Research paper

Emotions in teacher engaging messages: Their interplay with student outcomes

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ABSTRACT

This study investigates how teachers' emotional prosody influences student outcomes. Audio-recorded messages (N = 353) from 55 secondary school teachers were analysed using speech emotion recognition software. A latent profile analysis identified two prosody profiles: low and high emotional expression. Low emotional expression in gain-framed messages predicted higher student motivation, whereas high emotional expression in loss-framed messages predicted better academic performance. These findings suggest that the impact of emotional prosody depends on the message frame, offering new insights into how teachers' messages can shape students' motivation and achievement.

1. Introduction

Within human interactions, information is conveyed through various means. When people exchange information, a plethora of implicit cues is gleaned from speech (Mitchell & Ross, 2013; Sikveland et al., 2021). Therefore, words not only communicate ideas or information, but they also express emotions (Ariztimuño et al., 2022). These emotions along with words themselves, have shown a decisive role in shaping students' outcomes (Frenzel et al., 2018, 2021). In fact, negative and positive words have a very different impact on the brain (Cato et al., 2004; Unkelbach et al., 2020). While negative connotated words remain longer in the brain and alter our hormonal system releasing cortisol (Smeets et al., 2006), positively connotated words are processed quicker, helping the brain create a broader range of associations from them (Unkelbach et al., 2008, 2020). Thus, the power of words and their emotions seems a crucial aspect within educational contexts (Pekrun & Linnenbrink-Garcia, 2014; Zougkou et al., 2017).

In school settings, teachers' messages play an essential role in regulating students' behaviour and are central to all teacher-student interaction (Belcher et al., 2022; Caldarella et al., 2023; Jang et al., 2010). Such messages have been repeatedly found to affect students' behaviour, engagement, and well-being (Caldarella et al., 2020; Floress

et al., 2018; Putwain et al., 2021). Among these, teachers engaging messages (i.e., messages that try to engage students in school tasks) have gained increasing relevance due to their implications for students' performance, motivation, and well-being (Falcon, Admiraal, & Leon, 2023; Santana-Monagas & Núñez, 2022; Santana-Monagas, Putwain, et al., 2022). Despite this, little is known about how the emotions embedded in these messages relate to both students and teachers themselves. While teachers' engaging messages have been found to impact students' motivation to learn and academic performance (Santana-Monagas, Putwain, et al., 2022), research has not fully clarified under which conditions emotions within such messages are consistently beneficial.

Moreover, research in this area faces a methodological limitation: most studies examining teacher messages and emotions have done so relying solely on teacher and student self-reports, while those incorporating direct teacher data rely on small sample (Frenzel et al., 2021), raising concerns about potential biases (Paulhus & Vazire, 2007; Spooren et al., 2013). Consequently, teachers' actual communicative practices and the emotions they convey in authentic classrooms remain understudied. The present study aims to address these gaps by directly measuring teachers' messages in naturalistic classroom settings. Understanding the scope of these messages, the emotions they convey, and their potential associations with student outcomes can provide valuable

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insights for both research and practice. Hence, through the audio recording of teachers during lessons over the course of two academic years, this study examines and describes the emotions expressed in teachers' engaging messages, along with their relationship to classroom characteristics, students' motivation to learn, and academic performance. Altogether, the unique contribution of this study is threefold. First, it is the first to apply large-scale, naturalistic audio recording and AI-based emotion recognition to teachers' engaging messages in authentic classrooms, addressing methodological limitations of self-reports and experimental simulations. Second, it advances theory by testing whether emotional prosody profiles moderate the relationship between message content and student outcomes. Third, it provides practical insights to inform teacher training interventions: if certain emotional profiles are consistently associated with higher motivation and performance, professional development can target not only what teachers say but how they say it. Ultimately, this work aims to bridge the gap between theory and practice by identifying actionable patterns in teacher communication that can transform classroom interactions and improve student learning.

1.1. Teachers' engaging messages

Among the many messages teachers use in their day-to-day instruction they commonly advise students to take actions to pursue positive outcomes. These messages, referred to as teacher engaging messages, are intended to engage students in academic tasks (Falcon & Leon, 2023; Santana-Monagas, Putwain, et al., 2022). Such messages have been operationalized as having a specific frame and motivational appeal. Engaging messages focus on the consequences of taking (or not taking) an action, either by highlighting the benefits of performing a learning task (gain-framed messages) or the costs of not doing so (loss-framed messages; Rothman & Salovey, 1997). In regard with their motivational appeal, their purpose is to motivate and drive students' behaviour towards actions that enhance their learning experience. To achieve this, teachers can appeal to two primary forms of motivational regulations (autonomous and controlled; Santana-Monagas et al., 2022). These motivations range from the strongest to the weakest degree of self-determination (Ryan & Deci, 2020). For example, a teacher might appeal to an autonomous motivation by emphasizing the inherent pleasure or interest in the activity itself, or by stressing the value of the learning task, whereas they can appeal to a controlled regulation by invoking the need for approval from oneself or others, or by using rewards or punishments (Ryan et al., 2021). For instance, a teacher might engage students by suggesting that hard work (completing homework, studying for exams, paying attention in class, etc.) will lead to learning interesting facts, or conversely, by warning that inadequate effort may result in punishment. The first message highlights the benefits of engaging in the task, appealing to autonomous motivation (i.e., interest), while the second focuses on the drawbacks of inaction, appealing to controlled motivation (i.e., punishment).

Research on these types of messages is promising and rapidly expanding. Recent studies indicate that when teachers frequently use gain-framed messages and autonomous motivational, students report higher autonomous motivation, achieve better academic performance (Santana-Monagas et al., 2022; Santana-Monagas, Putwain, et al., 2022) and display a higher perseverance and passion for long-term goals (Ruiz-Alfonso et al., 2023). Studies have also highlighted how these messages relate with teacher-student relatedness increasing students' sense of vitality and how teachers adapt their messages to the students being taught (Santana-Monagas et al., 2022).

However, despite these positive findings, nearly all studies on teacher engaging messages, except two (Falcon et al., 2023; Falcon et al., 2023), have relied on student self-reports to assess teachers' messages. This approach, common in much other research on teacher communication (Belcher et al., 2022; Putwain et al., 2017), may present methodological concerns. The indirect nature of student perceptions may not

accurately reflect teachers' actual messages, potentially introducing bias (Paulhus & Vazire, 2007; Spooren et al., 2013). Consequently, there is a pressing need for research to rely on alternative methods, such as direct observational data, to evaluate teachers' messages (Tempelaar et al., 2020). The present study seeks to address these issues by audio recording teachers' speech during lessons, allowing for a precise analysis of the messages used and their classification based on frame and motivational appeal.

Moreover, as previous research has proven, not only the words we use are important, but also their non-verbal features, such as prosody (Weinstein et al., 2020). Examining both *what teachers say* and *how they say it* results essential to understand the effect messages can have (Reeve et al., 2022). In this sense, it could be that teachers engaging messages reflect different emotions based on non-verbal aspects of voice (i.e., emotion-related cues from prosody), that can ultimately guide how they are interpreted (Zougkou et al., 2017) shaping student outcomes such as motivation and academic performance. Given that a teacher's voice is one of their most accessible and fundamental educational tools available for them, research on the emotional prosody of teacher messages could significantly advance understanding of teacher communication and its effects on students.

1.2. Emotions in teachers' messages and classroom dynamics

It is well known that emotions are of vital significance for education and learning (Frenzel et al., 2018, 2021; Keller et al., 2020; Mazer et al., 2014; Pekrun & Linnenbrink-Garcia, 2014). Research has proven their deeply intertwined connection with cognitive processes such as memory, attention, motivation and learning outcomes (Pekrun & Linnenbrink-Garcia, 2014; Tyng et al., 2017). However, whereas most research has focused on examining how teachers' emotional experiences alter their behaviour and impact students' outcomes (Frenzel et al., 2021; Keller et al., 2020), less is known about how emotions can be communicated within teacher messages, without them being part of teachers' emotional experience. Specifically, the analysis of emotional prosody, this is the acoustic features that convey affective meaning, offers a unique window into these processes. Drawing on Emotional Contagion Theory (Hatfield et al., 1993), individuals tend to automatically and unconsciously mimic the emotional expressions of others and, in doing so, come to feel similar emotions themselves. In classroom settings, this process means that teachers' vocal expressions of emotion can be internalized by students, shaping their motivational states (Frenzel et al., 2009; Parkinson & Manstead, 2015). Therefore, understanding the emotions transmitted within engaging messages is vital, as this contagion could influence how these are perceived and thus, student outcomes. Such insights could also provide valuable feedback for teachers and inform researchers in developing effective interventions targeting teachers' prosody (Paulmann & Weinstein, 2025).

Most current approaches in examining teachers' voice have done so in the field of language (Ariztimuño et al., 2022; Ding & Xing, 2022) as how to teach certain oral skills. Some other few studies have examined voice through the lenses of motivational research, as how different voice tones elicit different responses (Gerson et al., 2019; Weinstein et al., 2020). From this perspective, motivational language has two key components: the speech content (i.e., the words said) and the speech prosody (i.e., the tone of voice used; Zougkou et al., 2017). Findings from studies on motivational prosody have shown that an autonomy-supportive tone of voice enhances closeness, intentional engagement, well-being, and sociability, whereas controlling tones predict defiant reactions (Weinstein et al., 2018, 2019, 2020). However, such research presents several limitations. First, common approach to assess emotions has been through the disproportionate reliance on self-reported data (Frenzel et al., 2021; Weinstein et al., 2020). Second, while research on student emotions include vast samples sizes, data on teacher emotions usually rely on small sample sizes (Frenzel et al., 2021). Third, most research on motivational prosody has focused on examining different voice tone

within the field of parenting, with few studies to date in the field of education focusing on teachers' voice (Paulmann & Weinstein, 2025). Lastly, such studies have used experimental designs that manipulated voice tones in different messages. Therefore, there remains a need for research conducted in naturalistic classroom settings, analysing teachers' voices during everyday teaching to gain a more accurate understanding of the phenomenon.

Moreover, while most research has concentrated on analysing what teachers say, such as the framework of engaging messages, fewer studies have explored how these messages are communicated. Additionally, research in this area has yielded inconsistent findings. For instance, previous research has found that in some cases, loss-framed controlled messages such as "*If you don't study, you'll fail the exam*", contrary to what is expected, can be interpreted in a positive way (Santana-Monagas et al., 2022). It may seem plausible to expect that the teacher's emotional prosody helps in such interpretation. A warm and gentle tone that reflects the teacher's concern and interest when delivering such messages could guide a positive reception. However, this relationship may be more complex than previously assumed, as emotional tone does not always produce uniformly beneficial effects across contexts and student characteristics. For instance, a previous study by (Falcon, Alonso, & Leon, 2023) found that the emotional intensity expressed in engaging messages, this is the strength or magnitude of the expressed emotion, indeed moderates their outcomes in students. In this sense, authors found an inverted U-shaped moderation effect, showing that emotional intensity can have a downside, where insufficient intensity fails to grab attention, excessive intensity triggers psychological reactance, and a moderate level of intensity enhanced engaging messages effects on performance. However, identifying the specific emotions conveyed in such speech is lacking, even though it could be crucial. Different emotions may evoke distinct reactions in students, influencing their motivation, engagement, and overall response to the messages (Hascher et al., 2024; Lazarides & Raufelder, 2021; Santana-Monagas et al., 2024). By recognizing these emotional cues, teachers could tailor their communication more effectively to foster positive outcomes.

Finally, it is important to understand that teacher emotions and messages are shaped by classroom and students' traits (Burić & Frenzel, 2023; Frenzel et al., 2015). Hence, teachers' emotional expressions and the ways they communicate engagement are not merely individual dispositions but are dynamically co-constructed in interaction with the broader classroom climate. For instance, previous works have examined whether gender class composition relates with teacher messages, not finding any significant relation (Santana-Monagas et al., 2025). However, given that such null results may stem from methodological limitations (e.g., sample size, context, or measurement sensitivity), further investigation is warranted. For instance, social norms often associate women with greater emotional attunement and relational warmth, as reflected in the "women are wonderful" effect (Hodges & Klein, 2001; Krys et al., 2018). These stereotypes may unconsciously influence teachers to convey more positive emotions within their engaging messages towards female students, potentially reinforcing gendered patterns in classroom interactions. Such practices could have long-term implications, particularly given research indicating that gender-biased expectations can negatively affect female students' performance in areas like mathematics and science (Carlana, 2019). Moreover, these may also vary as a function of the kinds of messages being said. Therefore, exploring whether teachers' engaging messages and the emotions embedded in them differ by student gender remains relevant, as even subtle patterns could have meaningful consequences for students' motivation, and academic development. By revisiting this issue with a more nuanced approach, the present study aims to contribute to a deeper understanding of potential gender dynamics in teachers' emotionally expressive communication.

Altogether, this study aims to address these issues by conducting first a descriptive study on the emotions present in teachers' engaging messages using an artificial intelligence tool and, secondly, to examine how

such messages and the emotions conveyed relate with both students' motivation to learn and performance. This approach allows for the analysis of a large teacher sample without compromising accuracy, providing valuable insights into the effectiveness of engaging messages.

1.3. Emotion recognition in teachers' messages

The integration of AI into educational settings has ushered in a new era. Speech emotion recognition (SER) is at the front of this transformation in education, emerging as a highly effective tool for measuring emotions expressed in teacher messages. Bridging disciplines such as computer science, psychology, and cognitive science (Tao & Tan, 2005, pp. 981–995) artificial intelligence algorithms such as SER allows the automatic identification of human emotions in speech (Chen et al., 2012; Sobol-Shikler & Robinson, 2010), allowing for the development of adaptive learning strategies and teacher feedback (Llurba & Palau, 2024) that foster motivation and emotional involvement of students (Fernández Herrero et al., 2023; Salloum et al., 2025). This process involves the extraction of speech features, like prosody and tone, that distinctly represent emotional content in speech, identifying patterns associated with emotion expressions (Bänziger & Scherer, 2005; Demircan & Kahramanlı, 2014). Applying SER in educational contexts offers the potential to move beyond hypothetical or lab-based assumptions, providing objective, fine-grained data about teachers' emotional expression that can inform theory and intervention design. Beyond its research significance, SER has been used for many purposes, including the elaboration of feedback for call centers (Schuller et al., 2009) or supporting e-learning environments (Seknedy & Fawzi, 2021, pp. 361–368). However, the implementation of SER has some limitations, such as the variability in the selection of emotions for analysis and the historically low agreement rates between human and the emotions detected automatically (Chintalapudi et al., 2023; Lotfian & Busso, 2019; Schuller et al., 2006). Nevertheless, recent advancements have enabled the identification of universal emotions through more robust methods, suggesting a promising future for SER in broader domains, including educational research (Brooks et al., 2023; Schuller et al., 2023).

In a recent study, Cowen et al. (2019) utilised an international sample, where participants assessed the emotion categories and affective features conveyed by 2519 speech samples produced by 100 actors from five different cultures. By applying large-scale statistical inference methods, they identified twelve distinct emotions consistently recognised across these cultures: adoration, amusement, anger, awe, confusion, contempt, disappointment, distress, fear, interest, sadness, and desire. Building on this theoretical framework, the research team developed the Hume AI tool (Hume AI, 2024), designed to quantify these twelve emotions in audio recordings. The model behind the tool employs a deep neural network trained on a dataset of culturally diverse vocal bursts, non-verbal sounds that express emotion (Hume Vocal Burst dataset; Tzirakis et al., 2023). This tool was specifically designed to overcome linguistic bias by providing average emotion judgements for each culture individually, ensuring that the neural network does not infer any specific relationship between emotion and its manifestation across different languages or countries. Thus, this validated tool proves extremely useful for the reliable analysis of emotions expressed by teachers in their engaging messages. To achieve our objectives, the present research will utilise this tool to examine the twelve universal emotions within teacher audio recordings, offering insights into teachers' emotional expression in naturalistic settings.

1.4. The current study

The present study aimed to address the issues posed by audio recording teachers during their classes. This enables researchers to avoid self-report biases when measuring teachers' messages (Paulhus & Vazire, 2007; Spooren et al., 2013) and access rich information from

teachers' voice. In a first step, similar to previous research (Falcon et al., 2023; Winarti et al., 2021), audio recordings transcripts are analysed following the Transcript-Based Lesson Analysis (TBLA; Rahayu et al., 2020) and content-based filtering method (see method section; Khorsi, 2007). In a second step, messages are classified according to their categories (Santana-Monagas, Putwain, et al., 2022). Finally, audio clips where engaging messages have been identified are analysed with the Hume AI tool (see method section; Hume AI, 2024).

Given that prosody gives context-cues that shape meaning, understanding what emotions engaging messages express could add valuable insight for educators and researchers to shape future research and interventions on teacher communication. As this is the first study to examine teachers' emotional prosody within their engaging messages, a descriptive design is initially used to explore potential patterns. For instance, it could be that a specific type of engaging message conveys a specific emotion or that different emotions could be conveyed using the same kind of message. Acknowledging this could help us discern whether emotions and words align or whether they don't and vary as a function of other characteristics.

Moreover, given that we are interested in informing future interventions, we followed a person-centred approach. This allows us to identify distinct subpopulations of teachers who share a similar trend regarding the emotions conveyed within their engaging messages (Collie et al., 2020). It is of particularly useful for addressing teacher characteristics rather than treating teachers as having an equal behaviour. Thus, interventions can be designed and tailored to specific teachers rather than applying broad strategies based on general variable associations (Lanza & Rhoades, 2013).

This approach is, to our knowledge, the first to examine large-scale, naturally occurring emotional prosody in teachers' engaging messages using validated AI tools, thus offering an unprecedented opportunity to bridge the gap between theory and classroom practice. Form a theoretical point of view, the Emotional Contagion Theory and Self-Determination Theory (SDT) provide complementary frameworks to understand how teachers' emotional communication influences student motivation. Emotional Contagion Theory (Hatfield et al., 1993) posits that individuals unconsciously mimic and internalize the emotional expressions of others. This automatic transmission of emotion in the classroom shapes students' emotional experiences and engagement. Complementarily, SDT (Ryan & Deci, 2000) explains that students' motivation is enhanced when their basic psychological needs for autonomy, competence, and relatedness are supported by the social environment. Teachers' emotional expressions, particularly those conveying warmth, interest, and enthusiasm, can foster such a supportive climate, promoting more autonomous forms of motivation and increasing students' performance. Thus, while Emotional Contagion Theory elucidates the process through which emotions are transferred from teacher to student, SDT clarifies why these emotional transmissions matter by linking them to students' motivational quality and learning outcomes. Together, these theories highlight the vital role of teachers' emotional prosody in shaping both affective and motivational processes in educational settings.

Moreover, by systematically combining direct observational data, AI-based emotion recognition, and student outcome measures over two academic years, this study aspires to clarify when and how the emotional prosody of engaging messages contributes to, or detracts from, student motivation and performance. In doing so, it provides actionable insights for teacher professional development. Specifically, the findings can guide the design of targeted training to help teachers recognize and regulate the emotional tone of their messages to enhance engagement and learning outcomes. Furthermore, integrating speech emotion recognition into teacher training could offer innovative tools for self-reflection and feedback, ultimately supporting more responsive and emotionally attuned instructional practices.

Accordingly, the present study aimed to: (1) Identify and describe the emotions expressed in teachers' engaging messages, (2) classify teachers

into distinct emotional prosody profiles based on the emotions expressed within different types of messages; and (3) examine whether classroom gender composition predicts these emotional prosody profiles, and how those profiles relate to student motivation and academic performance. Regarding the first aim, and following previous studies, researchers have shown that teachers tend to use positive emotional tones to foster student motivation and engagement. For example, instructional emotional expression in video lessons is an important teaching strategy to promote student learning and engagement (Zhang et al., 2024). Furthermore, teachers with higher emotional competence create encouraging and supportive classroom environments that enhance students' motivation and academic performance (Yang & Du, 2024). Hence, given that teacher engaging messages seek to motivate students and encourage students to participate actively in their learning and school tasks (Santana-Monagas, Putwain, et al., 2022) we hypothesize that teachers engaging messages will predominantly express a combination of positive emotions and neutral/informative tones, with fewer negative emotions expressed (H1).

In line with the second aim, previous studies on emotional intensity have found messages with very high emotional intensity and messages with very low intensity (Falcon, Alonso, & Leon, 2023). Hence, following such patterns, we hypothesize that two main profiles will be found: profile characterized by consistently moderate to high combined intensity scores across multiple positive emotions and a profile characterized by consistently low to moderate combined intensity scores across all emotions, maintaining a more subdued emotional delivery (H2).

Finally, regarding the third aim, to the best of our knowledge, only one study has examined how gender composition within classes relates with teachers' messages, finding no significant associations (Santana-Monagas et al., 2025). However, previous findings highlight gender biased expectations which align with the "women are wonderful" effect might prompt teachers towards teachers to convey more positive emotions within their engaging messages towards female students and even relying more on gain-frame messages, given these are more supportive and relationally attuned (Hodges & Klein, 2001; Krys et al., 2018). Given the scarce available evidence, we formulate the following exploratory hypothesis: Teachers' engaging messages and the emotions embedded within them will vary according to the gender composition of the class, although the direction and magnitude of these differences are examined exploratorily (H3a). Regarding student outcomes, based on the Control-Value Theory of Achievement Emotions (Pekrun & Linnenbrink-Garcia, 2014), positive emotions promote cognitive engagement and self-regulation (Pekrun et al., 2002), whereas anxiety can hinder performance by increasing cognitive load and distraction. Hence, we hypothesize that the profile of teachers with a moderate to high combined intensity scores across multiple positive emotions will be more effective in enhancing student motivation and academic performance than messages conveying anxiety or other negative emotions (H3b).

2. Method

2.1. Participants

During two academic years, a sample of 55 teachers, comprising 31 females and 24 males with an average age of 47.18 years (SD = 8.26), and their 1125 students (female = 574, mean age = 15.97, SD = 1.32) participated in the study. The teachers had, on average, 14.70 years of teaching experience (SD = 9.60). Most teachers contributed data from more than one student class, resulting in a total of 88 participant classes spanning Grades 9 to 12. All participating teachers worked in public secondary schools across five regions of Spain, representing both urban (N = 52 classes) and rural (N = 36 classes) contexts. The teachers taught a range of subjects, mainly Mathematics (N = 71), followed by Biology (N = 6), Physics and Chemistry (N = 5), Spanish Language and Literature (N = 3), Chemistry (N = 2), and Physics (N = 1). These subjects

were taught for 3–4 h per week, depending on the grade level, and the classes took place in the morning, between 8:00 and 14:00.

2.2. Procedure

At the beginning of each academic year, we contacted principal heads of schools for the purpose of enlisting participant teachers. Participation was voluntary, and teachers enrolled in the study according to their interest and availability. We clearly conveyed the objectives of the study to the interested teachers, emphasizing the guarantee of confidentiality. This was further affirmed by securing their agreement through an 'informed consent' form. The study remained compliant with the data protection laws, regulations, and standards at both the national and European levels.

Teachers' audio-recorded eight classroom lessons towards the end of the first term in each of the two academic years. We provided compact (8 cm) audio-recording devices that could be attached to their clothing and were easy to use, with a single button to start and stop recording and a mini USB port for file transfer. The devices were configured to capture nearby sounds only, ensuring that only the teacher's voice was recorded when placed near their mouth. Teachers received both in-person and video tutorials on how to use the recorders and were asked to send us the audio files at the end of the term.

Once received, we transcribed the audio files using a cloud-based transcript service.[1] In addition, we provided teachers with short online questionnaires designed to gather information about their students' motivation to learn (see Section 2.3.3.). The teachers distributed these questionnaires among their students, and the responses were collected anonymously. No incidents or concerns were reported during this process. Teachers also shared their students' academic grades with us in anonymised form.

2.3. Measures

2.3.1. Teachers' engaging messages

To examine teacher engaging messages within the transcript a combination of Transcript-Based Lesson Analysis (Arani, 2017; Rahayu et al., 2020) and content-based filtering (Khorsi, 2007) was followed. Mirroring the process developed in prior studies (Falcon et al., 2023; Falcon, Alonso, & Leon, 2023), we transcribed the lessons and applied a list of keywords to filter the transcripts, employing a python program for this purpose[2] (Falcon et al., 2024). The keyword list encompassed words frequently included within or associated with teachers' engaging messages (e.g., study, future, fail, pass, etc.). We then analysed the filtered transcript, containing only a 10 % of the original text with a concentration of engaging messages, to identify and classify these messages. Apart from filtering the transcript, the program extracted an audio clip for each filtered message, which were later used to measure emotions in the messages.

Two trained research assistants examined the filtered transcripts to identify teacher engaging messages and exclude any sentence that was not an engaging message. The inclusion criteria for selecting these messages were as follows: (1) messages aimed at engaging students in school tasks, (2) containing either a gain or loss frame, (3) appealing to a form of motivation, and (4) being meaningful on their own, which could include one or multiple sentences. The identification process achieved a high inter-coder agreement of 98.71 %, indicating reliable results (O'Connor et al., 2017). Disagreements were discussed with the researchers and resolved.

Once identified, the research assistants categorised these messages

based on two predefined dimensions: frame and motivational appeal. This resulted in four classifications: (1) gain-framed controlled, (2) gain-framed autonomous, (3) loss-framed controlled, and (4) loss-framed autonomous. The reliability of these categorisations ranged from a strong 98.18 % to an acceptable 74.40 % intercoder agreement. Disagreements were also discussed with the principal researcher and resolved.

2.3.2. Emotions

To identify the emotions present in the audio clips we employed the Speech Prosody model developed by Hume AI (Hume AI, 2024), which is based on the work of Cowen et al. (2019), Schuller et al. (2023), and Brooks et al. (2023). We chose this tool among of all the possible ones because it has a strong cross-cultural validation process behind it (see Section 1.3.) that allowed us to accurately quantify the emotional content in the audio clips of engaging messages. The model measures the following twelve emotions: adoration, amusement, anger, awe, confusion, contempt, disappointment, distress, fear, interest, sadness, and desire.

Through a service offered by the HumeAI platform itself,[3] we uploaded and analysed each audio file corresponding to an engaging message individually. This analysis is conducted through a regression process performed by the model, in which the intensity or degree of emotion present in the audio is quantified from the vocal signals. For each audio clip, the tool generates numerical values reflecting the degree of expression of twelve emotions. The output for each emotion ranges from 0, indicating minimal expression of that emotion, to 1, indicating a strong expression. We retained these values at the message level to preserve the variability in emotional prosody across different teacher utterances, rather than aggregating them.

2.3.3. Students' motivation to learn

We measured students' motivation to learn using the Spanish version of the *Échelle de Motivation en Éducation* (Núñez et al., 2005). Specifically, we used the subscale of intrinsic motivation to learn, which is composed of 4 items beginning with the question, "Why do you study?", followed by the statements: "For the satisfaction I feel when I succeed in my studies", "For the satisfaction of discovering new things", "For the satisfaction of learning more about subjects that interest me", and "Because studying allows me to continue learning many things that interest me". The items were measured through a seven-point Likert scale ranging from 1 (absolutely not true) to 7 (absolutely true). To examine the reliability of the instrument we calculated both Cronbach' Alpha and McDonald's Omega, obtaining a satisfactory .84 and .85, respectively.

2.3.4. Students' academic performance

We measured students' academic performance through their grades, obtained from schools' official records. In Spain, teachers evaluate their students based on standardized rubrics created by the government, giving them a mark between 0 and 10 (León et al., 2017). These rubrics evaluate the same contents and competencies acquired by students throughout the course, regardless of the region in which the school is located.

2.4. Data analysis

To examine these aims, we carried out the data analysis in several stages. First, to provide an overview and set the stage for a more detailed analysis, we conducted a preliminary analysis to quantify the number of engaging messages found and computed descriptive statistics to explore the average levels of each emotion expressed in each type of messages.

Next, we performed a series of Latent Profile Analyses (LPA), one for each message category, using the twelve emotional values extracted

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from the audio clips as input variables. LPA allowed us to identify distinct emotional prosody profiles specific to each message type. We chose this method because it captures unobserved heterogeneity in the data by identifying latent subgroups (profiles), within the sample (Korpipää et al., 2020). Unlike traditional cluster analysis, LPA lets us determine the number of profiles based on empirical fit indices, including the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and the adjusted likelihood ratio test (LRT; Lo et al., 2001; Morin & Marsh, 2015; Stanley et al., 2017). We selected the number of profiles by comparing AIC and BIC values, where lower values indicate better fit, and examining the LRT results, where a low p-value suggests that a model with k profiles fits better than one with k-1. We also inspected the shape of AIC/BIC plots to identify inflection points that signal optimal solutions (Morin et al., 2016), and the entropy values. In addition, we considered class sizes and interpretability, discarding solutions where additional profiles resulted in very small classes (typically <10 %) or produced overlapping emotional patterns that were difficult to meaningfully distinguish. To reduce the influence of measurement error, we used standardised emotional values in all models (Justice et al., 2011).

We conducted all LPAs at the class level (N = 88) rather than at the individual teacher level (N = 55), as prior studies indicates that teachers adapt their discourse depending on the characteristics of each class (Parsons et al., 2018; Parsons & Vaughn, 2016). In fact, previous work on teachers' engaging messages (Santana-Monagas et al., 2023) also found that teachers tended to deliver different messages depending on the group. These findings support the choice of the class as the aggregation unit in the present study. Building on this evidence that teachers adjust their communication based on student characteristics, we additionally examined whether the percentage of female students in the class predicted profile membership.

Finally, we examined whether the emotional prosody profiles within each message category were associated with differences in student outcomes (i.e., motivation to learn and performance). We used the Bolck-Croon-Hagenaars (BCH) method (Asparouhov & Muthén, 2014a, 2014b; Bolck et al., 2004) to compare students' motivation and performance across the latent profiles. Unlike traditional ANOVA, the BCH method accounts for classification uncertainty by considering the probability that each individual belongs to multiple profiles. To further aid interpretation of the practical significance of these differences, we also calculated Cohen's d for each comparison. We conducted all statistical analyses using Mplus 8.8 (Muthén & Muthén, 2024).

3. Results

3.1. Descriptive overview

Across all classes, we identified a total of 353 messages (Table 1). Among these, teachers used autonomous motivational appeals more frequently than controlled appeals (64 % vs. 36 %). In addition, gain-framed messages were also more prevalent than loss-framed ones (57 % vs. 43 %). We observed that the most common type of message combined a gain frame with an autonomous appeal (45 % of the sample), followed by loss-framed autonomous messages (29 %). In contrast, gain-framed controlled messages and loss-framed controlled messages accounted for smaller proportions of the total (12 % and 14 %, respectively).

In terms of general emotional prosody, interest consistently showed the highest mean intensity across all message categories (ranging from .11 to .14). Amusement, anger, distress, and fear also appeared frequently, though with lower mean values than interest. Conversely, adoration, desire, and sadness appeared least often (around .01 to .04). Regarding emotional expression across message categories, we noted subtle differences. For example, teachers expressed slightly more amusement and interest in autonomous messages compared to controlled messages. Messages that combined loss frame with

Table 1
Descriptive statistics of teachers' engaging messages and their emotional expression.

Message type	N	%	Mean values and standard deviation											
			Adoration	Amusement	Anger	Awe	Confusion	Contempt	Disappointment	Distress	Fear	Interest	Sadness	Desire
Gain-framed controlled	41	12	.01 (.01)	.09 (.05)	.04 (.04)	.02 (.03)	.03 (.04)	.03 (.03)	.05 (.04)	.06 (.07)	.06 (.09)	.11 (.04)	.03 (.04)	.01 (.01)
Gain-framed autonomous	158	45	.01 (.01)	.09 (.05)	.05 (.05)	.03 (.03)	.04 (.04)	.04 (.04)	.06 (.05)	.07 (.06)	.07 (.07)	.12 (.05)	.03 (.03)	.01 (.01)
Loss-framed controlled	51	14	.01 (.01)	.10 (.06)	.06 (.05)	.03 (.02)	.04 (.03)	.04 (.03)	.06 (.05)	.08 (.06)	.07 (.07)	.12 (.05)	.03 (.04)	.01 (.02)
Loss-framed autonomous	103	29	.02 (.01)	.12 (.06)	.06 (.06)	.03 (.03)	.05 (.04)	.05 (.04)	.07 (.05)	.09 (.07)	.08 (.08)	.14 (.05)	.04 (.04)	.01 (.01)
Total	353	100												

Note. N = Number of observations; % = Percentage of the total number of messages observed.

autonomous appeals also featured the highest average levels of anger, distress, and contempt. In contrast, gain-framed messages conveyed higher levels of interest and amusement than other emotions.

3.2. Latent profile analysis

We conducted separate LPAs for each of the four message types to identify patterns in the emotions conveyed by teachers. Table 2 presents the fit indices (AIC, BIC), likelihood ratio test results, and smallest group percentages for the one-to five-profile solutions.

In all cases, we excluded the five-profile solution because it contained at least one profile representing a small proportion of the sample, raising concerns about the reliability and interpretability of that classification (Marsh et al., 2009). We then evaluated the remaining models by visually inspecting elbow plots of the AIC and BIC values (Fig. 1). In some cases (e.g., gain-framed controlled messages), both the two- and four-profile solutions showed improvements in model fit. However, the smallest latent class in the four-profile solutions was often very small (e. g., 8 % in gain-framed controlled, 7 % in loss-framed autonomous, and 2 % in loss-framed controlled). Moreover, additional profiles in these solutions tended to display overlapping emotional patterns that were difficult to meaningfully distinguish. Lastly, the two-profile solutions showed consistently high entropy values (ranging from .987 to .996 across message types), supporting their classification quality. Therefore, based on the combination of the inflection points observed in the elbow plots, the relative size of the smallest latent classes, the lack of clear differentiation in additional profiles, and the entropy values, we determined that the two-profile solution provided the most interpretable and parsimonious representation of the data across all message types.

Table 3 presents the standardised mean values of emotional expressions for the two latent profiles identified within each message type. In all cases, profiles differed primarily in the overall intensity of emotions rather than in specific emotions. Profile 1 was characterised by low emotional prosody across all 12 emotions (standardised means between approximately −0.60 and −0.17), while Profile 2 showed high emotional prosody (means between 0.72 and 1.56). For all message types, Profile 1 included between 60 % and 69 % of classes, and Profile 2 between 31 % and 40 %. The values for each profile are represented graphically in Fig. 2 to enhance interpretability.

Regarding gender composition, the percentage of girls in the class did not significantly predict profile membership across message types (GF-Autonomous OR = 1.00, p = .88; GF-Control OR = 0.98, p = .37; LF-Autonomous OR = 0.98, p = .19; LF-Control OR = 1.00, p = .90). This suggests that the emotional prosody patterns identified were not associated with the gender composition of the class.

3.3. Emotional profiles and student outcomes

The comparisons between emotional prosody profiles revealed that the relation between emotions expressed and student outcomes varied by message type (Table 4). In gain-framed messages, both controlled and autonomous, students exposed to messages with low emotional prosody (Profile 1) reported higher motivation to learn. These differences were not reflected in their performance. Notably, for gain-framed controlled messages, the difference in motivation showed a large effect size (Cohen's d = 0.92), while for gain-framed autonomous messages the effect was smaller but still meaningful (Cohen's d = 0.39). In contrast, for loss-framed messages, emotional prosody did not significantly affect motivation to learn, although effect sizes suggested small to moderate differences (Cohen's d = 0.50 for loss-framed controlled and d = 0.30 for loss-framed autonomous messages). However, students whose teachers delivered loss-framed autonomous messages with high emotional prosody (Profile 2) performed significantly better, with this difference corresponding to a small to moderate effect (Cohen's d = −0.39).

4. Discussion

The present study aims where three: (1) to explore how emotions are conveyed within teacher messages, (2) to identify profiles of teachers according to the emotional prosody within their engaging messages, and ultimately, (3) to examine how classroom gender composition predicts these emotional prosody profiles, and how such profiles relate with students' motivation to learn and academic performance. Results indicated that, across the different message types, interest and amusement were the most frequently expressed emotions with some subtle differences observed across message types. Regarding the second aim, findings showed a total of two profiles per message type, a low emotional prosody profile (profile 1) and high emotional prosody profile. Finally, gender class composition did not relate with such profiles and, regarding student outcomes, findings showed that for gain-framed messages, both autonomous and controlled, a low emotional prosody was positively related with students' motivation to learn whereas for loss-framed autonomous messages, a high emotional expressiveness positively related with students' academic performance. For loss-controlled messages, no significant relation was found with student outcomes.

Altogether, these findings offer valuable insights that help bridge several gaps identified in previous research. First, this study examines an understudied phenomenon: how the emotions embedded within

Table 2
Fit indices for the latent profile solutions.

| Message type	Classes	AIC	BIC	LTR p	% SG	Entropy
Gain-framed controlled	1	1308.017	1346.679	–	100.00 %	–
	2	883.294	942.898	.000	24.32 %	.996
	3	684.314	764.86	.000	18.92 %	.996
	4	509.049	610.537	.000	8.11 %	.998
	5	487.861	610.291	.000	8.11 %	.999
Gain-framed autonomous	1	5326.451	5399.494	–	100.00 %	–
	2	3627.013	3739.62	.000	31.61 %	.993
	3	3157.974	3310.146	.000	20.00 %	.988
	4	2869.847	3061.583	.000	12.26 %	.986
	5	2708.06	2939.36	.000	11.61 %	.992
Loss-framed controlled	1	1648.563	1692.966	–	100.00 %	–
	2	1269.049	1337.505	.000	36.17 %	.987
	3	1102.254	1194.761	.000	23.40 %	.987
	4	1010.575	1127.135	.000	2.13 %	.996
	5	993.144	1133.756	.000	2.13 %	.999
Loss-framed autonomous	1	3453.452	3515.977	–	100.00 %	–
	2	2453.272	2549.663	.000	35.00 %	.982
	3	2095.837	2226.095	.000	24.00 %	.981
	4	1916.182	2080.307	.000	7.00 %	.991
	5	1801.909	1999.902	.000	10.00 %	.982
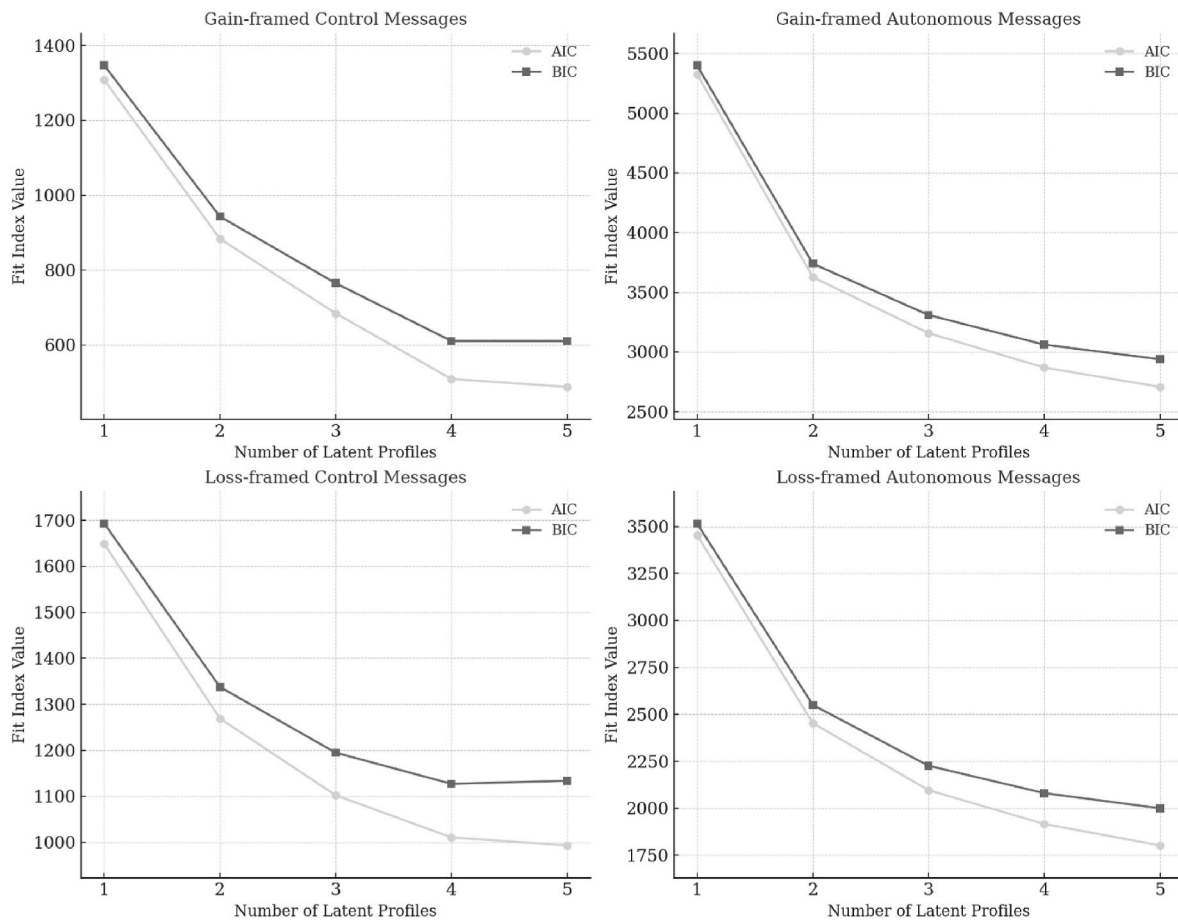
Fig. 1. Elbow plots of AIC and BIC values for latent profile models across message types.

teachers' engaging messages contribute to student outcomes. By exploring the emotional expressiveness of these messages, the study sheds light on how not only *what* is said but *how* it is said can moderate their effects. While prior research has addressed emotional intensity, such as the inverted U-shaped effects (Falcon, Alonso, & Leon, 2023), the specific emotional qualities conveyed through speech (e.g., joy, anger, concern) and their distinct influence on student outcomes have remained largely unexplored. Moreover, unlike most previous studies that relied on student self-reports, parenting contexts, or controlled experimental manipulations, this research is grounded in naturalistic classroom data. This enhances ecological validity and provides a more authentic understanding of how teacher emotions are expressed and interpreted in real educational settings. Thus, the present study contributes to advancing the understanding of the emotional dimension of teacher communication and its relevance for student motivation and performance. By capturing vocal emotional features from naturally occurring classroom messages, this research contributes a novel lens for understanding how affective communication mechanisms, central to both educational psychology and affective computing, operate in situ. A discussion of the main results and their practical implications follows.

4.1. Emotions within messages

Regarding our first aim, findings showed that the most frequently expressed emotions in teachers' messages were interest and amusement, confirming H1. According to the emotional contagion theory (Hatfield et al., 1993), these positive emotions are likely to foster similar affective states among students, as individuals tend to automatically mimic and internalize the emotional expressions of significant others in their environment (Frenzel et al., 2021). By conveying interest and

amusement through vocal prosody, teachers may capture students' curiosity and help maintain their attention. This phenomenon has been observed in previous studies, which demonstrate how teachers' emotions often align with those of their students (Frenzel et al., 2018). Given that the experience of positive emotions is essential for students' academic outcomes (Camacho-Morles et al., 2021; Liu et al., 2018), conveying these emotions through messages can significantly influence student engagement. Moreover, prior research has shown that emotion induction through message framing can activate behaviour (Yan et al., 2012). Therefore, teachers' voice and messages result an essential resource that could help understand why some teachers perform better than others.

However, results also indicated that the emotions expressed in teachers' messages were generally low in intensity. This could be attributed to the nature of engaging messages, which are designed to motivate students and are thus less emotionally charged compared to, for example, messages containing personal experiences. Another possible explanation is the misalignment between teachers' emotional states and the emotions they convey. For example, if a teacher is angry with a student but uses an engaging message during that emotional state, it is likely that the message will express anger with high intensity. Conversely, if a teacher attempts to convey an emotion without actually feeling it, the emotional intensity may be low. Alternatively, low expressiveness could reflect **a** strategic attempt to reduce student distraction by avoiding overly arousing tones in informative messages. Nonetheless, even low-intensity negative vocal emotions between a teacher and a student can be impactful. In fact, high-intensity emotions can sometimes overwhelm students, making it difficult for them to discern the emotions being communicated (Holz et al., 2021). Hence, results suggest that engaging messages are a resource that teachers use

Table 3
Standardised emotional expression means by profile and message type.

Message type	Profile	N	Adoration	Amusement	Anger	Awe	Confusion	Contempt	Disappointment	Distress	Fear	Interest	Sadness	Desire
Gain-framed controlled	Low	24	−.48	−.23	−.43	−.47	−.48	−.49	−.50	−.48	−.47	−.41	−.48	−.47
	High	9	1.50	.72	1.35	1.47	1.51	1.52	1.56	1.50	1.48	1.28	1.49	1.48
Gain-framed autonomous	Low	53	−.52	−.17	−.50	−.58	−.58	−.56	−.59	−.58	−.58	−.47	−.57	−.52
	High	26	1.13	.36	1.10	1.26	1.27	1.22	1.29	1.25	1.26	1.02	1.25	1.13
Loss-framed controlled	Low	24	−.60	−.30	−.58	−.66	−.63	−.62	−.59	−.57	−.55	−.51	−.55	−.43
	High	11	1.04	.51	1.00	1.15	1.10	1.07	1.02	1.00	.95	.89	.94	.74
Loss-framed autonomous	Low	43	−.57	.01	−.48	−.63	−.62	−.59	−.62	−.60	−.61	−.50	−.62	−.61
	High	21	1.06	−.02	.89	1.16	1.14	1.08	1.15	1.10	1.13	.93	1.14	1.13

Note. N = Number of classes assigned to each profile.

daily to motivate students as needed, and they do not necessarily carry a high emotional load. Future research could build on these findings by incorporating measures of teachers' emotional experiences, such as heart rate or facial expressions, to explore whether alignment between a teacher's emotional state and the emotions expressed in their messages affects the intensity of those emotions.

Interestingly, when examining emotional prosody across different types of messages, we observed nuanced variations. Specifically, teachers tended to display slightly higher levels of amusement and interest when delivering autonomous messages compared to those with a controlling tone. This suggests that when teachers appeal to autonomous motivations for engaging in a task, their delivery may naturally involve more positive affect, as they are referring to things students value and enjoy doing. This could help with teacher and student relationships while also reducing tension in their interactions. Hence, messages such as "*If you work hard, you will study what you want/what you like*" reflect teachers' intention to be supportive and caring, which aligns with the expression of emotions such as interest and amusement. Interestingly, messages that combined a loss frame with autonomous appeals showed the highest average levels of anger, distress, and contempt. This pattern might reflect a complex emotional tone, where teachers, while still encouraging student self-determine motivations, also express negative emotions perhaps tied to concern or urgency about potential failure or missed opportunities students really value and that are important to them. Conversely, gain-framed messages emphasizing positive outcomes, where characterized by higher levels of amusement and interest, indicating perhaps a more encouraging delivery and aligning the content of the message to its delivery.

4.2. Classroom gender composition, teacher profiles and student outcomes

In regard with the second aim the results presented in Table 3 reveal distinct emotional prosody profiles across different types of teacher messages. For each message category (gain-framed controlled, gain-framed autonomous, loss-framed controlled, and loss-framed autonomous), two latent emotional profiles were identified: one characterized by a *low* emotional prosody and the other by *high* emotional prosody, partially confirming hypothesis 2. This indicates considerable variability in how emotions are conveyed within the same message type across different classes. Messages classified within the high emotional prosody profiles consistently showed elevated levels across both positive emotions (e.g., amusement, interest, adoration, desire) and negative emotions (e.g., anger, contempt, distress, disappointment). In contrast, the low prosody profiles were marked by uniformly negative values, suggesting a much more neutral or emotionally flat delivery. Hence, findings suggest that what distinguishes teachers' delivery is whether they communicate their messages with strong emotional expression or in a more emotionally low tone, regardless of which emotions are involved.

Regarding our third aim, our results indicated that the percentage of girls in the class did not significantly predict teachers' emotional prosody profiles across different message types (gain-framed autonomous, gain-framed controlling, loss-framed autonomous, and loss-framed controlling). These findings suggest that the emotional expressiveness embedded in teachers' engaging messages is not systematically related to class gender composition. This outcome aligns with previous research (Santana-Monagas et al., 2025), which also found no significant association between gender composition and teacher messages. Given the exploratory nature of our hypothesis, this lack of significant findings provides valuable insight by suggesting that gender-related biases in teachers' emotional communication may be minimal or context-dependent in naturalistic classroom settings. Several explanations may account for these null results. It is possible that professional norms and increasing awareness about gender equality encourage teachers to adopt emotionally neutral or balanced communication strategies regardless of student gender composition. Additionally, the sample characteristics and measurement methods, although ecologically
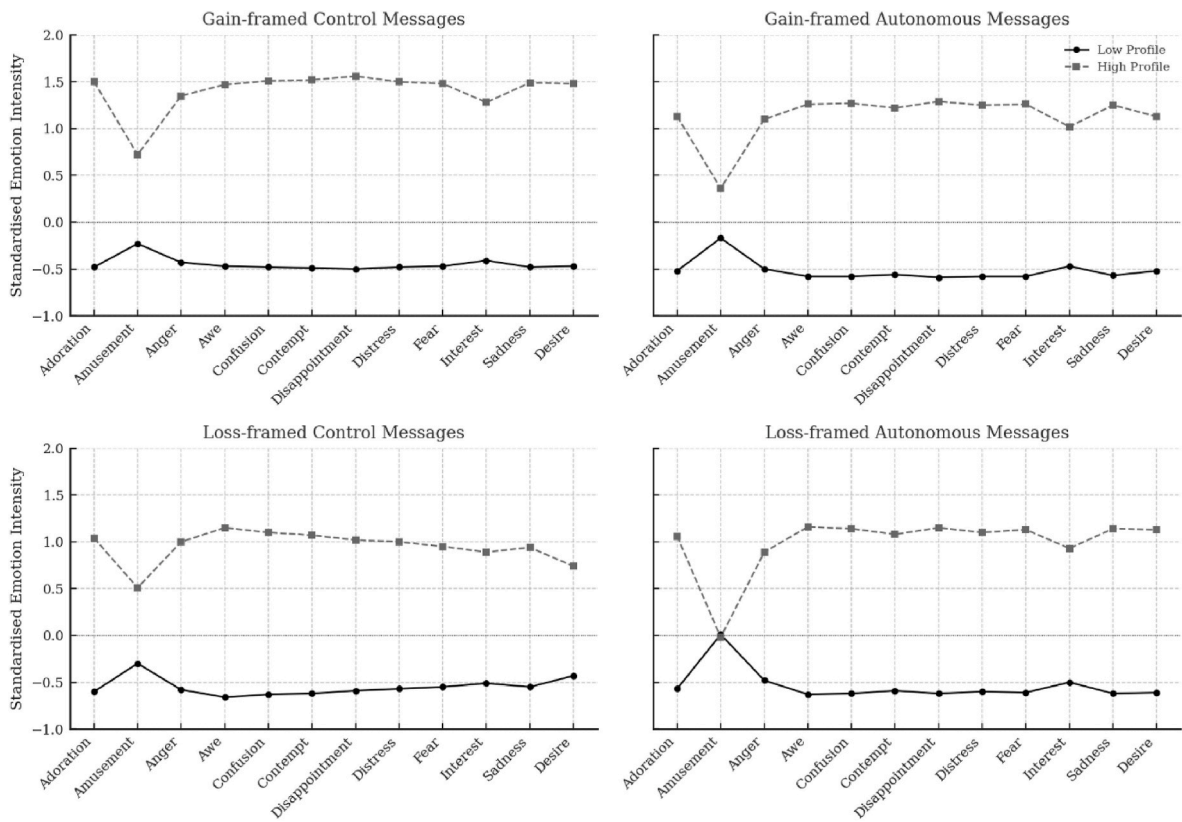
Fig. 2. Standardised emotion intensity in each profile by message type.

Table 4
Results of the comparison of students' motivation and performance across the latent profiles.

Message type	Variable	Profile 1 (Mean ± S.E.)	Profile 2 (Mean ± S.E.)	ΔM	χ^2	p-value	Cohen's d
Gain-framed controlled	Motivation to learn	**5.18 ± .11**	**4.64 ± .19**	**0.54**	**6.17**	**.01**	**0.92**
	Performance	5.77 ± 0.22	5.35 ± 0.28	0.42	1.38	.24	0.37
Gain-framed autonomous	Motivation to learn	**4.92 ± .05**	**4.70 ± .09**	**0.22**	**4.73**	**.03**	**0.39**
	Performance	5.17 ± .16	5.00 ± 0.21	0.17	.627	.43	0.13
Loss-framed controlled	Motivation to learn	5.13 ± .10	4.83 ± .17	0.30	2.43	.12	0.50
	Performance	5.60 ± .13	5.30 ± .38	0.30	.57	.45	0.26
Loss-framed autonomous	Motivation to learn	5.10 ± .06	4.80 ± .15	0.30	3.48	.06	0.46
	Performance	**4.90 ± .17**	**5.36 ± .14**	**−0.46**	**4.40**	**.03**	**−0.39**

Note. S.E. = Standard error. Significant differences are marked in bold. Profile 1 = low emotional expression. Profile 2 = high emotional expression.

valid, might not have captured subtle variations in emotional expressiveness. Furthermore, gender dynamics might manifest more strongly in other domains (e.g., academic feedback or classroom interactions) or vary by subject area and cultural context, aspects which were beyond the scope of the current study. Future research could explore these possibilities by examining diverse educational contexts, employing mixed methods, or focusing on specific subjects with traditionally gendered stereotypes. Such work would help clarify whether and how gender influences teachers' emotional engagement with students.

Finally, regarding student outcomes, for gain-framed messages, whether autonomous or controlled, a low emotional prosody (Profile 1) was associated with higher student motivation to learn, contradicting H3b. This suggests that, in contexts where engaging messages emphasizes potential gains, a more neutral emotional tone may help maintain students' focus on the message content rather than on the affective delivery. These results align with prior research, suggesting that excessive emotionality in certain engaging messages can have a downside. Specifically, authors found that whereas emotional intensity increases, the effect of messages on students' academic performance decreases (Falcon, Alonso, & Leon, 2023). From the perspective of message

framing theory (Tversky & Kahneman, 1986), this finding can be interpreted as reflecting how gain-framed appeals may be inherently motivating, making strong emotional expression redundant or even counterproductive by generating perceptions of pressure. In line with Emotional Contagion Theory, intense affective displays might also distract students or elicit defensive reactions when paired with positively framed content. This interpretation is consistent with findings by Weinstein et al. (2020) who reported that motivational messages delivered with intense emotional tones can be perceived as controlling, triggering defiant reactions. Translating this to the current context, when teachers use high-emotion messages intended to be engaging, the emotional intensity may paradoxically undermine engagement as such messages may be perceived as pressuring or misleading.

However, this trend observed with low-emotion gain-framed messages did not relate with students' academic performance, highlighting a possible dissociation between students' self-reported motivational states and actual task outcomes. One plausible explanation is that while low-emotion messages enhance students' intentions or interest, they may not provide enough arousal or urgency to influence performance in the short term. This interpretation aligns with Emotional Contagion Theory

(Hatfield et al., 1993), which posits that individuals can absorb and mirror even subtle emotional cues from others. In the case of gain-framed messages, a calm and steady emotional tone may transmit a sense of confidence, interest, or encouragement without triggering pressure or anxiety. This subtle affective contagion may create an emotionally safe and autonomy-supportive environment that fosters intrinsic motivation. However, because low emotional intensity lacks the arousing qualities that drive action or urgency, it may be insufficient to impact immediate academic performance, which often requires a higher level of activation.

Moreover, for loss-framed messages, no significant relation was found between the emotional expressiveness of profiles (low and high) and students' motivation to learn. These findings line up previous research highlighting showing the greater effect that gain-framed messages have on student outcomes in comparison with loss-framed messages, which usually have weak or non-significant relations with the studied variables (Santana-Monagas et al., 2024; Santana-Monagas, Putwain, et al., 2022). Here, the framing itself may dominate students' processing, triggering avoidant or defensive reactions regardless of teachers' emotional delivery. This raises interesting questions about whether certain message framings limit the potential for emotional tone to exert influence. In such cases, the message framing itself could be driving the response, leaving less room for emotional tone to make a difference. These findings underline the importance of carefully choosing messages.

Nevertheless, performance outcomes did vary as a function of the emotional prosody embedded within messages. Students' whose teachers relied on loss-framed autonomous messages delivered with high-emotion performed significantly better. This result suggests that while emotional expressiveness does not necessarily influence students' motivation in loss-framed contexts, it may still play a key role in driving actual performance. A possible explanation for this lies in the interaction between emotional intensity and the autonomy-supportive nature of the message. In situations where students are confronted with the potential consequences of failure, the combination of an emotionally expressive and autonomy-framed message might convey a stronger sense of urgency, but without undermining the student's sense of self-determination. Rather than being perceived as controlling, something that high emotional intensity can risk especially in gain-framed contexts, here the emotion may function as a marker of authenticity and care. When teachers express concern with intensity but within an autonomy-supportive framework ("If you don't work hard, you won't be able to study what you like" or "If you don't pay attention, you won't be able to enjoy this topic") students might interpret the message as both important and personally meaningful. In other words, students may feel that "this matters", not only because they might lose something, but because teacher clearly cares about the outcome. While loss-framed messages might not always foster motivation, under certain conditions, when delivered with a high emotional expression and in an autonomy-supportive way they can become powerful drivers of performance.

In this sense, while motivation reflects a person's subjective willingness or intent to engage, performance depends on the actual mobilization of cognitive and physiological resources. High emotional intensity in loss-framed autonomous messages may not increase students' conscious motivation because such messages can trigger ambivalent or defensive affective responses, reducing self-reported motivation. However, the emotional expressiveness combined with autonomy support may activate automatic regulatory processes, such as effort mobilization, that enhance performance despite stable motivation levels. In other words, the emotional tone may serve as an implicit signal of urgency or importance, driving behavioural outcomes even if it does not translate into increased motivational self-report. This distinction highlights the complex interplay between affective, cognitive, and behavioural systems in educational contexts and underscores the need for further research to unpack these mechanisms. These findings line up with previous research in the field, highlighting that under certain

circumstances, loss-framed messages can be positive (Santana-Monagas et al., 2023). Findings open up important questions for future research about how emotional and motivational elements interact, and how teachers can use this interplay to adapt their messaging strategies to different students and learning situations.

4.3. Limitations and future directions

Although the present study addresses several gaps in the literature some limitations should be addressed. First, similar to previous research (Falcon et al., 2023), certain types of messages were found in very little occasions (i.e., gain-framed controlled). This could be due to several reasons: not all teachers use all types of messages (Falcon et al., 2023); the proportion of class time dedicated to instruction in Spain and similar countries (70–80 %; OECD, 2019) limits the time available to deliver engaging messages; and that lessons were not record for the whole term. Thus, the number of messages in some categories may appear lower than expected limiting the scope of the present findings. Previous authors have argued the need for future research to record lessons during whole terms or gather larger samples in order to find more messages (Falcon et al., 2023).

Secondly, the study was conducted within the Spanish context. Although the Hume AI tool has demonstrated effectiveness in identifying twelve emotions across cultures, cultural differences in teachers' emotional expressiveness may still exist (Hareli et al., 2015; Matsumoto et al., 2008) as cultural norms play a significant role in shaping how people express their emotions. For instance, in East Asian cultures, collectivism and interdependence prioritize group harmony, leading to the suppression of disruptive emotions and a greater acceptance of self-conscious emotions to maintain social cohesion (Mesquita & Walker, 2003; Schunk et al., 2023) By contrast, Western cultures, emphasizing individualism and autonomy, encourage the direct expression of emotions, even confrontational ones, as a reflection of personal identity and authenticity (Jaikla & Piyakun, 2024; Matsumoto et al., 2008). Therefore, the results may be biased if interpreted from an ethnocentric perspective or based on norms specific to a single culture. Consequently, future research should replicate this study in different countries to account for potential cultural variations in teachers' speech. Therefore, it is important for future research to replicate this study in different countries to account for potential cultural variations in teachers' speech. Additionally, this study focused on secondary-level teachers, as older students are presumed to have a greater capacity to discern genuine emotions from vocal cues intended to enhance engagement. However, teachers' prosody may vary across educational levels. For example, teachers of younger students often exhibit greater emotional expressiveness to teach social-emotional competencies, which could result in differences in emotional prosody across grades (Denham et al., 2022). Future studies could investigate how teacher characteristics, school contexts, or their own emotions influence their emotional prosody and how this, in turn, affects student outcomes.

Another important direction for future research concerns the sequential and relational context in which teacher messages are delivered. In real classroom settings, messages such as gain-framed or loss-framed appeals are rarely produced in isolation. Teachers may begin by expressing interest, support, or concern, and only subsequently introduce motivational content (e.g., emphasizing potential gains or losses). The motivational impact of a given message may therefore depend not only on its framing and emotional tone, but also on how it is embedded within a broader communicative sequence. Hence, future studies could adopt discourse-analytic or interactional approaches to capture how engaging messages are situated within the flow of classroom dialogue. Investigating the timing, order, and relational framing of these messages could provide a more ecologically valid understanding of how teacher communication influences student outcomes. Similarly, teachers' baseline emotional states (e.g., stress, fatigue, or enthusiasm) could potentially influence the emotional prosody detected in their

messages. Since we did not assess teachers' affective states independently of their recorded messages, it is possible that some of the variation in emotional expression reflects underlying mood or stress levels rather than intentional emotional communication. Future studies could incorporate self-report or observational measures of teacher affect to better control for this potential confound and clarify the unique contribution of emotional prosody as a communicative tool.

Moreover, since engaging messages may not carry a high emotional load, future research could extend these findings by examining teachers' emotional prosody in other aspects of their behaviour. Given the rapid evolution of this emerging field and the novelty of the Hume AI tool, it is possible that by the time this study is read, more advanced and precise tools or updated versions of Hume AI may be available. Another limitation relates to the unbalanced distribution of subjects taught, with Mathematics being overrepresented. This imbalance prevented us from examining potential differences in emotional prosody across subject areas. Future studies should aim to recruit more balanced samples across disciplines to determine whether subject matter influences the emotional characteristics of teacher messages.

Furthermore, future research should consider additional student outcomes, such as other types of motivation (e.g., extrinsic, introjected, identified) and broader indicators of academic and psychological well-being, to provide a more comprehensive understanding of how teacher emotional prosody shapes student development. Additionally, more research is needed on the appraisals of teacher messages, particularly those that convey threat or challenge. As previous research highlights (Moè & Putwain, 2020) messages may activate distinct emotional and motivational pathways depending on how they are perceived by students. For example, a loss-framed message can be interpreted as either a challenge, eliciting constructive engagement and increased effort, or as a threat, triggering anxiety, avoidance, or defensive reactions. Future work could examine how these subjective appraisals interact with message framing and emotional tone to influence students' motivation, affect, and performance outcomes. Lastly, as participation in this study was voluntary, it is possible that self-selection bias occurred; teachers who chose to participate may differ systematically from those who did not (e.g., in communication style or openness to innovation). Future research should aim to include more diverse and representative samples to address this limitation.

4.4. Implications for practice

The findings of this study offer valuable insights for enhancing teacher training and classroom communication strategies. Recognizing distinct emotional prosody profiles in teachers' engaging messages can help educators become more aware of how their vocal emotional expression influences student motivation and academic performance. Teacher professional development programs could incorporate training modules focused on improving emotional communication skills, helping teachers use emotional prosody intentionally to foster a positive and motivating learning environment. Furthermore, these insights have implications for the design of educational technology tools, such as AI-driven platforms that analyse and provide feedback on teachers' vocal emotional expression during lessons. Such tools could support teachers in refining their delivery to maximize student engagement and learning outcomes. At the policy level, educational authorities might consider promoting emotionally responsive teaching practices by including emotional communication competencies in teacher evaluation frameworks and support systems. This could enhance teacher effectiveness and student well-being across diverse educational contexts. Finally, the study highlights the importance of tailoring interventions not only to message content but also to the emotional tone and delivery, acknowledging that emotional prosody is a modifiable aspect of teaching that can be developed to improve educational outcomes.

4.5. Conclusion

This study highlights the importance of how teachers emotionally express themselves when delivering engaging messages. Results showed that overall low emotional prosody in gain-framed messages was linked to higher student motivation, although it did not affect performance. Conversely, high emotional prosody in loss-framed, autonomy-supportive messages was associated with better academic outcomes, suggesting that in contexts involving potential loss, emotional intensity, when paired with support for autonomy, can enhance message impact. These findings underscore that the emotional tone of teacher communication, not just its content, plays a crucial role in shaping student responses, highlighting the importance of carefully choosing both the content and tone of feedback depending on the intended outcome, whether it's to spark motivation or improve performance. Future research could explore whether and how teacher-student relationship quality moderates the effects of emotional prosody on students' academic and motivational responses.

CRediT authorship contribution statement

Elisa Santana-Monagas: Writing – review & editing, Writing – original draft, Visualization, Investigation, Conceptualization. **Samuel Falcon:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Jaime Leon:** Writing – review & editing, Funding acquisition, Conceptualization.

Author note

Declaration of competing interest

Authors declare no conflict of interest.

Data availability

I have shared the link to my data in a footnote.

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