization) of emotions in learning. In line with the discussion of the previous examples, Sánchez and Sebastián (2024) state:

If learning is experienced as confusion and uncertainty and, at the same time, it also requires engagement through “positive” emotions, what we have developed here is a way to sustain that for learning to take place, there has to be some form of complex emotions in which opposing, and even contradictory “valence” can make up and be integrated into the same experience (Sánchez; Sebastián, 2024, p. 249).

This proposal, based on Vygotsky's theories, explicitly incorporates the possibility of the historical and social development of emotional processes through artistic means. In light of the convergence with the results of this exploration, we believe these are relevant insights to integrate into future approaches to measuring emotions in learning.

Along the same lines, the current instrument has multiple limitations that must be addressed to justify the validity of its interpretations.

One limitation is the cost of this analysis compared to other measurement instruments. Its use requires very expensive equipment (the activities were recorded using high-definition 360-degree cameras to allow for subsequent observation of the participants' facial details and audio recorders for transcribing the dialogues); it requires

⁷ Given the length of this article, we decided not to present this combination of emotions, choosing instead to prioritize the most controversial findings.

many hours of work (especially compared to analyzing the results of a questionnaire); and it requires a team trained in the construct and the instrument.

In addition, the indicators in the codebook still need to be refined. During coding, we realized that it is currently not possible to code confusion if the person does not express it verbally. In the example of the interindividual confusion between Karol and Amanda, we noted that Ian's body language matched our observations of confusion, which we also confirmed with the participant in a subsequent interview; however, Ian did not express it verbally at that moment, preventing its coding. However, if verbal expression of confusion were no longer required, the code would become too broad, risking the coding of "false positives."

On the other hand, curiosity has a single indicator: "exploratory behavior is observed," which, although it includes a description intended to make its use less lax, posed challenges within the team when we attempted to apply it. What can be considered exploratory behavior in the context of a structured discussion? In the specific case of this study, participants were encouraged to ask clarifying questions in order to classify responses at a level of epistemic thought; however, can such questions—framed by the rules of the game—be considered voluntary or original actions, as is typically associated with curiosity?

Finally, we identified theoretical limitations that need to be analyzed to advance our understanding and operationalization of epistemic emotions.

On the one hand, defining the scope of epistemic emotions is a necessary step for coding them, but it is a complex task. By definition, epistemic emotions emerge in the act of knowing or in relation to a cognitive incongruity. In that sense, when our participants looked at the researcher with a furrowed brow and explicitly indicated that they did not understand the task instructions, they not only met the indicators of confusion in our codebook but were also experiencing a cognitive incongruity—does that make that emotion an *epistemic* emotion? This question highlights the particular importance of clarifying the *object* of emotion in order to advance in this field.

On the other hand, maintaining the idea that interindividual emotions exist is extremely complex. One could interpret this proposal as referring to two individuals who separately experience the same emotion (or at least something they name in the same way). However, our intuition is that in certain situations it is possible to observe a psychological process that does not belong to a particular individual (or person) but rather occurs in a distributed manner among two or more individuals, transcending the

individual/person. Taking the example of Karol and Amanda's interindividual confusion, we note that at that point in the discussion, they did not need to finish each sentence to understand what the other was referring to. Not because they were clairvoyant (or at least that is not our hypothesis), but because by that point they had been engaged in the same task—attempting to use the same concepts—for a significant amount of time; at that moment, they shared a common history of attempting to operate (think, imagine, feel) together—operations that, by that point, had taken on a particular form distinguishable from other emotional forms (Vygotsky, 1934).

Some lines of inquiry along these lines have been explored by Larraín (2017) and Volet (2004). Explicitly situated within the Vygotskian tradition, the first author emphasizes the role of imagination and *common ground* in conceptual development, while the second, drawing on situational perspectives in the study of motivation, highlights the idea of psychological processes that are “Knowledge and cognitions are conceptualized as distributed or stretched over people and environments” (Volet, 2004, p. 280). Analyzing these theoretical works goes beyond the scope of this study; however, integrating them appears necessary for progress in this area.

Finally, returning to the critiques of the measurement of epistemic emotions that motivated this study, we could not agree more with Hyytinen's team (2020) when they state that “It is important to understand that theoretical frameworks play a significant role in how the data is analysed and interpreted” (p. 186), as well as with their complementary point: It is important to understand that data-generation instruments (our measurement tools) play a fundamental role in theoretical-conceptual construction, just as empirical work challenges and compels us to refine our theoretical models.

With this work, we hope to contribute to the discussion and offer initial insights into the possibilities enabled by instruments designed from perspectives alternative to the hegemonic one. All of this is aimed at improving our instruments, interventions, and understandings of learning; in this particular study, of the affective dimension of the learning process, embodied in epistemic emotions.

Funding

This study received support from Fondecyt Project 1240772.

References

- AHVANUIEE, M.; KARESHKI, H.; YAZDI, S. Measuring emotions during epistemic activities: Psychometric validation of the Persian epistemic emotions scale. *Psihologija*, [N.p.], vol. 56, no. 4, pp. 399–413, 2023. Available at: <https://doi.org/10.2298/PSI220420028A>.
- BALAŽ, B.; PAVLIN-BERNARDIĆ, N. A Mixed-Method Study on Measuring Epistemic Emotions as a Trait. *Psihologijske teme*, [N.p.], vol. 31, no. 3, pp. 619–639, Dec. 9, 2022. Available at: <https://doi.org/10.31820/pt.31.3.8>.
- CHEVRIER, M.; MUIS, K. R.; TREVORS, G. J.; PEKRUN, R.; SINATRA, G. M. Exploring the antecedents and consequences of epistemic emotions. *Learning and Instruction*, [N.p.], vol. 63, p. 101209, Oct. 2019. Available at: <https://doi.org/10.1016/j.learninstruc.2019.05.006>.
- CHIPMAN, P.; D'MELLO, S.; GHOLSON, B.; GRAESSER, A.; MCDANIEL, B.; WITHERSPOON, A. Detection of Emotions during Learning with AutoTutor. *Proceedings of the Annual Meeting of the Cognitive Science Society*, [N.p.], vol. 28, no. 28, pp. 285–290, 2006.
- DE PAULA, L.; ALENCAR, I.; LOPES, M.; UCHOA, A. Affectivity from the dialogical perspective of cultural psychology: Educational implications. In: FOSSA, P.; CORTÉS-RIVERA, C. (eds.). *Affectivity and Learning: Bridging the Gap Between Neurosciences, Cultural and Cognitive Psychology*. Cham: Springer Nature Switzerland, 2023. Available at: <https://link.springer.com/10.1007/978-3-031-31709-5>. Accessed: July 7, 2026. DOI: <https://doi.org/10.1007/978-3-031-31709-5>.
- DI LEO, I.; MUIS, K. R. “Confused, now what? A Cognitive-Emotional Strategy Training (CEST) intervention for elementary students during mathematics problem solving.” *Contemporary Educational Psychology*, [N.p.], vol. 62, p. 101879, July 2020. Available at: <https://doi.org/10.1016/j.cedpsych.2020.101879>.
- DI LEO, I.; MUIS, K. R.; SINGH, C. A.; PSARADELLIS, C. Curiosity... Confusion? Frustration! The role and sequencing of emotions during mathematics problem solving. *Contemporary Educational Psychology*, [N.p.], vol. 58, pp. 121–137, July 2019. Available at: <https://doi.org/10.1016/j.cedpsych.2019.03.001>.
- D'MELLO, S.; GRAESSER, A. Dynamics of affective states during complex learning. *Learning and Instruction*, [N.p.], vol. 22, no. 2, pp. 145–157, Apr. 2012. Available at: <https://doi.org/10.1016/j.learninstruc.2011.10.001>.
- D'MELLO, S.; LEHMAN, B.; PEKRUN, R.; GRAESSER, A. Confusion can be beneficial for learning. *Learning and Instruction*, [N.p.], vol. 29, pp. 153–170, Feb. 2014. Available at: <https://doi.org/10.1016/j.learninstruc.2012.05.003>.
- HAYE, A.; CARBALLO, M. James's theory of emotion and the affective turn in psychology. *Estudios de Psicología*, [N.p.], vol. 38, no. 1, pp. 115–139, Jan. 2, 2017. Available at: <https://doi.org/10.1080/02109395.2016.1268390>.

HENRÍQUEZ, C. *How Is the Affective Dimension Characterized in the Development of Epistemic Thought?: An Analysis Based on the Experience of Artistic Practices*. 2022. Master's Degree in Educational Psychology – Pontifical Catholic University of Chile. School of Psychology, 2022. Available at: <https://repositorio.uc.cl/handle/11534/74178>. Accessed: July 10, 2026. DOI: <https://doi.org/10.7764/tesisUC/PSI/74178>

HYYTINEN, H.; POSTAREFF, L.; LINDBLOM-YLÄNNE, S. Challenges in exploring individuals' conceptions of knowledge and knowing. In: KALLIO, E. (ed.). *Development of Adult Thinking: Interdisciplinary Perspectives on Cognitive Development and Adult Learning*. [n.p.]: [n.p.], 2020. pp. 177–192.

KOHATSU, M.; MUIS, K. R.; PEKRUN, R.; SINATRA, G. M.; KENDEOU, P.; ROBINSON, K. A.; KENNEDY, A.; SHANKAR, S. The Struggle is Real: An Intervention to Regulate and Resolve Confusion During Complex Statistics Problem Solving. *The Journal of Experimental Education*, [N.p.], pp. 1–27, Feb. 28, 2025. Available at: <https://doi.org/10.1080/00220973.2025.2459388>.

LARRAÍN, A. Argumentation and concept development: the role of imagination. *European Journal of Psychology of Education*, [N.p.], vol. 32, no. 4, pp. 521–536, Oct. 2017. Available at: <https://doi.org/10.1007/s10212-016-0316-7>.

LÓPEZ-CASSÀ, È.; BISQUERRA ALZINA, R. Epistemic emotions: A systematic review of a concept with applications to emotional education. *International Journal of Emotional Education and Well-being*, [N.p.], vol. 3, no. 2, pp. 35–60, July 3, 2023. Available at: <https://doi.org/10.48102/rieeb.2023.3.2.58>.

MUIS, K. R.; CHEVRIER, M.; DENTON, C. A.; LOSENNO, K. M. Epistemic Emotions and Epistemic Cognition Predict Critical Thinking About Socio-Scientific Issues. *Frontiers in Education*, [N.p.], vol. 6, p. 669908, Apr. 14, 2021. Available at: <https://doi.org/10.3389/educ.2021.669908>.

MUIS, K. R.; CHEVRIER, M.; SINGH, C. A. The Role of Epistemic Emotions in Personal Epistemology and Self-Regulated Learning. *Educational Psychologist*, [N.p.], pp. 1–20, Feb. 8, 2018. Available at: <https://doi.org/10.1080/00461520.2017.1421465>.

MUIS, K. R.; PEKRUN, R.; SINATRA, G. M.; AZEVEDO, R.; TREVORS, G.; MEIER, E.; HEDDY, B. C. The curious case of climate change: Testing a theoretical model of epistemic beliefs, epistemic emotions, and complex learning. *Learning and Instruction*, [N.p.], vol. 39, pp. 168–183, Oct. 1, 2015. Available at: <https://doi.org/10.1016/j.learninstruc.2015.06.003>.

MUIS, K. R.; PSARADELLIS, C.; LAJOIE, S. P.; DI LEO, I.; CHEVRIER, M. The role of epistemic emotions in mathematics problem solving. *Contemporary Educational Psychology*, [N.p.], vol. 42, pp. 172–185, July 2015. Available at: <https://doi.org/10.1016/j.cedpsych.2015.06.003>.

MUNZAR, B.; MUIS, K. R.; DENTON, C. A.; LOSENNO, K. Elementary students' cognitive and affective responses to impasses during mathematics problem solving. *Journal of Educational Psychology*, [N.p.], vol. 113, no. 1, pp. 104–124, Jan. 2021. Available at: <https://doi.org/10.1037/edu0000460>.

NERANTZAKI, K.; EFKLIDES, A.; METALLIDOU, P. Epistemic emotions: Cognitive underpinnings and relations with metacognitive feelings. *New Ideas in Psychology*, [N.p.], vol. 63, p. 100904, Dec. 2021. Available at: <https://doi.org/10.1016/j.newideapsych.2021.100904>.

ORTEGA, F. Epistemic Emotions in the Teaching of Argumentation in Science. [N.p.], vol. 22, 2022.

PEKRUN, R.; LICHTENFELD, S.; KILLI, U.; REISS, K. Achievement Emotions Questionnaire – Elementary School - User's Manual. [N.p.], 2007.

PEKRUN, R. "Using Self-Report to Assess Emotions in Education." In: ZEMBYLAS, M.; SCHUTZ, P. A. (eds.). *Methodological Advances in Research on Emotion and Education*. Cham: Springer International Publishing, 2016. pp. 43–54. Available at: <http://link.springer.com/10.1007/978-3-319-29049-2>. Accessed: July 10, 2026. DOI: <https://doi.org/10.1007/978-3-319-29049-2>.

PEKRUN, R.; GOETZ, T.; PERRY, R. P. *Achievement Emotions Questionnaire (AEQ) - User's Manual* -. [N.p.], 2005.

PEKRUN, R.; MEIER, E. *Epistemic Emotion Scales (EES)*. 2011.

PEKRUN, R.; VOGL, E.; MUIS, K. R.; SINATRA, G. M. "Measuring emotions during epistemic activities: the Epistemically-Related Emotion Scales." *Cognition and Emotion*, [N.p.], vol. 31, no. 6, pp. 1268–1276, 2016. Available at: <https://doi.org/10.1080/02699931.2016.1204989>.

PENG, Y. When Emotion Meets Reason: The Development and Validation of the EpiCT-CI Scale to Measure Epistemic Emotions in Critical Thinking Applications and Cultural Identity Constructions. *Frontiers in Psychology*, [N.p.], vol. 16, p. 1687003, Oct. 15, 2025. Available at: <https://doi.org/10.3389/fpsyg.2025.1687003>.

SÁNCHEZ, F.; SEBASTIÁN, C. Integrating Affection, Emotion, and Aesthetics into a General Theory of Learning. *Theory & Psychology*, [N.p.], vol. 34, no. 2, pp. 233–256, Apr. 2024. Available at: <https://doi.org/10.1177/09593543241229740>.

VALDIVIA-YÁBAR, S. V. Exploring Epistemic Emotions in Creative Teacher Education. *European Public & Social Innovation Review*, [N.p.], vol. 10, pp. 1–14, Feb. 3, 2025. Available at: <https://doi.org/10.31637/epsir-2025-1222>.

VOGL, E.; PEKRUN, R.; MURAYAMA, K.; LODERER, K. Surprised–curious–confused: Epistemic emotions and knowledge exploration. *Emotion*, [N.p.], vol. 20, no. 4, pp. 625–641, June 2020. Available at: <https://doi.org/10.1037/emo0000578>.

VOGL, E.; PEKRUN, R.; MURAYAMA, K.; LODERER, K.; SCHUBERT, S. Surprise, Curiosity, and Confusion Promote Knowledge Exploration: Evidence for Robust Effects of Epistemic Emotions. *Frontiers in Psychology*, [N.p.], vol. 10, p. 2474, Nov. 12, 2019. Available at: <https://doi.org/10.3389/fpsyg.2019.02474>.

VOLET, S. "Understanding learning and motivation in context: What do alternative research traditions have to offer?" In: WOSNITZA, M.; FREY, A.; JÄGER, R. S. (eds.). *Learning Process, Learning Environment, and Learning Assessment. Scientific Contributions to Learning in the 21st Century*. [N.p.]: Landau: VEP, 2004. pp. 276–293.

WALKER, W. Some considerations for the use of qualitative methodology in social research. *Foro Educacional*, [N.p.], pp. 13–32, Feb. 28, 2017. Available at: <https://doi.org/10.29344/07180772.27.795>.

Received: July 2026

Accepted: July 2026

Table 1 - Instruments Used to Measure Epistemic Emotions

Type of instrument	Instrument (authors)	Description of the instrument
Self-Report Questionnaires	Achievement Emotions Questionnaire (Pekrun; Goetz; Perry, 2005)	Composed of three scales with 5-point Likert-type items (1 = not at all, 2 = a little, 3 = somewhat, 4 = a lot, 5 = very much) that measure the emotions of <i>enjoyment</i> , <i>hope</i> , <i>pride</i> , <i>anger</i> , <i>anxiety</i> , <i>shame</i> , <i>hopelessness</i> , and <i>boredom</i> in relation to: Class-related emotions (80 items) Emotions related to learning (75 items) Emotions related to assessments (77 items)
	Achievement Emotions Questionnaire - Elementary School (Pekrun <i>et al.</i> , 2007)	Composed of three scales with 5-point Likert-type items (1 = strongly disagree, 5 = strongly agree) using images of faces to measure the emotions of <i>enjoyment</i> , <i>anxiety</i> , and <i>boredom</i> in relation to: Emotions related to math class (12 items) Emotions related to math homework (8 items) Emotions related to math assessments (8 items)
	Epistemic Emotion Scales (Pekrun & Meier, 2011)	A 24-item 5-point Likert scale (1 = not at all, 5 = very much) to measure 7 epistemic emotions (<i>surprise</i> , <i>curiosity</i> , <i>confusion</i> , <i>enjoyment</i> , <i>frustration</i> , <i>anxiety</i> , <i>boredom</i>). Each emotion had one item in which that emotion was explicitly mentioned and two to three other items with synonyms.
	Confusion Scale (D'Mello <i>et al.</i> , 2014)	A 3-point Likert scale (1 = not confused, 2 = slightly confused, 3 = confused) to repeatedly measure the confusion experienced at different points during a task.
	Epistemically-Related Emotion Scales (Pekrun <i>et al.</i> , 2016)	A 21-item 5-point Likert scale (1 = not at all, 5 = very much) to measure 7 epistemic emotions (<i>surprise</i> , <i>curiosity</i> , <i>confusion</i> , <i>enjoyment</i> , <i>frustration</i> , <i>anxiety</i> , <i>boredom</i>). Each emotion had one item in which that emotion was explicitly mentioned and two other items, each with a synonym.
	Confusion Regulation Questionnaire (Kohatsu <i>et al.</i> , 2025)	Composed of two scales with 5-point Likert-type items: Scale to measure confusion regulation strategies (34 items) Scale to measure the frequency of use of confusion regulation strategies (28 items)
	Epistemic Emotions in Critical Thinking and Cultural Identity Constructions Scale (EpiCT-CI Scale, Peng, 2025)	A scale of 48 5-point Likert-type items (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree) to measure

Other self-report procedures	Retrospective Self-Reported Affect Judgment Protocol (Chipman <i>et al.</i> , 2006)	Protocol for self-reporting emotions after completing a task. After completing a task, participants are asked to watch a video recording of their own faces and select from a list the emotions they experienced.
	Emote-aloud procedure (D'Mello & Graesser, 2012)	A protocol for verbal self-reporting. While performing a task, participants are asked to pause to identify their emotions from a list containing definitions of seven emotional states.
	Think-aloud procedure with an emotions coding scheme (Di Leo <i>et al.</i> , 2019)	Coding scheme for analyzing a think-aloud procedure. The scheme includes the emotions <i>surprise, curiosity, enjoyment, confusion, frustration, anxiety, boredom, pride, hope, relief, hopelessness, shame, and anger</i> .
Video analysis	Emotions matrix (Henríquez, 2022)	Coding manual for video analysis. It includes indicators for seven epistemic emotions (surprise, curiosity, enjoyment, confusion, frustration, anxiety, and boredom).

Source: Author's own work

Table 2 - Epistemic Emotions Coding Matrix

	Surprise	Curiosity	Enjoyment	Confusion	Frustration	Anxiety	Boredom
I n d i c a t o r s	Expression of surprise and Abrupt break in the rhythm of actions	Exploratory behavior is observed	A cheerful expression is observed and/or The person shows enjoyment	It is observed that the person does not understand something and A troubled expression is observed	Discomfort with the activity is expressed by the person or by others. and A troubled expression is observed	The person expresses concern about themselves, their abilities, or the group's ability to perform the activity and/or Signs of restlessness or discomfort regarding the task.	Evidence of disengagement from the activity.

D e s c r i p t i o n o f i n d i c a t o r s	<p>Expression of surprise: raising of eyebrows and eyelids</p> <p>Abrupt break in the rhythm of actions:</p> <ul style="list-style-type: none"> - The person interrupts the action they are performing - There may be a brief pause (how does this differ from the natural pause expected in conversation?) - The gaze fixates on the unexpected event. 	<p>Exploratory behavior:</p> <ul style="list-style-type: none"> - Manipulation of the material - Asking questions to gain a better understanding (Example: "Why?" Grossnickle, 2014) - Making comments on the topic (Nojavanasghari et al., 2016). 	<p>Joyful expression: A smile involving the eye muscles (Miles & Johnston, 2007)</p> <p>Expressing enjoyment:</p> <ul style="list-style-type: none"> - An effusive tone of voice compared to the previous tone. - Increased voice volume (Frank et al., 1993). - Faster, more energetic, and/or expansive body movements (Keck et al., 2022) compared to previous behavior, such as clapping, pointing at another person, or raising one's arms. - How can this be distinguished from expansive signs of frustration? How can the playful nature of enjoyment be encoded? 	<p>It is observed that the person does not understand something:</p> <ul style="list-style-type: none"> - They explicitly state that they do not understand or that something is complex. - They express that they are torn between at least two possible options for the task. - They interrupt their statements midway ("but..."). - Can there be signs of not understanding something without the person explicitly stating it? In other words, should we broaden this indicator so that it doesn't require the person to say they don't understand something in order to code it as confusion? <p>A troubled expression:</p> <ul style="list-style-type: none"> - Furrowed brow, pursed lips. - Repetitive movements without an obvious purpose or intention (scratching the face, touching the face, touching the hair, touching the chest) - Tense body postures (crouching, leaning forward) - Forced smile 	<p>Discomfort:</p> <ul style="list-style-type: none"> - The person expresses discomfort, distress, or aversion toward the task - Those around the person recognize their distress, as evidenced by comments directed at them or attempts to comfort them - Abrupt change in the pace of their attempts at the activity (stopping mid-discussion, silences, sudden increase in volume) <p>Troubled expression:</p> <ul style="list-style-type: none"> - Furrowed brow, pursed lips. - Repetitive movements without an obvious purpose or intention (scratching the face, touching the face, touching the hair, touching the chest, moving the leg) - Expansive body gestures (raising the arms, leaning back, holding the head with both hands) - Non-expansive body gestures (crouching, covering the face with both hands) 	<p>Concern about oneself or one's abilities:</p> <ul style="list-style-type: none"> - Expresses little confidence or uncertainty regarding their own solutions to the task - The person questions their ability to arrive at a solution considered correct <p>Signs of unease or discomfort:</p> <ul style="list-style-type: none"> - Body language indicating withdrawal (crouching, leaning forward) - Repetitive movements without an obvious purpose or intention (scratching the face, touching the face, touching the hair, touching the chest, moving the leg) 	<p>Evidence of disengagement from the activity:</p> <ul style="list-style-type: none"> - Slow, monotonous speech (Harris, 2000; Mikulas & Vodanovich, 1993) - Actions focused on something other than the activity (checking a phone, talking about other topics) - Slumped posture (sustained unfocused gaze, slumping in the chair, letting arms or hands hang limply, resting the head on one or both hands)
--	--	---	---	--	--	---	--

C o u n t e r i n d i c a t o r s	<ul style="list-style-type: none"> - The abruptness of the break should be considered in light of the history of interactions and what is typical for the person expressing the emotion. 	<ul style="list-style-type: none"> - Exploratory questions are not spontaneous (they are part of the structure of an activity) - The behavior stands out in relation to the rest of the group or to the person's behavior during the rest of the activity. 	<ul style="list-style-type: none"> - When enjoyment stems from a joke or comment that does not advance the conversation but rather refers to topics tangential to or different from the subject of discussion. 	<ul style="list-style-type: none"> - The expression of not understanding something refers to the content itself and is not due to the person not having listened, read, or having difficulty accessing the activity. 			<ul style="list-style-type: none"> - If the inattention is brief and the person then returns to the activity
--	---	--	---	---	--	--	---

Source: Prepared by the author

Appendix 1

First prototype of a coding instrument

	Surprise	Curiosity	Enjoyment	Confusion	Frustration	Anxiety	Boredom
When are these emotions expected to occur, according to the literature on epistemic emotions?	Arises in response to something unexpected, or when one cannot generate an explanation for new information because it conflicts with prior knowledge, expectations, or beliefs (Meyer et al., 1997; Foster and Keane, 2015; Muis, Chevrier & Singh, 2018; Di Leo, Muis, Singh & Psaradellis, 2019)	It is an emotion that arises when discrepant information (i.e., cognitive conflict) is perceived as potentially understandable despite being novel and complex, prompting people to seek cognitive and metacognitive strategies to resolve the cognitive conflict, thereby fostering learning (Chevrier, Muis, Trevors, Pekrun & Sinatra, 2019; Di Leo, Muis, Singh & Psaradellis, 2019; Muis, Chevrier & Singh, 2018; Silvia, 2010)	It is an emotion that arises when the cognitive conflict—generated by the task or object of knowledge—is resolved (Chevrier, Muis, Trevors, Pekrun & Sinatra, 2019; Di Leo, Muis, Singh & Psaradellis, 2019; Muis, Chevrier & Singh, 2018)	An activating emotion resulting from the perception of uncertainty, novelty, complexity, conflict, or unfamiliarity (Ellsworth, 2003). It follows a peak in comprehension, when new and complex information is perceived as incomprehensible (Muis et al., 2018)	When the discrepancy cannot be resolved, sustained confusion may transition into epistemic frustration (D'Mello and Graesser, 2012; Di Leo et al., 2019; Munzar et al., 2021). It can be understood as a mixture of anger and disappointment (Pekrun et al., 2002).	An emotion that arises when a person experiences cognitive conflict, generating doubt and/or uncertainty, perceiving that they cannot resolve it, yet perceiving it as highly valuable to them, since they feel their identity is at stake or threatened (Hookway, 2008; Muis, Chevrier & Singh, 2018)	An emotion that arises when a person perceives that they have little control over resolving the task and that it holds little value for them, leading them to disengage from the task or learning process (Muis, Chevrier & Singh, 2018). An emotion that arises when an individual is unable to resolve a cognitive conflict, having experienced surprise, confusion, frustration, and/or anxiety, which leads to disengagement from the task

Indicators (Henríquez, 2022)	Attention is focused on the unexpected event. Interest is elicited (Vogl et al., 2020)	Exploratory behavior manifests itself as manipulation of the material or questions aimed at gaining a deeper understanding. ("Why?" Grossnickle, 2014) High level of engagement/concentration on the task	Expressions showing enjoyment ("How fun!") accompanied by an enthusiastic tone of voice.	It is evident that something is not understood.	Low enjoyment of the activity is evident. Irritability may also be evident	Signs of concern, repetitive behaviors.	The gaze and attention are not focused on the activity. There is evidence of disengagement from the activity.
Physical cues (Henríquez, 2022)	-A fixed gaze on an object or on the person presenting new or conflicting information. -An expression of perplexity	-Maintains sustained attention and gaze on the activity -Seeks to make the most of the entire duration of the activity -Discusses the activity with teachers -Continues to discuss the activity even after it has ended.	-Laughter -Smiles when the eye muscles are engaged (Miles & Johnston, 2007)		-Holds the head in an irritated manner -Crossed arms	-Tense expression -Repeatedly touching one's hair -Repeatedly glances at the clock -Keeps looking at what her classmates are doing -Biting her nails	-Using a cell phone -Stares out the window for extended periods -Talks with a classmate about topics unrelated to the activity
Counter-indicators (Henríquez, 2022)		-Exploratory questions are not spontaneous (they are part of the structure of an activity)					-If the inattention is brief and the student then returns to the activity

Indicators from other authors	It is observed that an unexpected event occurred for the person in relation to the activity. and Interest is elicited (Vogl et al., 2020) Abrupt break in the rhythm of actions	Exploratory behavior is evident in the task and Thinks about the topic (Nojavanasghari et al., 2016) and Sustained attention to the task is observed or Demonstrates mastery of the interaction (Nojavanasghari et al., 2016)	"Cheerful expression": A smile involving the eye muscles (Miles & Johnston, 2007) - An effusive tone of voice compared to the previous tone. Increased volume. - Rapid or energetic movements (clapping, pointing at another person, raising the arms)	The person indicates that something is not understood. and/or A "confused expression" is observed (In D'Mello et al., 2014, the authors noted that confusion was not always evident, but they interpreted it based on facial expressions) and It is observed that the focus of attention is on the activity	This is expressed by the person themselves or by others who are enjoying the activity. and/or The person expresses a desire to stop the activity and/or The person displays irritability. (Please specify: How do you know this indicates irritability?) and/or A "troubled expression" is observed	The person expresses concern about themselves or their ability to perform the activity and/or Signs of restlessness or discomfort	Evidence of withdrawal from the activity. The person expresses a desire to stop the activity (Goetz & Hall, 2014) Slow, monotonous speech (Harris, 2000; Mikulas & Vodanovich, 1993)
Verbal indicators from other authors	Expressions such as: "I find this very surprising," "This surprises me a lot" (Chevrier, Muis, Trevors, Pekrun & Sinatra, 2019: Table 1 Coding scheme for epistemic emotions (7)						-Slow, monotonous speech (Harris, 2000; Mikulas & Vodanovich, 1993 - Expresses a desire to stop the activity.

Source: Author's own work

Appendix 2

Second prototype of the coding instrument

	Surprise	Curiosity	Enjoyment	Confusion	Frustration	Anxiety	Boredom
Indicators	Expression of surprise and Abrupt break in the rhythm of actions and It is observed that the focus of attention is on the activity	Exploratory behavior is observed and It is observed that the focus of attention is on the activity	A “joyful expression” is observed and/or The person shows enjoyment and It is observed that the focus of attention is on the activity	The person indicates that something is not understood and A “confused expression” is observed and It is observed that the focus of attention is the activity	The person or others express discomfort with the activity. and An “unproblematic expression” is observed and It is observed that the focus of attention is the activity	The person expresses concern about themselves or their ability to perform the activity and/or Signs of restlessness or discomfort	Evidence of abandoning the activity.

<p>Description of the indicators</p>	<ul style="list-style-type: none"> - Expression of surprise: raising of eyebrows and eyelids - Break in the rhythm of actions: the child interrupts the action they are performing; there may be a brief pause, and their gaze fixes on the unexpected event. 	<ul style="list-style-type: none"> - Exploratory behavior: handling the material or asking questions to gain a better understanding (e.g., "Why?" Grossnickle, 2014) or making comments about the topic (Nojavanasghari et al., 2016). - Task focus: gaze and body posture oriented toward the activity. 	<ul style="list-style-type: none"> - Joyful expression: A smile involving the eye muscles (Miles & Johnston, 2007) - Expressing enjoyment: An effusive tone of voice compared to the previous tone. Increased voice volume (Frank et al., 1993). Faster, more energetic, and/or expansive body movements (Keck et al., 2022), such as clapping, pointing at another person, or raising one's arms, compared to previous behavior. 	<ul style="list-style-type: none"> - A troubled expression: furrowed brow, pursed lips, - Focus on the task: gaze and body posture oriented toward the activity. - Repetitive movements (scratching the face, touching the face, touching the hair, touching the chest) - Contracted body postures (crouching, leaning forward) - Forced smile 	<ul style="list-style-type: none"> - Abrupt changes in pace during attempts at the activity (stopping mid-discussion, silences, sudden increase in volume) - Troubled expression: (furrowed brow, pursed lips) - Repetitive movements (scratching the face, touching the face, touching the hair, touching the chest, moving the leg) - Expansive body language (raising arms, leaning back, holding one's head with both hands) - Non-expansive body cues (crouching, covering the face with both hands) - Manifest irritability: Feeling tense, nervous, or "about to explode." - Laughter - Classmates try to calm her down and/or The person expresses a desire to leave the activity and The person shows signs of irritability. (Specify: How do you know this indicates irritability?) 	<ul style="list-style-type: none"> - Physical signs of withdrawal (crouching, slouching) - Repetitive movements (scratching the face, touching the face, touching the hair, touching the chest, moving the leg) 	<ul style="list-style-type: none"> - Slow, monotonous speech (Harris, 2000; Mikulas & Vodanovich, 1993 [cited in International Handbook...]) - Actions focused on something other than the activity at hand (checking the phone, talking about other topics) - Slumped posture (sustained unfocused gaze, slouching in the chair, letting arms or hands hang down, resting the head on one or both hands)
---	---	--	---	---	---	---	--

Counterindicators		- Exploratory questions are not spontaneous (they are part of the structure of an activity)					- If the inattention is brief and the person then returns to the activity
--------------------------	--	---	--	--	--	--	---

Source: Author's own work