Multimethod Investigation of Individual and Shared Emotions in Language Classrooms

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Abstract
The body of research on learner and teacher emotions has expanded considerably in recent years, providing insights into how emotions shape language learning and teaching. However, existing research has focused predominantly on a limited set of emotions, particularly anxiety, enjoyment, and boredom, overlooking the broader emotional repertoire experienced during classroom interaction. Moreover, classroom emotions are inherently dynamic, socially situated, and interconnected, yet relatively little is known about how they fluctuate throughout a lesson, how they are shaped by classroom ecology, or how they become shared among learners and teachers (Gkonou, 2020; Sulis & Mercer, 2024). To address this gap, the present study adopted a multimethod approach to investigate the real-time dynamics of individual and shared emotional experiences in an authentic English language classroom. Galvanic skin response (GSR) sensors were used to collect electrodermal activity (EDA) data from six learners and their teacher during two regular lessons, thereby preserving the ecological validity of the study and complementing the limitations of self-report measures (Plonsky, 2022). Because GSR reflects physiological arousal rather than discrete emotions (Albert & Tullis, 2023), both lessons were video-recorded and followed by video-stimulated recall (VSR) interviews. Integrating physiological, behavioral, and retrospective data made it possible to identify the emotions accompanying fluctuations in physiological arousal, trace their temporal development throughout the lessons, and examine patterns of emotional synchrony and interdependence among learners and between learners and their teacher (cf. Wiertelak et al., in prep.). By combining objective physiological measures with participants' own interpretations of their experiences, the study provides a more comprehensive account of the dynamic, individual, and social nature of emotions in the language classroom.
Key words: positive language education, emotional synchrony, emotional contagion, social appraisal, galvanic skin response (GSR), video-stimulated recall (VSR)

1. Introduction

Every language lesson is emotionally charged, with learners and their teacher experiencing, expressing, interpreting and shaping one another's emotional states from moment to moment. In fact, emotions experienced within individual lessons vary considerably, shift rapidly, and interact in complex ways (cf. Gkonou, 2020). Yet, despite their crucial role in language education, they remained largely neglected until the emergence of Positive Psychology (Seligman & Csikszentmihalyi, 2000) and its subsequent application to second language acquisition (MacIntyre & Mercer, 2014), which laid the foundations for Positive Language Education (Clare et al., 2025). Over the past two decades, research has expanded beyond predominantly negative classroom emotions, such as foreign language classroom anxiety (FLCA; Dewaele, 2017) and boredom (FLB; Kruk et al., 2022), to include positive experiences associated with language learning, particularly foreign language enjoyment (FLE; Dewaele & MacIntyre, 2014). Nevertheless, research in applied linguistics has continued to focus primarily on selected classroom emotions, especially FLCA, FLE, and FLB (Dewaele et al., 2023), leaving a much broader range of learners' and teachers' emotional experiences comparatively underexplored. At the same time, the field has increasingly

embraced a wider range of related affective and psychological constructs, including emotional labour (Benesch, 2017), emotion regulation (Bielak & Mystkowska-Wiertelak, 2024), grit (Zawodniak et al., 2021), resilience (Capstick, 2018), academic buoyancy (Yun et al., 2018), engagement (Mercer & Dörnyei, 2020), well-being (Sulis et al., 2023), and flow (Mystkowska-Wiertelak & Słowik-Krogulec, 2024). Despite this, there is still limited understanding of how the diverse emotional experiences evolve over time, are influenced by the classroom ecology, or contribute to shared emotional states (Shao & Parkinson, 2021), emotional synchrony and contagion, and the development of a positive and engaging classroom climate (Sulis & Mercer, 2024; Solhi et al., 2024).

Such complexity requires methodological approaches that can capture affective states in real time while preserving the authenticity of classroom interaction (cf. Mystkowska-Wiertelak et al., in review a, b; Wiertelak et al., in prep.). To this end, the present study combines galvanic skin response (GSR) measurements with video-stimulated recall (VSR) interviews to map the range of emotions experienced by learners and their teacher during authentic language lessons. By integrating physiological and qualitative data, the study seeks to identify the emotions accompanying fluctuations in physiological arousal, examine their development over time, and explore the extent of emotional interdependence among learners and between learners and their teacher. The findings are expected to shed light on the dynamic, relational, and context-embedded nature of classroom emotions, including their potential for reciprocity, multidirectionality, and synchrony, inform pedagogical practices aimed at fostering a positive emotional climate and mitigating negative emotional experiences, and advance methodological approaches to investigating emotional dynamics in educational settings.

2. Literature review

2.1 Conceptualizing emotions in the language classroom

Emotions are dynamic, multifaceted, and multidimensional phenomena rather than fixed states that can be objectively recognized (Barrett, 2006; Gkonou et al., 2020; Wang et al., 2024). According to Pekrun et al. (2018), emotions comprise multiple interrelated psychological components, including a compulsory affective core and a range of optional cognitive, motivational, physiological, and expressive components. Consequently, a person can undergo several different processes while experiencing a single emotion. Rather than arising automatically from physiological experiences, emotions are actively constructed. Barrett (2006: 20) argues that people experience emotions when they "conceptualize an instance of affective feeling" by interpreting and categorizing it in light of their prior knowledge and experiences. In fact, according to the Theory of Constructed Emotion, "the brain continually constructs concepts and creates categories to identify what the sensory inputs are, infers a causal explanation for what caused them, and drives action plans for what to do about them. When the internal model creates an emotion concept, the eventual categorization results in an instance of emotion" (Barrett, 2017: 13). Thus, the emergence of specific emotions results from the brain's continuous interpretation and categorization of sensory input informed by past knowledge, experiences and contextual information. Moreover, emotional experiences are not necessarily mutually exclusive. Rafaeli et al. (2007) introduced the concept of affective synchrony to describe stable individual differences in the tendency to experience positive and negative emotions simultaneously, demonstrating that mixed emotions vary systematically across individuals.

The construction and interpretation of emotions are fundamental to language learning and teaching, shaping how learners and teachers perceive, engage with, and respond to classroom experiences. Consequently, emotions have become central to SLA research and have informed the development of Positive Language Education. Positive

emotional experiences contribute to long-term effects by accumulating over time and building physical, intellectual, social and psychological resources to be drawn from later (Fredrickson, 2004). Importantly, both positive and negative emotions, when balanced, contribute to learner and teacher subjective well-being. Within the language classroom, emotions are increasingly recognized as essential for understanding learning and teaching processes and their influence on language achievement (Pekrun et al., 2018). Each classroom participant experiences unique emotions shaped by the interplay between contextual and individual learner- and teacher-related factors. Pekrun et al. (2018) categorize these emotions according to their valence (the distinction between positive and negative states) and activation (the range from physiologically activating, preparing for a quick reaction, to deactivating, allowing the body to rest), with both dimensions functioning independently from one another. Accordingly, emotions can be grouped into positive activating (e.g. enjoyment) and deactivating (e.g. relief), or negative activating (e.g. anxiety) and deactivating (e.g. boredom) categories (Pekrun et al., 2018; see also Barrett & Russell, 1998). Pekrun et al. (2018) further distinguish academic emotions according to their object focus, including mood-related emotions, achievement emotions (related to learning activities or their outcomes), epistemic emotions (associated with knowledge acquisition), and social emotions arising through interactions with others. Consequently, emotional experiences fluctuate throughout the lessons and may become shared among learners and between learners and their teacher.

2.2 Emotional synchrony, contagion and social appraisal

As socially and culturally situated phenomena, emotions emerge through the interplay between individual experiences and interactions with others, while also being shaped by shared beliefs, values, and social norms (Barrett, 2017; Mesquita, 2001; Pekrun et al., 2018). Consequently, emotions cannot be understood solely as individual experiences but also as interpersonal phenomena (Parkinson, 2011). In classroom settings, emotions may be co-constructed through interaction among learners and their teacher. Such shared emotional experiences may emerge through emotional contagion, when emotions spread between individuals, or through social appraisal, when classroom participants interpret situations through one another's emotional reactions (Jiang et la., 2026; Shao & Parkinson, 2021). One possible outcome of these processes is emotional synchrony, that is, the temporal alignment of emotional or physiological responses across individuals (Palumbo et al., 2017). Importantly, emotional synchrony does not need to result from the process of contagion. Instead, it may arise from course participants' responses to classroom events or their similar interpretations through social appraisal, which can be a cause of collective emotions (Bruder et al., 2014). According to Bruder et al. (2014), there is a crucial distinction between "collective" or "shared" and "group-based" emotions. Collective emotions are experienced by whole groups of people and reflect "the shared nature of the experience and expression of emotion" (p. 141). Group-based emotions, on the other hand, do not need to be collective as they refer to the basis of the emotion and can be expressed by individuals in isolation.

Although emotional contagion is only one of the mechanisms underlying shared emotional experiences, it has received increasing attention within SLA research (e.g., Dewaele & Li, 2021; Jiang et al., 2026; Moskowitz & Dewaele, 2021; Shao & Parkinson, 2021; Talebzadeh et al., 2020). Gordani et al. (2025) define contagion as the "catchiness of behaviors, perspectives, emotions and actions among social groups or connected people" (p. 1). Emotional contagion denotes the unconscious synchronization of expressions, behaviors, and feelings through visual and auditory communication (Hatfield et al., 1993). According to the law of contagion (Hasford et al., 2015), emotions are transferred reciprocally between individuals, often through automatic mimicry and facial expressions, facilitating the recognition and sharing of emotional states (Gordani et al., 2025). People may become emotionally similar either

through contagion (socialization), when interpersonal ties promote emotional or behavioral alignment, or through homophily, since individuals with similar beliefs, attitudes, or interests are more likely to interact (Barabási, 2002). These two processes may operate independently or reinforce one another.

Given that emotions can spread between individuals (Ryan, 2001; Tee, 2015) and members of social groups may synchronize their emotional states with one another and with their leaders, such as teachers (Burgess et al., 2018), emotional transmission has attracted growing attention in SLA (Jiang et al., 2026). In fact, teachers' emotions have been shown to influence not only learners' motivation and engagement but also their own emotional experiences and well-being through classroom practices and interactions (Sulis et al., 2023). Yet, the relationship between teachers and learners is neither straightforward nor unidirectional. Rather, it involves reciprocal influence that may foster emotional contagion and social appraisal, contributing to shared emotional experiences and synchrony. Evidence for such interpersonal alignment has also emerged from research on flow – an optimal psychological state typically accompanied by intense positive emotions (Csíkszentmihályi, 1990). Although originally conceptualized as an individual experience, flow has been shown to emerge collectively during activities that promote interaction and appropriate challenge, resulting in shared experiences among learners and between learners and their teacher (Słowik-Krogulec & Mystkowska-Wiertelak, 2026; Mystkowska-Wiertelak & Słowik-Krogulec, in review).

These findings underscore the importance of investigating classroom emotions as dynamic, interpersonal phenomena. The present study thus seeks to explore the momentary emotional experiences of learners and their teacher during a regular language lesson by combining physiological measures of arousal with stimulated recall interviews. The following research questions (RQs) guide the study:

RQ1. What emotions do learners and their teacher experience during a regular language lesson?

RQ2. What factors shape the emotional experiences associated with fluctuations in physiological arousal during the language lesson, as perceived by learners and their teacher?

RQ3. What contextual and learner-related factors contribute to synchronized physiological arousal among learners and between learners and their teacher?

3. Method

3.1 Ethics

The study received ethical approval from the University's Research Ethics Committee (approval no. 1/2026). Prior to data collection, all participants were informed about the study's aim and procedure and provided written informed consent. Participation was voluntary, with the right to withdraw at any time without consequences. All data were anonymized and treated confidentially. Non-participating students were seated outside the recording area and took part in the lesson as usual.

3.2 Participants

The study was conducted during a regular 90-minute General English: Integrated Skills (CEFR B2) class taught by one of the researchers, who was also the participants' regular instructor, thereby ensuring ecological validity. Both lessons followed the *Speakout* (3rd ed., B2) coursebook and involved the same teacher and six students (five female students and one participant who preferred not to disclose their gender; all participants use she/her pronouns, which are used throughout this article). The participants were second-year students aged 20–21 and shared Polish as their L1. Four were enrolled in their first university program, while two had previously studied psychology without completing a degree. The instructor was Cambridge CELTA- and

DELTA-qualified, with over a decade of teaching experience in private language schools and at the university level.

3.3 Context

The lesson began with two short student presentations (5 and 7 minutes long), prepared at home and related to the coursebook content, followed by a whole-class Q&A session. Since this stage generated most of the strong negative emotional responses reported in the study, it warrants brief explanation. One student chose car racing as a hobby and, after the presentation had been reviewed, incorporated a story about speeding and a photograph from a car accident in which they had been involved. The way the story was presented, together with a photograph depicting smiling teenagers standing beside the overturned car, was perceived by many participants as inappropriate and as trivializing dangerous driving. The remainder of the lesson focused on the topic of online communities. Students discussed introductory questions in pairs, read the article *Building Better Communities* and completed individual comprehension tasks, followed by pair checking and a class discussion. They were then introduced to language for presenting arguments and first brainstormed and wrote down their ideas individually. This was followed by a small-group discussion on topics related to social media and the online world, during which they shared and developed their ideas before giving brief oral presentations. The last task was a pair-work vocabulary game in which students described words and phrases from the unit for their partner to guess.

3.4 Study design

To capture the real-time dynamics of classroom emotions, the study combined physiological and qualitative measures. Electrodermal activity (EDA), recorded using galvanic skin response (GSR) sensors, provides an objective index of physiological arousal by measuring changes in the skin's electrical conductance associated with sweat gland activity (Albert & Tullis, 2023). Although EDA does not identify discrete emotions or their valence, it enables the detection of fluctuations in physiological arousal over time. GSR data were synchronized with classroom video recordings and subsequently used to guide video-stimulated recall (VSR) interviews.

Shortly following each lesson (max. 24 hrs), individual VSR interviews were conducted with all learners and the teacher (mean duration = 27 mins 6 seconds). Prior to the interviews, GSR recordings were analyzed to identify moments of high, low physiological arousal and periods of relative stability.

The output generated by the GSR_Analyzer App (Wiertelak et al., in prep.) consisted of statistically significant synchrony episodes involving pairs or groups of participants. Each episode was aligned with the corresponding segment of the lesson using the video recordings to identify the instructional activity, participants involved, and the behavioral context. The synchrony episodes were then linked to the stimulated recall interviews, allowing participants' accounts of their thoughts, emotions, and actions during the synchronized periods to be examined. This multimodal procedure enabled physiological synchrony to be interpreted in relation to the observable classroom context and participants' subjective experiences rather than on the basis of physiological data alone.

3.5 Analysis

Physiological synchrony was analyzed using the GSR_Analyzer App (Wiertelak et al., in prep.). Pairwise synchrony was estimated using windowed cross-correlation with temporal lags up to a predefined maximum, allowing the identification of similar patterns of physiological change occurring simultaneously or following short delays. Where appropriate, coherence and Dynamic Time Warping (DTW) were additionally used to quantify similarity between participants' physiological trajectories. Synchrony

was calculated as a signed measure so that anti-phase relationships were distinguished from positive synchrony rather than treated as equivalent.

Pairs maintaining synchrony above the predefined threshold were grouped into synchrony episodes. Independently of the episode analysis, participants' whole-session signals were clustered once per session on the basis of global similarity, in order to describe overall groupings of physiological dynamics across the lesson. Statistical significance was assessed using surrogate testing based on circular time shifts (or phase randomization), which preserved the autocorrelation structure of each individual's physiological signal while disrupting temporal alignment between participants. Consequently, significant synchrony reflected inter-individual coordination beyond that expected from the temporal characteristics of the individual signals alone.

The estimated temporal lag indicates the shift required to obtain the highest correspondence between two physiological signals. It should therefore be interpreted as a measure of temporal alignment rather than evidence that one participant's physiological response caused the other's.

The interview data were analyzed following the principles of reflexive thematic analysis (RTA; Braun & Clarke, 2021). An inductive–deductive approach was adopted, allowing themes to emerge from participants' accounts while remaining in line with the study's research questions. The interviews were transcribed and analyzed in NVivo. The data were initially coded semantically to identify participants' reported emotions, emotional triggers, and descriptions of classroom events before being analyzed at the latent level to identify broader patterns of meaning across the dataset. Codes were iteratively reviewed, grouped, and turned into candidate themes, which were then redefined and refined to provide a meaningful interpretation of the dataset and address the research questions.

4. Results and Discussion

The Results and Discussion are presented as a single integrated section to facilitate the interpretation of findings in relation to the complementary qualitative (sec. 4.1-4.2) and quantitative evidence (sec. 4.3) while minimizing unnecessary repetition. Section 4.1 focuses on the emotions experienced by learners and their teacher during the lesson (RQ1). Section 4.2 examines the learner- and contextual factors perceived to shape emotional experiences associated with fluctuations in physiological arousal (RQ2). Finally, Section 4.3 explores the contextual and learner-related factors contributing to synchronized physiological arousal among learners and between learners and their teacher (RQ3).

4.1 Emotional experience during the language lesson

4.1.1 Learners' emotional experiences

The analysis of video-stimulated recall (VSR) interviews, interpreted alongside participants' electrodermal activity (EDA) recordings, revealed a broad range of emotions experienced during the language lesson. Following Pekrun et al.'s (2018) classification, the identified emotions were grouped according to their valence (positive vs. negative) and activation (activating vs. deactivating). Overall, positively valenced emotions constituted the majority of the dataset. Among positive activating emotions, enjoyment was by far the most frequently reported emotion (29 instances across all participants), followed by excitement (3 – P3, P5, P6), pride (3 – P1, P3, P6), and hope (1 – P3). Positive deactivating emotions occurred considerably less frequently and included relief (10 – P3, P4, P5), contentment (2 – P1, P2), and relaxation (1 – P5). In addition to specific positive emotions, participants described related affective experiences accompanying positively valenced emotions associated with fluctuations

in physiological arousal, including self-consciousness (3 – P3, P5); self-confidence (2 – P1, P6), and curiosity (1 – P2).

Negatively valenced emotions also constituted a substantial proportion of the dataset. The most frequently reported emotions were shock (19 instances) and confusion (15), both experienced by all participants, followed by frustration (14 – P1, P3, P4, P6), negatively valenced surprise (10 – all participants), and worry related to empathy (2 – P3). Although related, shock and surprise were retained as separate categories because participants consistently used them to describe experiences of different emotional intensity. In terms of activation (Pekrun et al., 2018), the most frequently reported negative activating emotion was anxiety (16 – P1, P2, P3, P4, P5), followed by anger (5 – P3, P5) and shame (4 – P1, P3, P4). Negative deactivating emotions included boredom (7 – P1, P4, P5) and helplessness (1 – P1). Most negative emotions (apart from anxiety and boredom) were concentrated in the first stage of the lesson and were associated with a presentation on a topic that many participants considered inappropriate. This finding highlights the strong influence of task content on learners' emotional experiences and supports the view that classroom emotions are actively shaped by contextual factors (Barrett, 2017; Pekrun et al., 2018).

Interestingly, in several instances, participants (P1, P2, P4, P5, and P6) described their emotional experiences as generally positive without identifying a specific emotion, whereas negative emotions were typically labeled more precisely. For example, P1 reflected: *"Did I feel any particular emotions? I don't know... maybe a bit of stress, or perhaps something more positive. I think something positive because I remember it being a fun task. So, mainly positive emotions here as well."* Similarly, P2 stated: *"I think they were positive emotions, mainly positive. Looking at my facial expression... yeah, I quite like this task. This activity is like a game, and it's always fun."* Instead of recalling a discrete emotion, both participants appeared to reconstruct their emotional experiences by drawing on contextual cues, such as their memory of the task or their own facial expressions in the video. This finding is consistent with Barrett's (2006) view that emotional experiences are actively interpreted and categorized rather than directly perceived.

Similarly, participants occasionally described their emotional experiences as neutral (6 instances). For example, P6 commented: *"I think [the emotions] were just neutral, not really positive and not really negative."* However, such instances also reflected intense focus rather than an absence of emotion, as explained by P1:

> *I became more focused because my attention immediately shifted to the task – that's what I can see from watching myself. I think the emotions here were rather neutral, mainly just concentration. I've noticed that when I'm focused on doing something, my emotions kind of take a back seat because I'm simply concentrating on the task. So, I don't think there were any particularly positive or negative emotions at that point.*

This suggests that high levels of concentration, reflecting strong cognitive engagement with the task, reduced participants' awareness of their emotional experiences, making them more difficult to identify retrospectively despite the video-stimulated recall procedure and clear fluctuations in physiological arousal.

Finally, mixed emotions (18 instances) emerged as a distinct category, further illustrating the complexity and dynamic nature of emotional experiences in the language classroom (Wang et al., 2024). Instead of experiencing a single emotion at a given moment, participants frequently described combinations of emotions as differing in valence, activation, intensity, or changing momentarily. For instance, P6 described an attempt to help her partner guess a given word, which combined enjoyment of speaking with fear of negative evaluation and being misunderstood. She referred to this experience as an "emotional roller coaster":

> *I didn't understand what we were supposed to do. You can definitely see it from my facial expression. I was trying to figure it out. So maybe that's why*

it was such an emotional roller coaster. (...) I don't generally have a problem speaking and I like it, but I feel this pressure not to make mistakes, to say everything correctly, and to make sure everyone understands me.

Similarly, P3 experienced co-occurring emotions arising from different aspects of the same classroom event. While evaluating her classmate's presentation negatively, she simultaneously felt relief and happiness when another student expressed the opinion she wanted to voice:

Then my friend gave exactly the answer I wanted to give. I was so happy that someone had said it. So, at that moment I wasn't experiencing any negative emotions. I mean, they were positive emotions within an otherwise negative situation. I didn't like the situation overall, but I was happy that someone spoke up and said something sensible.

Overall, these findings suggest that learners' emotional experiences were often characterized by the coexistence of emotions of opposite valence rather than discrete affective states. This is consistent with Rafaeli et al.'s (2007) concept of *affective synchrony*, which emphasizes that positive and negative emotions can be experienced simultaneously within the same individual.

Emotions also evolved over time. For example, P5 described how her initial dissatisfaction developed into laughter, which she explicitly interpreted as a way of coping with the situation, illustrating both the dynamic nature of emotions and the use of emotion regulation strategies during classroom interaction: "*I simply didn't know how else to react because I felt I'd already shown quite clearly how unhappy I was with what he was saying. So, I just started laughing as a way of coping with it because that's how I react in situations like this."* Likewise, P4 explained that an unpleasant private interaction with her partner at the beginning of the lesson continued to shape her emotional experience during subsequent tasks:

Working in a group of four helped because it distracted me a bit. I didn't have to work only with [P3], which had a positive effect at that moment. But the topic quickly became boring and we run out of things to say, so then I didn't really feel like continuing the task.

Taken together, these accounts demonstrate that learners rarely experienced isolated emotions, but rather their emotional experiences were characterised by co-occurring, evolving, and context-dependent affective states shaped by ongoing classroom interaction, which supports the dynamic, context-dependent, and actively constructed view of emotions (Barrett, 2006, 2017; Gkonou, 2020).

4.1.2 Teacher's emotional experiences

Compared with learners, whose positive emotions were primarily linked to their own participation and task performance, the teacher reported a narrower range of positively valenced emotions, which were predominantly associated with students' reactions, engagement, and the perceived success of classroom activities. Among positive activating emotions, enjoyment (3) and excitement (3) were the most frequently reported, followed by hope (3), pride (1), and interest (1). Positive deactivating emotions included relaxation (3), relief (1), and calmness (1). In addition to discrete positive emotions, the teacher also referred to the related affective experience of satisfaction (5), which was associated with students' trust, successful task design, and the perceived effectiveness of classroom activities. For example, she reflected: *"I like the fact that they kind of trust me and they know that even if it's a task, they can still ask for help. That makes me feel good as well, that they don't feel threatened or worried,"* and *"I'm really happy and kind of pleased that I came up with this idea... it makes me feel good, it's like 'I did a thing' kind of moment."*

In contrast to the broad range of positive emotions experienced throughout the lesson, the teacher's negatively valenced emotions were largely confined to two

challenging moments: the confusing group task and the controversial student presentation. Among negative activating emotions, stress (2), frustration (1), anger (1), and anxiety (1) were identified. There were no instances of negative deactivating emotions, but the teacher reported other negative emotions not included in Pekrun et al.'s (2018) taxonomy, including worry (8), confusion (4), and negative surprise (1), as well as related affective experiences that co-occurred with negative emotional experiences, such as concern for students (4), responsibility (3), self-criticism (3), and uncertainty (1). Unlike learners, whose negative emotions were primarily associated with their own task performance and reactions to classroom events, the teacher's negative emotions were predominantly other-oriented and stemmed from concern for students, responsibility for the success of the lesson, and the perceived effectiveness of her pedagogical decisions.

A particularly interesting episode during which the teacher experienced a complex mixture of emotions involved the controversial student presentation. Surprise, worry, stress, confusion, and irritation, coexisted with responsibility, pride and satisfaction, reflecting her simultaneous appraisal of the presentation, the students' reactions, and her own role in responding to the situation. While the presentation itself elicited discomfort, observing that the remaining students clearly disapproved of the topic gave rise to positive emotions. Moreover, by closely monitoring learners' facial expressions and eye contact, the teacher interpreted their reactions as cues that they expected her to intervene. As the teacher explained:

> *I was surprised during the presentation and I was worried about what they were feeling. I was watching them closely (…). I could see that they were looking at me, waiting for my reaction, and they seemed to expect some criticism of the situation. It was a difficult moment. I felt that I had to react, and it was really stressful. I was also upset with the student who had chosen to do such a thing, but I was trying not to show it as much. I think I also felt slightly... proud, maybe pleased that they were unhappy about the topic and that they didn't support their colleague, who was trying to be 'cool' at all costs. Somehow, it made me feel good, I was relieved about the whole situation, despite the obvious irritation and discomfort.*

The teacher's continuous interpretation of learners' emotional reactions further supports the view that classroom emotions are complex, socially situated, and actively constructed (Barrett, 2017). It also illustrates mixed emotional experiences, consistent with Rafaeli et al.'s (2007) observation that emotions of opposite valence may co-occur within individuals. Additionally, the teacher's conscious effort to conceal her negative emotions while responding professionally to the situation illustrates the emotional labour involved in language teaching, as she actively regulated her emotional expression in an attempt to maintain a supportive classroom climate.

4.1.3 Shared emotional experiences

The previous sections demonstrated the richness and diversity of individual emotional experiences in the language classroom. However, the data indicated that many of these emotions were shared among classroom participants. In fact, the social dimension emerged as the second most frequently coded category (124 instances), surpassed only by emotions, highlighting the fundamentally interpersonal nature of affect in the language classroom.

Positive emotional experiences shared among learners

The following example illustrates emotional alignment rooted in common personal experiences rather than a salient classroom event. P2 describes discovering that she and her partner had similar experiences of receiving extra support with mathematics before graduation. She interpreted this common ground as the source of their mutual amusement during the conversation:

> *We both have friends we first met online who later helped us prepare for our maths exams before graduation. I was probably amused by the fact that it was maths. I remember thinking that maths is something we both struggle with and that people often need help with. Our emotions were similar at that moment. We were both happy and smiling, so I think that having such similar experiences made us laugh.*

P2 further interpreted her partner's emotional responses as matching her own, suggesting that recognising common experiences contributed to their shared enjoyment. A similar reflection can be observed in P4's account, in which laughter and joking during a collaborative task were accompanied by the perception that emotions spread between the interaction partners:

> *We had to explain the words written on the slips of paper. From that point on, my emotions were only positive. Sometimes I didn't know how to explain a particular word, but there was a lot of laughter, [P3] and I kept joking with each other. The emotions were contagious, and I didn't even notice the teacher walking around behind us, it didn't distract me at all.*

Together, these accounts suggest that shared enjoyment and emotional alignment may have enhanced participants' engagement with the task, resulting in focused attention on the interaction partner and reduced awareness of the surrounding classroom, a pattern consistent with descriptions of deep task involvement (Mystkowska-Wiertelak & Słowik-Krogulec, in review a).

Positive emotional experiences shared between learners and the teacher

Although, for most of the lesson, learners' task focus left them with little awareness of the teacher's presence in the classroom (as in the example above), a few instances of shared positive emotional experiences between learners and the teacher emerged during the game, the whole class listening task or subsequent collaborative activities. In the following excerpt, P4 described perceiving the teacher as sharing the learners' enjoyment of the activity: *"I mean, she did seem to be enjoying walking around and listening to some of our sometimes rather silly comparisons and our struggles to explain things we couldn't say directly. It felt like a shared positive moment."* A similar pattern emerged during the vocabulary game, where positive emotions were perceived as experienced between learners and the teacher, as exemplified by P2: *"Yes, I think [the teacher] affected me in a positive way because she was engaged as well. It seemed like she was enjoying it because she could see that we were competing in a good way. So, seeing that she was happy that we liked the activity made me feel more motivated too."* Such emotional reciprocity that led to increased motivation and encouragement was also present in P4's account. The participant attributed her positive emotional experience to the teacher's active listening and brief encouraging feedback. Feeling acknowledged and listened to fostered a sense of support, which, in turn, increased her willingness to participate in classroom interaction: *"I really liked that I was listened to and that I received feedback, like, 'Okay, that's nice.' I think that affected me a lot because if nobody had been listening to me, I wouldn't have felt encouraged to speak up, I probably just wouldn't have. And the teacher seemed to be honestly enjoying my speech."*

Negative emotional experiences shared among learners

The excerpt from P4 illustrates the inherently social nature of classroom emotions. The participant describes her own disbelief but also her continuous monitoring of peers' emotional reactions through eye contact and non-verbal behaviour:

> *The presentation continues and I feel awkward that [Tom] chose to tell this story. I don't really know how to react (…) I exchange glances with [P3], and the rest of the group also influences how I feel because they're reacting in a*

similar way. None of us really knows how to behave. I look at [P3] again, she's covering her head… I just can't believe he did that.

The exchange of glances and participants' similar emotional responses exemplify emotional synchrony among group members, while the P4's acknowledgement that the reactions of her peers influenced her own emotions reflects the process of social appraisal (Shao & Parkinson, 2021). However, the data do not allow conclusions regarding the direction of emotional influence, and the observed synchrony may equally reflect emotional contagion (Barabási, 2002; Hasford et al., 2015).

Negative emotional experiences shared between learners and the teacher

The same classroom episode that generated the strongest negative emotional responses also elicited shared emotional experiences among learners and the teacher. In the following excerpt, P5 described a dynamic shift in her emotions and explicitly linked her emotional experience to the reactions she observed in others, including the teacher. Her account suggested the presence of emotional contagion, implying a causal relationship between observing others' emotions and experiencing similar emotions herself: "*[Tom] started his presentation, and my emotions shifted from shock to almost feeling horrified. Seeing the teacher's reaction and everyone else's reactions, I reacted in the same way. I simply couldn't believe that someone would do something like that."* Similarly, P2 describes not only sharing emotions with her peers but also monitoring and interpreting the teacher's emotional reactions:

It seemed that the people around me were experiencing similar emotions. We kept exchanging glances. You could see [P1] and [P3] looking shocked. I was looking at the girls sitting opposite me, [P2] and [P5], and they reacted in a similar way. I also remember looking at the teacher because I was curious what she thinks about the presentation. (…) I think she was shocked by the whole situation as well.

In this quotation, the emotions extended beyond the learners and included the teacher. The P2's perception of emotional alignment with her peers again indicates perceived emotional synchrony, whereas her attempts to interpret the teacher's emotional reaction in order to evaluate the situation illustrate the process of social appraisal, again highlighting the socially situated, multidirectional, and co-constructed nature of classroom emotions (Barrett, 2017; Mesquita, 2001; Shao & Parkinson, 2021).

4.2 Factors shaping emotional experiences associated with physiological arousal

4.2.1 Task-related factors

Participants most commonly explained factors shaping fluctuations in physiological arousal by referring to characteristics of the tasks they were performing. Their accounts focused predominantly on their own appraisals, cognitive processes, and emotional responses to task demands rather than on interactions with peers or the teacher, with the exception of the inappropriate presentation. Complex, cognitively engaging activities often elicited multiple co-occurring emotions that changed as the task unfolded. For example, one of the moments characterized by heightened physiological arousal (high GSR) corresponded to a vocabulary game, during which P1 described simultaneously experiencing engagement, enjoyment, frustration, and anticipation as the lesson was drawing to a close:

This was the game, and it was very engaging, but I don't really like this kind of activity because my brain just switches off. Or maybe I don't mean that I dislike them, but I find them frustrating because I can't work out what's going on. So, I definitely felt some frustration. I was also already aware that the lesson was coming to an end, so I had that feeling of, 'Okay, we'll be leaving the classroom soon.' Still, I enjoyed the game."

Similarly, P6 described a cognitively demanding moment during the game, in which the challenge of explaining a word elicited mild stress while simultaneously maintaining positive emotions and persistence towards task completion:

> *I was having trouble explaining the word so that she could guess what was written on the card. I was trying to come up with another way of explaining it. Maybe there was a bit of stress? But I think they were mainly positive emotions because I wanted to succeed and I kept trying. It's hard for me to put it into words.*

Another instance characterized by heightened physiological arousal occurred during a listening task. In the subsequent stimulated recall interview, P2 explained that, despite considering such tasks as relatively easy, she was consistently anxious because of the possibility of missing information:

> *Listening tasks stress me out because sometimes you don't hear something properly, or the sound echoes off the walls. I mean, generally I think I'm quite good at them, they're not particularly difficult, but even so, they still make me a little stressed. I don't really like them.*

This account suggests that the heightened physiological arousal was associated not with the objective difficulty of the task but with the participant's appraisal of its demands. Although P2 perceived listening tasks as manageable, the anticipation of potentially missing information, for example, due to classroom acoustics, was sufficient to evoke stress. This finding highlights the importance of subjective task appraisal in shaping emotional experiences, rather than objective task difficulty (Barrett, 2017; Pekrun et al., 2018).

Interestingly, several participants described becoming highly focused on their own task performance, with attention directed primarily towards individual task completion rather than interaction with others. Even when learners briefly noticed their peers, these observations served as cues to re-engage with the task, showing the short-lived quality of emotional experiences, as exemplified by P1:

> *When everyone is focused on their own work, even if your attention briefly wanders and you look around, it serves as a reminder that, 'Okay, we're working now. I need to focus.' So yes, I think the others definitely influenced me, but not emotionally.*

These findings suggest that moments of heightened physiological arousal were not always consciously experienced as intense emotions. Instead, participants frequently recalled being absorbed in the demands of the task, which is consistent with Ayres et al.'s (2021) claim that heightened physiological arousal can be associated with cognitive load.

In contrast, another instance characterized by a marked decrease in physiological arousal (low GSR) occurred in a group discussion. During stimulated recall, P3 attributed this decrease to boredom resulting from a mismatch between the discussion topic and her personal interests: *"I really don't like questions like that. I enjoy discussions and thought-provoking questions, but this topic just didn't appeal to me at all. I was incredibly bored."* Unlike the previous examples, this account illustrates that lower physiological arousal was associated with a decline in emotional and cognitive engagement. Rather than the interactional format itself, the participant attributed her boredom to the discussion topic, suggesting that learners' emotional experiences depended not only on task type but also on the perceived personal relevance and interest of the task content.

4.2.2 Learner-related factors

Participants also explained fluctuations in their emotional experiences by referring to learner-related factors. One instance characterized by heightened physiological arousal was interpreted by P1 in relation to her self-perceived role during classroom interaction:

Generally, when I speak, I try to sound quite confident. [P2] is a bit more reserved, and I had already noticed that (...). I always try to encourage her a little. I've realised that I often do that in conversations with people who are quieter, I try to draw them out.

P1 explained her experience through stable personal characteristics and her perceived interpersonal role. She described herself as a confident speaker who naturally encourages quieter peers to participate, suggesting that learners' emotional experiences were shaped by their self-perceptions and interactional tendencies. This account illustrates that individual characteristics influenced not only how participants experienced classroom activities but also how they positioned themselves in relation to others during interaction.

Another segment characterized by high physiological arousal illustrates the interplay between self- and other-related factors. During stimulated recall, P1 attributed her positive emotional experience to having the opportunity to express her own views while simultaneously feeling listened to by her interaction partner:

I felt relieved that we could finally have a deeper, more philosophical discussion. I had quite a strong opinion on the topic, and I was happy that I could share it. It also felt good that [P2] was listening to me, which made me feel more confident. It was really fun.

This account suggests that heightened physiological arousal was associated with both self-expression and interpersonal validation. P1 attributed her positive emotions to being able to articulate her own views while also perceiving that her partner was listening attentively, which enhanced her confidence. The excerpt illustrates that learners' emotional experiences were shaped by the interaction between their own sense of agency and their perceptions of others' responsiveness.

A segment characterised by reduced physiological arousal highlighted the role of other-related factors. During stimulated recall, P3 reflected on how her approach to the task differed from that of her peers and considered whether these differences may have influenced the group:

I really liked that task because I enjoy group work and brainstorming. I had an idea, while the others in the group didn't really know how to answer, so I definitely felt satisfaction and positive emotions. (...) I approached [the task] more broadly (...). It's possible that they reacted to that in some way, but I don't know how much of an effect it had.

Unlike the previous examples, this period of lower physiological arousal was associated with reflective evaluation rather than heightened emotional activation. Instead of focusing on the intensity of her own emotions, P3 considered how her approach differed from that of her peers and whether these differences might have influenced the interaction. Even though she remained uncertain about the extent of this influence, the excerpt suggests that learners interpret their classroom experiences in relation to their perceived role within the group.

4.2.3 Teacher-related factors

Although learners frequently reported being so absorbed in the tasks that they paid little attention to the teacher's actions, they also identified several moments in which the teacher directly shaped their emotional experiences. These instances typically occurred when the teacher provided explanations, feedback, or clarification, which often elicited positive emotions. One such moment was characterised by heightened physiological arousal. For instance, P2 described a moment when the teacher clarified the meaning of an unfamiliar word, which resulted in amusement and shared laughter: "*The teacher explained the meaning of a word she had written on the board. [P1] thought it meant something different, and I remember laughing because I didn't know the word either or what it actually meant."* Unlike the previous examples, this account suggests that the teacher influenced learners' emotional experiences by facilitating understanding rather

than directing the activity itself. Clarifying the unfamiliar vocabulary transformed potential uncertainty into a moment of shared amusement, illustrating how brief teacher interventions could evoke positive emotions despite learners' general focus on task completion.

4.2.4 Study-related factors

An example account that was characterized by heightened physiological arousal attributed not to the classroom activity itself but to the research procedure was presented by P1. She explained that the novelty of wearing the GSR sensors initially elicited stress, which gradually disappeared as she became immersed in the lesson:

> *At first, I had to get used to it because it's not an everyday experience to have your hand covered with sensors. There was some stress simply because it was something new. But as the lesson progressed, I forgot about it and stopped focusing on it. I was just in the zone.*

The excerpt therefore highlights the importance of considering research-related influences when interpreting physiological data collected in authentic classroom settings (Wiertelak et al., in prep).

4.3 Synchronised physiological arousal in the language classroom

The synchrony analysis identified 37 episodes of physiological synchrony distributed across the lesson, with an average synchrony strength of 0.339 (Figure 1). Overall synchrony across the group was statistically significant according to the surrogate analysis (p = .005), indicating that the observed temporal coordination was unlikely to have occurred by chance after controlling for the autocorrelation structure of individual physiological signals.

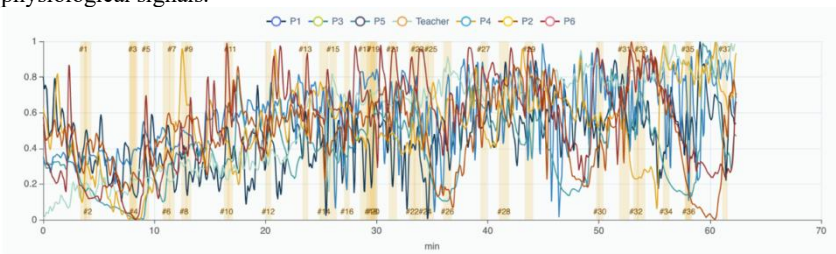


Figure 1. Physiological synchrony over the lesson

Pairwise analyses revealed considerable variability in synchrony across participant pairs (Table 1; Figure 2). Significant synchrony following surrogate testing was observed for P3–Teacher (r = .557, p = .005), P2–P6 (r = .559, p = .020), P3–P5 (r = .497, p = .005), P5–P6 (r = .523, p = .005), P3–P6 (r = .446, p = .015), P1–P5 (r = .353, p = .020), P1–P4 (r = .372, p = .040), and Teacher–P4 (r = .551, p = .020). All remaining pairwise associations were non-significant. The synchrony matrix (Figure 2) further illustrates that physiological coordination was concentrated within a small number of participant pairs rather than being evenly distributed across the classroom. Signal clustering identified two stable synchrony clusters, comprising P3–Teacher (r = .557) and P2–P6 (r = .559). The remaining participants did not form stable synchrony clusters.

Table 1. Significant pairwise synchrony

Pair	Max. *r*	Lag (s)	*p* (surrogate)
P1-P3	.211	-10	.204
P1-P5	**.353**	-10	**.020**
P1-TEACHER	.447	-10	.129
P1-P4	**.372**	10	**.040**
P1-P2	.051	-10	.313
P1-P6	.143	10	.363
P3-P5	**.497**	9	**.005**
P3-TEACHER	**.557**	1	**.005**
P3-P4	.328	-10	.095
P3-P2	.246	-10	.085
P3-P6	**.446**	-10	**.015**
P5-TEACHER	.370	-2	.075
P5-P4	.277	-10	.104
P5P2	.370	-10	.070
P5-P6	**.523**	-6	**.005**
TEACHER-P4	**.551**	-10	**.020**
TEACHER-P2	.113	-7	.294
TEACHER-P6	.477	-10	.159
P4-P2	-.032	10	.622
P4-P6	.256	10	.179
P2-P6	**.559**	6	**.020**

Note. Significant pairwise synchrony ($p < .05$) is shown in **bold**. Synchrony was estimated using signed windowed cross-correlation and evaluated with a surrogate test based on 200 circular time shifts. Lag represents the temporal shift producing the highest correspondence between the two physiological signals and should not be interpreted as evidence of causal influence. P = participant

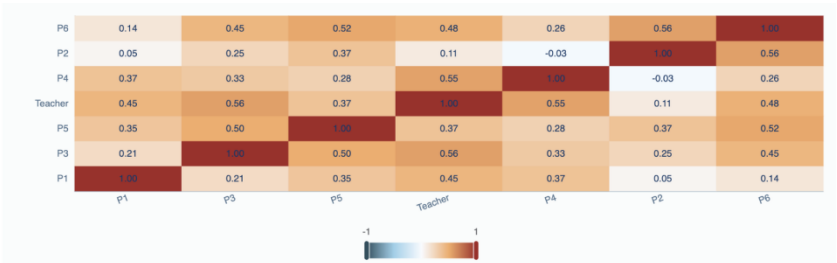


Figure 2. Pairwise physiological synchrony matrix showing maximum signed cross-correlation coefficients between all participant pairs. Darker colors indicate stronger in-phase synchrony.

Most synchrony episodes involved dyads, although several episodes included three participants, indicating temporary expansion of physiological coordination beyond pairs. Representative high-synchrony episodes are presented in Table 2. Across all episodes, duration ranged from 30 to 55 s, with mean synchrony strengths ranging from .71 to .95. The strongest multi-participant episodes occurred at approximately 3:40–4:20 min, 7:45–8:20 min, 28:30–29:20 min, and 34:35–35:10 min, when three participants exhibited highly coordinated physiological responses. The optimal temporal lag varied across participant pairs, ranging from −10 to +10 s. These lags indicate the temporal shift required to maximize correspondence between physiological signals and should be interpreted as reflecting temporal alignment rather than directional influence or causal effects.

Table 2. Representative high-synchrony episodes during the lesson

Episode	Time (min:s)	Duration (s)	Participants	Mean synchrony (*r*)	Peak synchrony (*r*)	Event
1	3:20–3:55	35	P1, Teacher	.939	.994	listening – focused attention
2	3:40–4:20	40	P1, Teacher, P4	.908	.974	listening – focused attention
3	7:45–8:20	35	P1, P5, P6	.883	.975	listening – focused attention
7	11:20–11:50	30	P1, P2, P6	.880	.952	distraction by study procedure
17	28:30–29:20	50	P3, P5, P4	.890	.959	group discussion
25	34:35–35:10	35	P5, P2, P6	.945	.974	individual work
28	41:00–41:55	55	P1, P4	.898	.992	group discussion

Note. The table presents representative episodes with the highest mean physiological synchrony. Synchrony strength was estimated using signed windowed cross-correlation. Peak synchrony refers to the maximum synchrony coefficient observed within each episode.

The first three episodes were associated with the same classroom activity, namely listening to peer presentations. In each case, the participants directed their attention towards the presenter, and their facial expressions and body language suggested sustained engagement (e.g., maintaining eye contact with the speaker, nodding, and producing backchannel responses). Episodes 1 and 2 also involved the teacher, who listened attentively and took notes in preparation for providing feedback. By Episode 3, however, the teacher had shifted her attention to organizing the subsequent lesson stage (Teacher: "*Here I looked at my notes and was thinking about feedback I was about to give.*"), indicating that synchrony can dissolve as participants orient themselves towards different goals.

Episode 7 occurred when several students were temporarily distracted by the research procedure after one participant's physiological sensor became detached. The students discussed the incident in their first language, and notably, all of those involved were seated either adjacent to or opposite one another, suggesting that physical proximity facilitated their coordinated responses. Episode 17 emerged during a small-group discussion in which students collaboratively generated answers to a set of questions. P5 noted that:

> *At that point we were discussing the topic, choosing it, and saying whether we agreed with it or not. I think it was because I agreed with the girls, and I partly had the same answer in mind, (…) I think I felt happy that I would have given a similar answer, but at the same time I was a bit confused. I felt that I wanted to add something, but I didn't really know what*.

Episode 25 occurred when students worked individually (as part of the writing brainstorming stage); however, classroom observations indicated that the synchronized students occasionally consulted or checked their work with nearby classmates. Finally, Episode 28 was recorded during another group discussion characterized by polling, negotiating, and exchanging ideas. P1 concluded that:

> *I was happy that I could present my ideas. And it was definitely nice that [P2] was listening to me.(…) I felt, 'Okay, she's really listening to what I'm saying.' It made the conversation flow well.*

Overall, the episodes indicate that synchrony was closely associated with moments of shared attention and interpersonal coordination. It occurred not only during collaborative tasks but also during collective listening and even in response to

unexpected classroom disruptions, suggesting that coordinated physiological activity reflects participants' joint engagement with a common situation rather than a particular task type.

The synchrony analysis demonstrated that physiological coordination was not a stable feature of the classroom context but emerged on an intermittent basis in reaction to particular events. Participants repeatedly entered and exited episodes of synchrony, showing that physiological synchrony is a dynamic feature of classroom interaction. Although synchrony episodes were established across the lesson, only two stable dyads emerged during the entire class. This suggests that physiological coordination may depend on social factors to a greater degree than on sharing the same context. Being in the same classroom was not sufficient for synchrony to emerge.

It needs to be noted that physiological synchrony should not be understood as evidence that participants experienced identical emotions. Episodes characterized by highly correlated physiological responses were often accompanied by qualitatively different subjective experiences. Some participants described enjoyment, whereas others reported uncertainty or frustration during the same synchronized period. The findings therefore support the interpretation of physiological synchrony as coordinated responsiveness to common classroom events rather than direct evidence of emotional contagion or shared affect (Palumbo et al., 2017).

The relatively short optimal lags observed between participants indicate that physiological responses were closely aligned in time. However, these temporal offsets should not be seen as evidence that one participant's physiological state caused another's response. Instead, they are more plausibly understood as reflecting differences in the timing with which individuals responded to the same evolving classroom event.

5. Limitations

Several limitations should be acknowledged. The study involved a small, self-selected sample of six learners and one teacher and examined a single language lesson, which limits the transferability of the findings. Future research should replicate the proposed multimethod approach with larger and more diverse samples, across multiple lessons and instructional contexts, to examine the stability of physiological synchrony and emotional dynamics over time and their relationship with learning outcomes and teacher–learner interactions.

6. Conclusions

The present study combined galvanic skin response (GSR), physiological synchrony analysis, classroom observations, and video-stimulated recall (VSR) to investigate the individual and shared emotional experiences in an authentic language classroom. The VSR interviews revealed the richness and complexity of learners' and the teacher's emotional experiences, demonstrating that emotions were embedded within and shaped by the classroom ecology. Participants reported a broad spectrum of both positive and negative emotions, including satisfaction, pride, excitement, hope, embarrassment, discomfort, uncertainty, and confusion. Importantly, emotional experiences were interpreted as resulting from the interplay of learner-internal and contextual factors, with task characteristics emerging as one of the key determinants of emotional trajectories. Rather than representing static responses to classroom activities, emotions fluctuated dynamically as participants continuously interpreted task demands, their own abilities, the actions of others, and the wider classroom context (Barrett, 2017; Pekrun et al., 2018).

The interviews further demonstrated that emotional experiences were often socially situated. Participants described numerous instances of perceived emotional synchrony, social appraisal, and emotional contagion, particularly within interacting dyads and between learners and the teacher. However, an important difference emerged

between the two perspectives. While learners primarily explained fluctuations in physiological arousal through their own appraisals, cognitive processes, and task experiences, the teacher's emotional experiences were predominantly learner-oriented, reflecting her continuous monitoring of students' engagement, participation, learning, and overall well-being.

The quantitative synchrony analysis complemented these findings by identifying when participants became physiologically coordinated during the lesson. Rather than revealing what participants experienced, synchrony analysis identified collectively meaningful classroom moments that subsequently became the focus of qualitative interpretation. Synchrony emerged intermittently throughout the lesson, primarily within dyads, and was associated with episodes of shared attention, collaborative interaction, collective listening, and responses to unexpected classroom events. The findings therefore support the interpretation of physiological synchrony as coordinated responsiveness to common classroom events rather than direct evidence of emotional contagion or shared affect (Palumbo et al., 2017).

The integration of GSR, synchrony analysis, classroom observation, and VSR proved particularly informative. Physiological analyses identified moments of heightened arousal and coordinated physiological activity, whereas stimulated recall revealed the subjective meaning participants attributed to these moments. Importantly, the findings also demonstrated that heightened physiological arousal did not necessarily correspond to consciously experienced high-intensity emotions. Instead, participants frequently described periods of cognitive effort, attentional engagement, or task immersion, highlighting the importance of combining physiological and qualitative methods when investigating classroom emotions.

The findings show that although GSR does not directly identify emotions, it enables researchers to detect individually and collectively significant classroom moments that can then be interpreted through classroom observations and stimulated recall. Such multimodal approaches provide a richer understanding of how emotions emerge, fluctuate, and become shared in authentic language learning environments.

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AI Statement

Artificial intelligence (AI) tools were used solely to support code generation for statistical analyses and figure preparation. The authors conducted all study design, data analysis, interpretation of findings, and manuscript writing and take full responsibility for the manuscript's content.

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