



Research paper

Teachers' engaging messages, students' motivation to learn and academic performance: The moderating role of emotional intensity in speech

Samuel Falcon^a, Jesús B. Alonso^b, Jaime Leon^{a,*}

^a Department of Education, University of Las Palmas de Gran Canaria, Las Palmas de Gran Canaria, Spain

^b Instituto Universitario para el Desarrollo Tecnológico y la Innovación en Comunicaciones (IDeTIC), University of Las Palmas de Gran Canaria, Las Palmas de Gran Canaria, Spain



ARTICLE INFO

Keywords:

Teacher professional development
Secondary education
Pedagogical issues
Improving classroom teaching
Evaluation methodologies

ABSTRACT

This study examined how emotional intensity of speech affects the relationship between teachers' engaging messages, and students' motivation to learn and academic performance. To achieve our goal, we recorded and transcribed teachers' lessons. Results revealed that messages appealing to external stimuli had lower emotional intensity than those appealing to internal stimuli. Our results also suggest that emotional intensity moderates the relationship between engaging messages and academic performance, with the effect decreasing as emotional intensity increases. This study offers insights into the role of acoustic features in teachers' influence on students' motivation and academic performance and suggests avenues for further research.

1. Introduction

Much of the literature since the mid-1980s emphasises the importance of teachers verbal behaviours and its impact on students' outcomes and learning (e.g., Babad, Bernieri, & Rosenthal, 1987; Gorham, 1988; Kearney, Plax, Richmond, & McCroskey, 1985). These behaviours have been studied from different perspectives, including instructional communication competence (Titsworth, Quinlan, & Mazer, 2010) and teacher clarity (Comadena, Hunt, & Simonds, 2007). Studies have also highlighted the importance of verbal behaviour aimed at encouraging and motivating students (Ahmadi et al., 2022; Kiemer, Gröschner, Kunter, & Seidel, 2018). Drawn upon the results of this line of evidence, a considerable amount of literature has grown up around the topic of teachers' messages.

To date, several studies have investigated the use of different types of teachers' messages, a verbal behaviour, and their impact on students (Ntoumanis, Quested, Reeve, & Cheon, 2017; Putwain, Symes, Nicholson, & Remedios, 2021; Spilt, Leflot, Onghena, & Colpin, 2016). For instance, Floress, Jenkins, Reinke, and McKown (2018) examined the use of teachers' praise, finding that higher use of praise was related to a decrease in students' off-task behaviour in classrooms. On the contrary, other authors have focused on fear-based motivational messages prior to exams and have found that these messages can be perceived as threats, diminishing motivation and increasing anxiety (Putwain & Best, 2011;

Putwain et al., 2021; Putwain & Remedios, 2014). However, few studies have considered the role of different types of motivational incentives that can be appealed to in the messages, while they may also influence student outcomes (Aelterman et al., 2019; Collie, Granziera, & Martin, 2019).

This context was the basis for the development of teachers' engaging messages, which are the messages explicitly directed towards students with the purpose of engaging them in their school tasks (Santana-Monagas, Núñez, Loro, Moreno-Murcia, & León, 2023). Examples of these messages include "If we finish the activity early, I'll leave you 5 min of spare time at the end of the class", or "If you don't study now, you won't be able to study medicine in the future". These messages differ in that the first one emphasises the benefits of completing the task (*gain-framed*) and appeals to an external stimulus (time as a reward), while the second one emphasises the disadvantages of not studying (*loss-framed*) and appeals to an internal stimulus (something valuable to the student). Recent research has found that using *gain-framed* messages that appeal to internal stimuli positively predicted students' academic performance via enhancing their motivation to learn (Santana-Monagas, Putwain, Núñez, Loro, & León, 2022).

These previous studies have assessed engaging messages through students reports, but this might not be enough. Existing research on teachers' messages has demonstrated that students' perceptions of them can vary widely (Urda, 2004), and that students' evaluations of

* Corresponding author. Calla Sta. Juana de Arco, 1, Gran Canaria, 35004, Spain.
E-mail address: jaime.leon@ulpgc.es (J. Leon).

teachers' behaviour might be influenced by different factors, such as class attendance, effort, and teachers' gender, reputation, or personal traits (Spooren, Brockx, & Mortelmans, 2013). In light of these limitations, the utilization of observational data is essential for gaining a more precise understanding of the relationship between engaging messages and student outcomes (Tempelaar, Rienties, & Nguyen, 2020).

Moreover, by utilizing direct observational methods, researchers are able to gather important acoustic information, such as paralinguistic and prosodic features (Mitchell & Ross, 2013; Weinstein, Zougkou, & Paulmann, 2018, 2019, 2020). The significance of these acoustic characteristics in the educational setting, specifically in relation to teachers' communication with pupils, has been the focus of recent studies (Paulmann & Weinstein, 2022). Emotional intensity, as an acoustic feature related to the activation dimension of the perceived emotion (Alonso, Cabrera, Medina, & Travieso, 2015), accounts for both prosodic and paralinguistic features of speech, including pitch and energy values. This aspect of human communication has been found to be a crucial predictor of communication effectiveness (Holz, Larrouy-Maestri, & Poeppel, 2021). However, emotional intensity has been understudied in educational contexts, especially in natural settings, even when it may be affecting message retention through attention (Anikin, 2020; Arnal, Kleinschmidt, Spinelli, Giraud, & Mégevand, 2019). Only recent advancements in technology have allowed researchers to begin exploring this area (Paulmann & Weinstein, 2022; Weinstein et al., 2018, 2019).

Therefore, it is imperative to investigate the potential impact of emotional intensity on a teacher's verbal behaviour, like their engaging messages, to examine its relationship with the students' academic performance and motivation to learn. This study aims to contribute to the literature by being the first to explore the role of emotional intensity in the relationship between teachers' engaging messages and students' performance and to understand how it can influence the effectiveness of the messages in the classroom. Specifically, based on the findings of previous studies where messages have been found to influence academic performance through students' motivation to learn (Santana-Monagas, Putwain, et al., 2022), we propose a moderated mediation model in which the direct impact of engaging messages on academic performance and the interaction of these messages with student motivation may be moderated by emotional intensity.

1.1. Teachers' engaging messages, students' motivation to learn, and academic performance

Teachers' engaging messages refer to those messages used by teachers to engage their students in school tasks (Santana-Monagas et al., 2023). These messages are rooted in two major theories: the Message Framing Theory (MFT; Rothman & Salovey, 1997) and the Self-Determination Theory (Ryan & Deci, 2020). The MFT focuses on messages' frame, which emphasises the benefits of engaging in a school task (*gain-framed*) or the disadvantages of not doing it (*loss-framed*). Research on teachers' messages based on this theory found that *loss-framed* messages lead to increased student anxiety and poorer behavioural engagement and performance (Putwain, Nicholson, Pekrun, Becker, & Symes, 2019, 2021; Putwain & Symes, 2011). The SDT, on the other hand, examines the different types of incentives that drive people to engage in activities. Teachers can appeal to external motivators like rewards and punishments (i.e., *extrinsic* motivation) or feelings (i.e., *introjected* motivation), or to internal forms like the value of studies (i.e., *identified* motivation) or the pleasure of engaging (i.e., *intrinsic* motivation). Research has found that students who are internally motivated are more engaged, perform better, and acquire higher-quality learning (Taylor et al., 2014).

In addition, previous studies have shown that regardless of the type of motivation being appealed to, teachers tend to emphasize the importance of achievement (e.g., GPA, grade retention, etc.) to engage students (Dufaux, 2012; Faubert, 2009; Ryan & Brown, 2005; Ryan & Deci, 2000). For example, they may use the achievement of good grades

as a reward, appealing to an *extrinsic* motivation, by telling their students: "With a little more work, you will raise that grade a lot and your parents will buy you the bike". However, they may also do so by making the students see that it will help them get into the career they want, appealing to an *identified* motivation: "With a little more work, you will raise that grade and it will be easier to get into medical school". Focus on achievement has been identified as an external motivation (Ryan & Deci, 2017), but passing a subject or getting a good grade can also be a potential goal that students are typically expected to identify with because their future learning goals depend on it (Lim & Chapman, 2012). For this reason, a message that appeals to internal motivation but emphasises achievement might have a different effect than a message that also appeals to internal motivation but does not refer to achievement (Falcon, Admiraal, & Leon, 2023). Therefore, since the focus on achievement is compatible with all appeal categories and might influence the message's effect, for each of the four *appeal* categories, there is a subcategory focusing on *achievement*. According to the combination of *frame* and *appeal*, teachers can rely on 16 different types of engaging messages to engage students (Fig. 1).

Recent large-scale studies have provided information on teachers' use of classroom time and when they may be using these engaging messages. Specifically, the OECD's Teaching and Learning International Survey (TALIS) collected data from teachers across 48 education systems on time spent on various classroom activities (OECD, 2019). In sum, this study provides evidence that around 20–30% of class time involves non-instructional activities, where teachers may deliver engaging messages to students. Despite the short period of time where teachers can employ these messages, they have been found to influence students in several ways. Santana-Monagas et al.'s (2022) findings showed that engaging messages indirectly predicted students' academic performance via their motivation to learn. Specifically, they found that *gain-framed* messages appealing to autonomous forms of motivations (i.e., *identified*, and *intrinsic*) positively predicted internal forms of motivation to learn, which in turn predicted academic performance.

These previous studies have assessed teachers' engaging messages through student reports. However, while student reports offer important insights into perceptions of messages, they have limitations. Research shows students' evaluations can vary widely based on factors like effort, attendance, and teacher traits (Spooren et al., 2013; Urdan, 2004). Thus, student-reported data alone may not capture the full picture.

Direct observations, utilizing audio recordings of lessons and subsequent transcript analysis, have been employed in several studies to avoid reporting biases (Rahayu, Rahmawan, Hendayana, Muslim, & Sendi, 2020; Winarti, Saadi, & Rajiani, 2021). This method, known as Transcript-Based Lesson Analysis (TBLA; Arani, 2017), allows for breaks for coders and for the information to be reviewed (Vrikki et al., 2019). Whereas previously, gathering large numbers of naturalistic observations required extensive manual transcription, making in-depth analysis difficult, recent advancements in artificial intelligence transcription enable fast and reliable transcription of lessons. By using this methodology, we can gather observational data on teachers' engaging messages and also obtain audio data that cannot be collected through the use of reports alone (Falcon et al., 2023). Thus, our study extends the existing knowledge by exploring the established relationship between teachers' messages and students' motivation to learn from a different methodological perspective.

1.2. Audio data from teachers' speech: emotional intensity of messages

The incorporation of audio data in the examination of teachers' messages allows for the analysis of acoustic features such as prosody, intensity, pitch, and emotions (Khalil et al., 2019). In educational research, acoustic features have been extensively studied in the field of language (Nickels & Steinhauer, 2018; Piazza, Martin, & Kalashnikova, 2022) and reading teaching (Chung, Jarmulowicz, & Bidelman, 2017), but there has been limited investigation of their role in teachers verbal

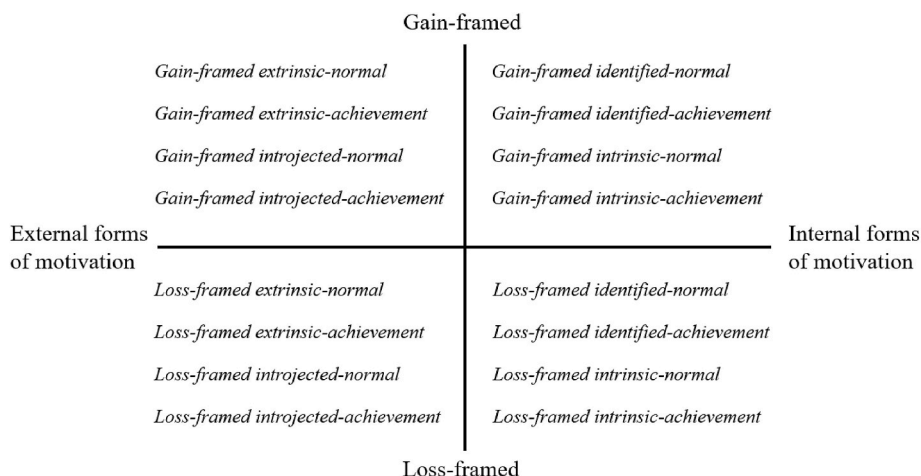


Fig. 1. Categories of teachers' engaging messages
 Note. Y axis = *frame* dimension; X axis = *appeal* dimension.

behaviour and their relationship with student outcomes, despite the role they might be playing (Paulmann, 2015).

Among these features, emotional intensity, defined as an acoustic feature related to the activation dimension of perceived emotion (Alonso et al., 2015), encompasses prosodic and paralinguistic aspects of speech, including pitch and energy values. Speeches with high emotional intensities have properties such as elevated pitch, energy, and tempo, and vice versa. This factor, although potentially influential on communication effectiveness, remains notably understudied within educational contexts.

Recent studies have shown that emotional intensity may interact with attention processes (Anikin, 2020; Arnal et al., 2019; Holz et al., 2021; Raine, Pisanski, Simner, & Reby, 2019). Specifically, information imparted with heightened emotional intensity increases salience and attention paid to the speech. In an educational context, this could imply that messages delivered with higher emotional intensity may receive more attention from students, thereby enhancing their effectiveness. However, literature also indicates that emotional intensity may have an inverted U-shaped effect, whereby too little intensity fails to capture attention, but too much intensity elicits psychological reactance (Weinstein, Vansteenkiste, & Paulmann, 2020). Therefore, moderate levels of intensity may be optimal for maximizing message impact and retention. Due to these contradictory findings, the role of emotional intensity requires further research, especially in natural educational settings.

Given that emotional intensity can influence how closely students pay attention to the discourse, this suggest that the level of intensity might also affect how well students attend to and retain the engaging messages. This could, in turn, affect the impact of these messages both directly on performance and indirectly through motivation, as students might be more or less attentive to the messages depending on their emotional intensity. Our study aims to contribute to this emerging field by investigating the role of emotional intensity in the context of teachers' engaging messages. We propose that emotional intensity could potentially moderate the effects of these messages. This moderated mediation model suggests that the direct impact of engaging messages on academic performance may be moderated by emotional intensity, and the indirect effect mediated through motivation could also be influenced. Hence, the proposed model (Fig. 2) implies that emotional intensity might not only moderate the relationship between the messages and academic performance, but also the interaction of these messages with students' motivation to learn.

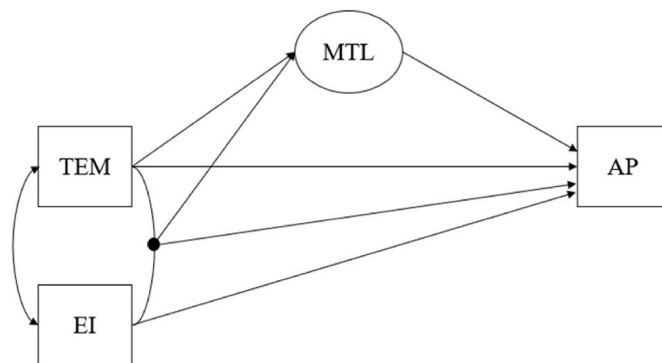


Fig. 2. Proposed model
 Note. TEM = Teachers' engaging messages; EI = Emotional intensity; MTL = Motivation to learn; AP = Academic performance.

1.3. This study

As mentioned before, engaging messages relations with academic performance can be divided on a direct effect and an indirect effect through motivation to learn (Santana-Monagas, Putwain, et al., 2022). The direct effect pertains to the immediate influence that the message itself may exert on academic performance. For instance, engaging messages, by their very design, seek to involve students in their school tasks. Supporting studies also demonstrate the direct impact of teacher motivational messages on student outcomes (Putwain et al., 2021; Putwain & Remedios, 2014). The indirect effect, conversely, stems from the potential of these messages to enhance students' motivation, thereby indirectly leading to improved academic performance. Consequently, it is pivotal to understand both these direct and indirect effects to fully grasp the overall influence of engaging messages.

Regarding the influence of emotional intensity, we postulate that it may function as a moderator of these effects. Specifically, due to the influence of the emotional intensity level on attention (Anikin, 2020; Arnal et al., 2019; Holz et al., 2021; Raine et al., 2019). If the emotional intensity is high, messages may receive more attention from students, thereby enhancing their effectiveness and improving students' motivation to learn and academic performance. This moderated mediation model allows us to not only examine the direct and indirect influences of engaging messages, but also how emotional intensity might relate to these effects.

To examine the possibility of moderation and how it varies depending on the level of emotional intensity, we will use the

counterfactual approach to mediation analysis (Muthén & Asparouhov, 2015; VanderWeele, 2015). This approach is more efficient than traditional methods derived from Baron and Kenny's (1986) work for two main reasons. Firstly, it provides more precise estimates with small sample sizes, which enhances the robustness of the findings. Secondly, this approach allows us to segment the moderator values, thereby providing a more detailed examination of the moderating role of emotional intensity on the effects of engaging messages. Consequently, we can discern if different levels of emotional intensity alter the direct and indirect effects of teachers' engaging messages on students' performance.

Based on the theoretical insights and empirical evidence presented in previous sections, this study will focus on the following research question:

RQ: Do the emotional intensity levels of teachers' engaging messages moderate their direct effect on academic performance, as well as their indirect effect through student motivation to learn?

With this RQ, we will test two hypotheses to shed light on the possible moderating effect of emotional intensity. Drawing on evidence linking greater intensity to enhanced attention (Anikin, 2020; Arnal et al., 2019), higher intensity could amplify the relation between teachers' engaging messages, motivation to learn, and academic performance. However, based on findings that excessive intensity elicits reactance (Weinstein et al., 2020) while insufficient intensity fails to capture attention (Holz et al., 2021), emotional intensity could have an inverted U-shaped moderation effect, whereby moderate levels optimize engaging message effects on motivation to learn and academic performance.

To examine the research question, we will audio record teachers during regular lessons over the course of the first term of an academic year. These recordings will be transcribed using an automated AI service. To make analysis feasible, transcripts will be filtered using a python script to extract sections likely to contain engaging messages based on related keywords. Next, two research assistants will manually review the filtered transcripts to identify specific messages, which will then be categorised by *frame* and *appeal* type. We will extract brief audio clips from each identified message to allow for acoustic analysis. These clips will be processed using the Emotional Temperature model (Alonso et al., 2015) to generate emotional intensity scores for each message clip. Finally, we will analyse the relationship between messages, emotional intensity scores, student motivation to learn, and academic performance using counterfactual mediation modelling. This approach will enable gathering naturalistic behavioural data at large scale and evaluating how acoustic factors may moderate the effects of teacher messages. This understanding will contribute to a more comprehensive knowledge of the mechanisms through which engaging messages impact students' academic performance, thereby providing valuable insights for educators and researchers alike.

2. Material and methods

2.1. Participants

The study involved 36 teachers (19 females and 17 males; mean age = 45.98, SD = 7.99) and 807 students (395 females, 412 males; mean age = 16.39, SD = 1.27) from 16 secondary schools in Gran Canaria, Tenerife, and Santander (Spain). Teachers could choose to participate with one or more of their groups, resulting in a total of 56 participant groups. Students were from Grades 9 to 12. All teachers taught math and all students took math classes at the same level of intensity (four lessons per week).

2.2. Procedure

Teachers' engaging messages were assessed using the TBLA method (Arani, 2017; Rahayu et al., 2020). Based on findings from previous

studies showing effects of term one messages on term two motivation to learn and performance (Santana-Monagas, Putwain, et al., 2022), we sought to model these temporal dynamics. To obtain observations of the messages, teachers themselves audio-recorded eight lessons at the end of the first term in each group. These recordings were then transcribed into approximately 100 pages of text using an artificial intelligence-based transcription service. As done by similar previous studies (Falcon et al., 2023; Winarti et al., 2021), the transcripts were filtered by a list of keywords using a python script. The list of keywords was based on the validated Teachers' Engaging Messages Scale (Santana-Monagas, Putwain, et al., 2022) and included words like "work", "pass", "daily", "learn", etc. These words were chosen as they often encompass or are part of teachers' engaging messages. The filtered transcript, which contained only 10% of the original transcript and a concentration of teachers' engaging messages, was then used to identify and code the messages. We obtained one audio clip for each engaging message and used these clips to measure their emotional intensity. In the second term, students' motivation to learn was evaluated using a questionnaire administered in the classroom under the teacher's supervision via Google Forms. Finally, students' performance in the second term was collected from the high schools' official records.

Participant teachers filled an 'informed consent form', where we explained the objectives of the research and ensured its confidentiality and voluntary nature. An external committee reviewed the study's ethics section to ensure that it complied with national and European data protection laws, directives, and opinions.

2.3. Instruments

2.3.1. Teachers' engaging messages

To assess teachers' engaging messages from the filtered transcripts, two research assistants identified the messages and discarded the false positives. Their instructions included selecting messages from the teacher that: (1) were aimed at engaging students in school tasks, (2) had a frame, either gain or loss, (3) appealed to a motivational incentive, and (4) were meaningful in their own sense (could be one or more sentences). Reliability results in the identification of engaging messages by assistants showed a satisfactory inter-coder agreement of 98.71% (O'Connor, Michaels, Chapin, & Harbaugh, 2017).

After their identification, research assistants classified the messages based on the two dimensions defined in the introduction: "frame" and "appeal". The resulting sixteen categories were: (1) *gain-framed extrinsic-normal*, (2) *gain-framed extrinsic-achievement*, (3) *gain-framed introjected-normal*, (4) *gain-framed introjected-achievement*, (5) *gain-framed identified-normal*, (6) *gain-framed identified-achievement*, (7) *gain-framed intrinsic-normal*, (8) *gain-framed intrinsic-achievement*, (9) *loss-framed extrinsic-normal*, (10) *loss-framed extrinsic-achievement*, (11) *loss-framed introjected-normal*, (12) *loss-framed introjected-achievement*, (13) *loss-framed identified-normal*, (14) *loss-framed identified-achievement*, (15) *loss-framed intrinsic-normal*, and (16) *loss-framed intrinsic-achievement*. Reliability results showed very good (98.18% for the category "intrinsic-normal" of the *appeal* dimension) to acceptable (74.40% for the category "identified-normal" of the *appeal* dimension) agreements.

2.3.2. Emotional intensity of engaging messages

To obtain the messages' emotional intensity, we analysed the audio clips of each message using the Emotional Temperature Model, developed by Alonso et al. (2015). This model combines two prosodic features derived from the pitch contour, with four paralinguistic features relating to the energy concentration in different frequency bands. The pitch contour is modelled using linear regression, yielding two coefficients: α , representing the original pitch, and β , reflecting the pitch trend.

An integral part of this model is a hierarchical classification system that initially segments speech signals into emotional segments, each categorised as 'high activation' or 'low activation'. If the percentage of high activation segments exceeds a certain threshold, the overall speech

signal is classified as ‘high activation’. This model enables quantifying activation, discriminating between high and low levels, with minimal computational cost. The resulting values ranged from 0 to 100 points, with 0 representing no emotional intensity and 100 indicating maximum emotional intensity. After computing the emotional intensity scores of each message, we then calculated an average emotional intensity score for each teacher in each participating group. After computing the emotional intensity scores of each message, we then calculated an average emotional intensity score for each teacher in each participant group.

2.3.3. Motivation to learn

Motivation to learn was measured in the second term using the Spanish version of the *Échelle de Motivation en Éducation* (Núñez, Martín-Albo, & Navarro Izquierdo, 2005). This scale consists of 20 items, beginning with the question, ‘Why do you study?’, followed by a series of statements such as ‘Because it will help me find a highly valued job’ or ‘To prove to me that I am an intelligent person’. The items were measured through a seven-point Likert scale ranging from 1 (absolutely not true) to 7 (absolutely true). In this study, we used the subscales that evaluate extrinsic, introjected, identified, and intrinsic motivations. We used McDonald’s Omega to examine the reliability of the instrument, and it was estimated using factor loadings from a congeneric CFA for each variable. McDonald’s Omega was between 0.89 and 0.93.

2.3.4. Academic performance

Academic performance of the second term was measured by math grades obtained from official school records. In Spain, teachers use standardized rubrics created by the government to assign a score from 0 to 10 (Leon, Medina-Garrido, & Núñez, 2017). These rubrics assess the same competencies acquired by students throughout the course, regardless of the region in which the school is located.

2.4. Data analysis

To accurately analyse the data, we followed Nussbaum et al.’s (2008) recommendations and transformed the message counts of each category into ratios. As previous research has shown (Falcon et al., 2023), the most effective way to obtain these ratios is by dividing the number of messages of each category by the number of words spoken by the teacher. This allows for comparisons between teachers who speak more and those who speak less. For example, a teacher who says 15 *gain-framed extrinsic-normal* messages in 50 000 words is not equivalent to another teacher who says 15 *gain-framed extrinsic-normal* messages in 20 000 words. This means the first teacher used 0.0003 messages from that category throughout all the words he said during his speech, while the second one used 0.00075. Given that the obtained values were very small, we multiplied them by 10 000 for better interpretation. The final formula for the ratios was as follows: $\text{ratio} = m/w * 10\ 000$, where m = ‘messages from one of the categories said by the teacher’ and w = ‘total number of words spoken by the teacher’. This method enabled us to make fair comparisons between teachers and to accurately assess the impact of the messages on student outcomes.

To examine the influence of emotional intensity, we employed a moderated mediation model using the counterfactual approach to mediation analysis (Muthén & Asparouhov, 2015; Valeri & VanderWeele, 2013; VanderWeele, 2015). This approach was chosen for several reasons. Firstly, it has been shown to provide more accurate estimation with small sample sizes than the traditional method derived from Baron and Kenny’s (1986) work. Secondly, the counterfactual approach allows for the division of moderator values into different segments of the moderator variable. This segmentation provides a more granular view of the interaction of variables within each segment. In our study, we divided emotional intensity, which was scaled from 0 to 100, into 10 equally sized segments, each spanning 10 points. This allowed us to observe how the relations of interest may change at different levels of

emotional intensity. The decision to use 10-point segments was pragmatic, providing a balance between granularity and interpretability. While smaller segments could provide a more detailed picture of the interactions, they might also become increasingly difficult to interpret and explain. By using this approach, we aim to gain a more nuanced understanding of the moderator role of emotional intensity in order to answer the research question.

To test the moderated mediation model, we created separate models for each type of engaging message. Each model included four variables: (1) the different type of engaging message, which served as the independent variable, (2) the different type of motivation to learn, which acted as the mediator, (3) the emotional intensity score, as the moderator, and (4) student performance as the outcome variable. This approach of using separate models for each type of engaging message mitigates the risk of multicollinearity. Moreover, it simplifies the model’s complexity, making the interpretation of the results more intuitive and reliable.

The resulting models (Fig. 3) tested the following paths: (Path 1) the direct effect of engaging messages on academic performance, moderated by different levels of emotional intensity; and (Path 2) the indirect effect of engaging messages on academic performance, via students’ motivation to learn. The direct effect refers to the impact of engaging messages on academic performance without considering the effect of motivation to learn. The indirect effect refers to the impact of engaging messages on academic performance through motivation to learn. The total effect is the combination of the direct and indirect pathways.

To assess the fit of each model, we followed Hu and Bentler’s (1999) guidelines for the following fit indices: comparative fit index (CFI) and Tucker–Lewis index (TLI) > 0.95, root mean square error of approximation (RMSEA) < 0.05, and standardized root mean square residual (SRMR) < 0.08. However, as we are working with naturalistic data, these indices can be interpreted with some flexibility (Heene, Hilbert, Draxler, Ziegler, & Bühner, 2011). All data analysis were performed using MPlus 8.8 (Muthén & Muthén, 2022).

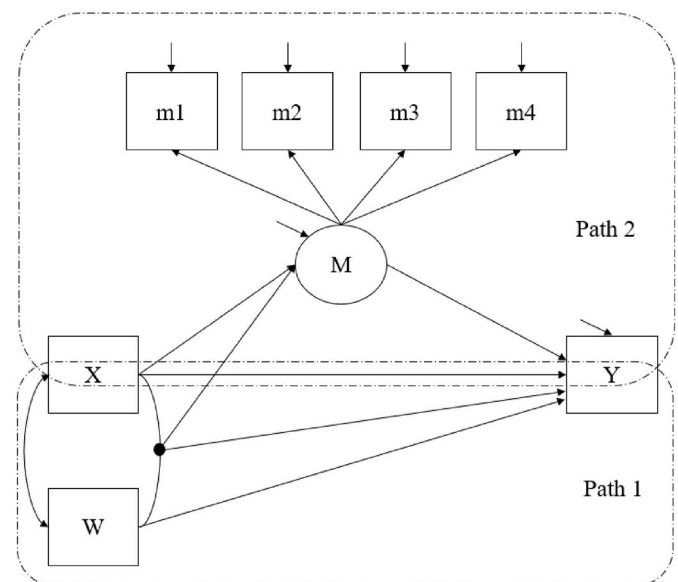


Fig. 3. Tested paths

Note. X = Engaging messages; W = Emotional intensity; M = Motivation to learn; Y = Academic performance; Path 1 = Direct effect of engaging messages on academic performance, moderated by the emotional intensity; Path 2 = Indirect effect of engaging messages on academic performance, mediated by the motivation to learn.

3. Results

3.1. Preliminary analyses

We detected a total of 178 engaging messages in the first term. The maximum number identified for an individual teacher was 17 messages, with a range of 0–17 across teachers. At the classroom level, the group with the most messages had a total of 10. There were 8 groups where no messages were identified. Due to the few observations in some categories, only the following were used for statistical analyses: *gain-framed extrinsic-normal*, *gain-framed extrinsic-achievement*, *gain-framed introjected-normal*, *gain-framed identified-normal*, *gain-framed identified-achievement*, *loss-framed extrinsic-achievement*, *loss-framed introjected-normal*, *loss-framed identified-normal*, and *loss-framed identified-achievement*. The most frequently observed category was *gain-framed identified-normal*, with 59 total messages. The Figure below (Fig. 4) illustrates the means and standard deviations of the emotional intensity for each one of these categories. Students’ motivation to learn showed the following univariate statistics: extrinsic motivation (mean = 5.57, SD = 1.39), introjected motivation (mean = 4.39, SD = 1.72), identified motivation (mean = 5.82, SD = 1.30), and intrinsic motivation (mean = 4.83, SD = 1.62), all with a range of 1–7.

The messages’ emotional intensity varied depending on the type of message used. The maximum value of 100 points was observed in *gain-framed identified-achievement* messages, while the minimum value of 28 points was observed in *loss-framed identified-normal* messages. As shown in Fig. 4, the lowest mean value was found in *gain-framed extrinsic-achievement* messages, while the highest mean value was observed in *loss-framed identified-achievement* messages. Additionally, when differentiating by *frame*, we found that messages with *extrinsic* and *introjected* appeals have lower mean emotional intensity levels compared to those with *identified* appeals.

We detected 31 messages with very high emotional intensity, scoring over 95 on the 0–100 scale. These high intensity messages were characterized by elevated pitch, energy, and tempo in the audio clips. Furthermore, it is notable that 61.3% of these engaging messages were *loss-framed*. For example, one of these messages stated: “*Either you change your attitude and get your act together or I can see you failing the third term*”. Conversely, we only detected 17 low intensity messages scoring below 35, which exhibited lower pitch, energy, and tempo. Of these calmer messages, 52.94% were *loss-framed*, such as: “*It is not the same to get a five as to get an eight, because that grade is part of the GPA and those who want a career that requires a high grade to get in, have to start now*”. In general, however, we observed that teachers used very different levels of

emotional intensity to convey similar message content. For instance, we observed *gain-framed identified-normal* messages such as “*If you keep studying like this, you will get into medicine*” delivered with both high and moderate intensity.

3.2. Moderated mediation models

Table 1 show the fit indices for the tested models. As can be seen, all models showed good values of each fit index given the naturalistic nature of our data.

Table 2 shows the indirect effect, the direct effect, and the total effects of each model. What stands out in the table is that significant direct (Path 1) and total effects were observed in all tested models, except for the ones which tested the *loss-framed extrinsic-achievement* and *introjected-normal* messages. In contrast, none of the indirect effects from engaging messages to academic performance through motivation to learn (Path 2) were found to be significant.

A closer examination of Table 2 reveals that the directions of direct and total effects varied depending on the type of message used. The findings suggest two trends in these effects. Trend 1 is an inverse trend: as the emotional intensity increases, the effect on performance decreases. In some cases, this relationship went from merely diminishing to becoming negative, suggesting that high emotional intensity messages can potentially have a detrimental impact on academic performance. Significant relations pertaining to this trend were found with *gain-framed extrinsic-normal*, *extrinsic-achievement introjected-normal* and *identified-achievement*, and *loss-framed identified-normal* messages. In trend 2, as the emotional intensity increases, the effect on performance also increases. Significant relations belonging to this trend were found in *gain-framed identified-achievement* and *loss-framed identified-achievement*

Table 1
Model fit indices.

Engaging message analysed	χ^2	CFI	TLI	RMSEA	SRMR
<i>Gain-framed extrinsic-normal</i>	8.53	.99	.99	.001	.03
<i>Gain-framed extrinsic-achievement</i>	6.17	.99	.99	.001	.03
<i>Gain-framed introjected-normal</i>	20.92	.97	.94	.059	.04
<i>Gain-framed identified-normal</i>	27.07	.98	.96	.041	.02
<i>Gain-framed identified-achievement</i>	11.07	.99	.99	.001	.03
<i>Loss-framed extrinsic-achievement</i>	24.87	.96	.93	.058	.04
<i>Loss-framed introjected-normal</i>	16.02	.99	.97	.040	.04
<i>Loss-framed identified-normal</i>	15.60	.99	.99	.018	.03
<i>Loss-framed identified-achievement</i>	20.84	.95	.91	.062	.05

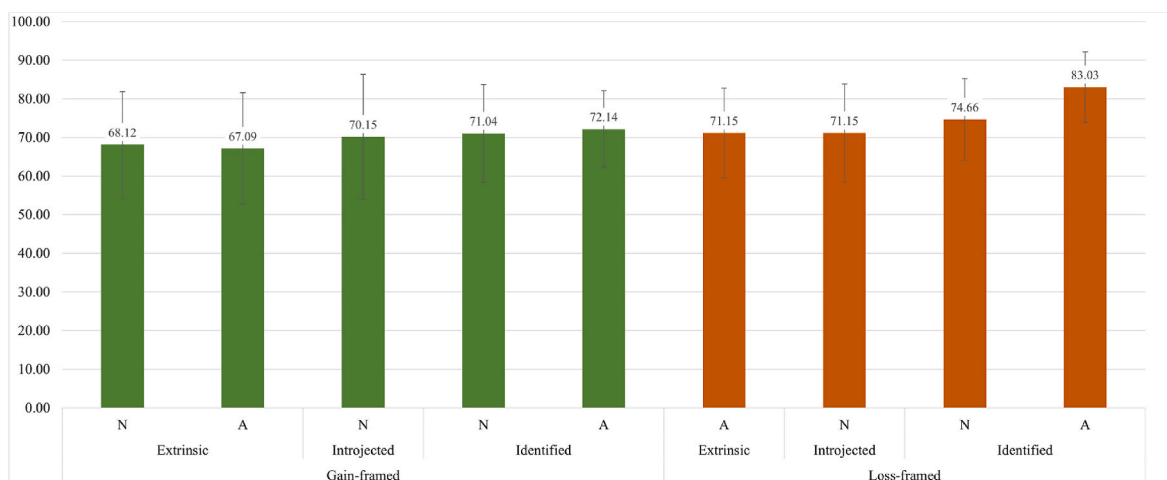


Fig. 4. Means and standard deviations of the emotional intensity for the used categories.

Note. N = Normal; A = Achievement; Green bars = Gain-framed messages; Orange bars = Loss-framed messages. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

Table 2
Effects of engaging messages on academic performance for different values of emotional temperature.

Engaging message analysed	Emotional intensity value	Indirect effect (Path 2)					Direct effect (Path 1)					Total effects				
		β	SE	p-value	CI 95 lower	CI 95 upper	β	SE	p-value	CI 95 lower	CI 95 upper	β	SE	p-value	CI 95 lower	CI 95 upper
<i>Gain-framed extrinsic-normal</i>	30	-50.41	32.08	.12	-113.29	12.47	298.10	88.93	.00	123.79	472.40	247.69	88.12	.01	74.97	420.41
	40	-33.85	21.90	.12	-76.77	9.08	194.16	62.85	.00	70.98	317.34	160.31	62.33	.01	38.16	282.47
	50	-17.29	11.89	.15	-40.59	6.02	90.22	37.68	.02	16.37	164.07	72.93	37.44	.05	-.44	146.31
	60	.73	3.81	.85	-8.19	6.74	-13.72	17.83	.44	-48.67	21.23	-14.44	17.79	.42	-49.31	20.42
	70	15.84	9.95	.11	-3.66	35.33	-117.66	25.40	.00	-167.44	-67.87	-101.82	25.09	.00	-150.99	-52.66
	80	32.40	19.87	.10	-6.55	71.34	-221.59	49.00	.00	-317.63	-125.55	-189.20	48.37	.00	-284.01	-94.39
	90	48.96	30.03	.10	-9.91	107.82	-325.53	74.74	.00	-472.02	-179.05	-276.58	73.81	.00	-421.25	-131.90
	100	65.52	40.25	.10	-13.38	144.41	-429.47	100.99	.00	-627.41	-231.53	-363.95	99.77	.00	-559.51	-168.40
<i>Gain-framed extrinsic-achievement</i>	30	-15.31	29.07	.60	-72.29	41.67	788.42	191.57	.00	412.93	1163.90	773.11	194.37	.00	392.14	1154.08
	40	-13.84	23.59	.56	-60.06	32.39	651.38	149.29	.00	358.77	944.00	637.55	151.48	.00	340.65	934.44
	50	-12.36	18.50	.50	-48.61	23.89	514.35	108.84	.00	301.03	727.67	501.99	110.39	.00	285.63	718.34
	60	-10.89	14.24	.45	-38.80	17.02	377.32	73.30	.00	233.65	520.98	366.43	74.16	.00	221.08	511.78
	70	-9.41	11.76	.42	-32.46	13.63	240.28	53.57	.00	135.30	345.27	230.87	53.74	.00	125.54	336.21
	80	-7.94	12.19	.52	-31.83	15.95	103.25	65.84	.12	-25.80	232.30	95.31	65.97	.15	-33.99	224.61
	90	-6.47	15.29	.67	-36.43	23.50	-33.78	98.85	.73	-227.52	159.96	-40.25	99.45	.69	-235.17	154.68
	100	-4.99	19.84	.80	-43.88	33.90	-170.82	138.48	.22	-442.23	100.60	-175.81	139.66	.21	-449.53	97.92
<i>Gain-framed introjected-normal</i>	30	31.83	37.51	.40	-41.69	105.35	216.88	96.62	.03	27.50	406.26	248.71	85.41	.00	81.31	416.10
	40	23.10	27.53	.40	-30.86	77.06	196.27	72.23	.01	54.71	337.83	219.37	63.58	.00	94.76	343.98
	50	14.37	17.72	.42	-20.37	49.11	175.66	51.65	.00	74.43	276.90	190.03	46.02	.00	99.83	280.24
	60	5.64	8.69	.52	-11.38	22.67	155.06	41.10	.00	74.51	235.60	160.70	39.02	.00	84.21	237.18
	70	-3.09	6.47	.63	-15.76	9.59	134.45	47.75	.01	40.85	228.05	131.36	47.49	.01	38.27	224.45
	80	-11.82	14.60	.42	-40.44	16.81	113.84	66.65	.09	-16.79	244.47	102.02	65.70	.12	-26.75	230.80
	90	-20.55	24.29	.40	-68.15	27.06	93.23	90.41	.30	-83.97	270.44	72.69	87.79	.41	-99.38	244.75
	100	-29.28	34.23	.39	-96.36	37.81	72.63	116.09	.53	-154.91	300.16	43.35	111.47	.70	-175.12	261.82
<i>Gain-framed identified-normal</i>	30	2.37	4.07	.56	-5.60	10.34	35.63	16.77	.03	2.77	68.49	38.00	16.73	.02	5.21	70.80
	40	1.63	3.08	.60	-4.42	7.67	26.96	12.75	.03	1.98	51.94	28.59	12.77	.03	3.57	53.61
	50	.88	2.14	.68	-3.31	5.08	18.29	8.87	.04	0.91	35.68	19.18	8.94	.03	1.65	36.70
	60	.14	1.31	.92	-2.43	2.71	9.63	5.46	.08	-1.07	20.32	9.76	5.56	.08	-1.12	20.65
	70	-.61	.97	.53	-2.51	1.30	0.96	3.97	.81	-6.82	8.73	.35	3.96	.93	-7.42	8.12
	80	-1.35	1.50	.37	-4.30	1.59	-7.71	6.05	.20	-19.57	4.15	-9.06	5.87	.12	-20.57	2.45
	90	-2.10	2.38	.38	-6.76	2.56	-16.38	9.61	.09	-35.22	2.46	-18.48	9.34	.05	-36.78	-0.17
	100	-2.85	3.33	.39	-9.38	3.69	-25.05	13.53	.06	-51.56	1.47	-27.89	13.19	.03	-53.74	-2.05
<i>Gain-framed identified-achievement</i>	30	3.05	8.86	.73	-14.32	20.41	-139.83	42.57	.00	-223.26	-56.40	-136.78	44.75	.00	-224.50	-49.07
	40	2.10	6.97	.76	-11.56	15.77	-109.06	34.23	.00	-176.15	-41.98	-106.96	35.92	.00	-177.37	-36.55
	50	1.16	5.11	.82	-8.86	11.18	-78.29	25.99	.00	-129.23	-27.36	-77.14	27.20	.01	-130.44	-23.83
	60	.21	3.33	.95	-6.32	6.74	-47.53	17.99	.01	-82.79	-12.26	-47.31	18.72	.01	-84.01	-10.62
	70	-.73	1.88	.70	-4.41	2.94	-16.76	10.79	.12	-37.90	4.38	-17.49	11.08	.11	-39.21	4.23
	80	-1.68	1.83	.36	-5.27	1.92	14.01	7.30	.06	-3.0	28.32	12.33	7.54	.10	-2.44	27.10
	90	-2.62	3.26	.42	-9.02	3.77	44.78	11.60	.00	22.04	67.51	42.16	12.34	.00	17.97	66.34
	100	-3.57	5.04	.48	-13.44	6.30	75.55	18.98	.00	38.35	112.74	71.98	20.23	.00	32.32	111.64
<i>Loss-framed extrinsic-achievement</i>	30	-23.21	18.52	.21	-59.50	13.08	20.50	74.12	.78	-124.77	165.77	-2.71	74.73	.97	-149.19	143.77
	40	-16.46	13.27	.22	-42.46	9.55	23.01	54.89	.68	-84.58	130.60	6.55	55.43	.91	-102.09	115.20
	50	-9.70	8.15	.23	-25.68	6.27	25.52	36.71	.49	-46.43	97.47	15.82	37.17	.67	-57.04	88.67
	60	-2.95	3.73	.43	-10.26	4.36	28.03	22.29	.21	-15.66	71.72	25.08	22.65	.27	-19.31	69.46
	70	3.80	4.30	.38	-4.63	12.24	30.54	21.48	.16	-11.55	72.63	34.34	21.58	.11	-7.96	76.64
	80	10.55	8.96	.24	-7.01	28.12	33.05	35.22	.35	-35.98	102.07	43.60	35.22	.22	-25.43	112.64
	90	17.31	14.11	.22	-10.35	44.97	35.56	53.24	.50	-68.79	139.90	52.86	53.27	.32	-51.54	157.26
	100	24.06	19.37	.21	-13.90	62.02	38.07	72.41	.60	-103.86	179.99	62.13	72.50	.39	-79.97	204.22

(continued on next page)

Table 2 (continued)

Engaging message analysed	Emotional intensity value	Indirect effect (Path 2)					Direct effect (Path 1)					Total effects				
		β	SE	p-value	CI_95 lower	CI_95 upper	β	SE	p-value	CI_95 lower	CI_95 upper	β	SE	p-value	CI_95 lower	CI_95 upper
<i>Loss-framed introjected-normal</i>	30	.51	69.36	.99	-135.44	136.46	320.58	224.69	.15	-119.80	760.97	321.09	232.48	.17	-134.57	776.75
	40	.41	56.44	.99	-110.22	111.04	258.58	177.29	.15	-88.90	606.06	258.99	182.82	.16	-99.33	617.31
	50	.32	43.53	.99	-84.99	85.63	196.57	130.62	.13	-59.45	452.59	196.89	133.79	.14	-65.33	459.11
	60	.23	30.61	.99	-59.77	60.22	134.57	85.92	.12	-33.84	302.97	134.79	86.48	.12	-34.70	304.28
	70	.13	17.69	.99	-34.55	34.81	72.56	48.87	.14	-23.23	168.35	72.69	46.47	.12	-18.39	163.77
	80	.04	4.78	.99	-9.33	9.40	10.55	45.63	.82	-78.88	99.98	10.59	44.08	.81	-75.82	96.99
	90	-.06	8.14	.99	-16.02	15.90	-51.45	80.39	.52	-209.01	106.11	-51.51	82.64	.53	-213.49	110.46
	100	-.15	21.06	.99	-41.43	41.12	-113.46	124.62	.36	-357.71	130.79	-113.62	129.68	.38	-367.79	140.57
<i>Loss-framed identified-normal</i>	30	.83	3.24	.80	-5.52	7.19	53.51	15.99	.00	22.17	84.85	54.34	16.08	.00	22.83	85.86
	40	.85	2.54	.74	-4.13	5.83	42.41	12.43	.00	18.06	66.77	43.26	12.49	.00	18.77	67.75
	50	.87	1.88	.65	-2.82	4.56	31.31	8.95	.00	13.78	48.84	32.18	8.99	.00	14.57	49.79
	60	.89	1.32	.50	-1.71	3.48	20.21	5.70	.00	9.03	31.38	21.09	5.70	.00	9.92	32.27
	70	.91	1.04	.39	-1.14	2.95	9.11	3.45	.01	2.34	15.87	10.01	3.38	.00	3.39	16.63
	80	.93	1.24	.46	-1.51	3.36	-2.00	4.27	.64	-10.36	6.37	-1.07	4.18	.80	-9.26	7.11
	90	.94	1.77	.59	-2.53	4.42	-13.10	7.17	.07	-27.15	.95	-12.16	7.11	.09	-26.10	1.79
	100	.96	2.42	.69	-3.78	5.70	-24.20	10.56	.02	-44.90	-3.51	-23.24	10.53	.03	-43.88	-2.60
<i>Loss-framed identified-achievement</i>	30	-2.20	9.61	.82	-21.04	16.64	-519.13	158.25	.00	-829.29	-208.96	-521.32	158.75	.00	-832.47	-210.18
	40	-1.75	7.73	.82	-16.91	13.41	-416.30	127.51	.00	-666.22	-166.37	-418.05	127.91	.00	-668.75	-167.34
	50	-1.31	5.86	.82	-12.79	10.18	-313.47	96.82	.00	-503.23	-123.70	-314.77	97.11	.00	-505.11	-124.43
	60	-.86	3.99	.83	-8.68	6.97	-210.63	66.22	.00	-340.42	-80.85	-211.49	66.41	.00	-341.65	-81.33
	70	-.41	2.14	.85	-4.60	3.78	-107.80	35.94	.00	-178.25	-37.36	-108.21	36.04	.00	-178.84	-37.59
	80	.04	.52	.94	-.99	1.07	-4.97	9.79	.61	-24.17	14.22	-4.94	9.83	.62	-24.21	14.34
	90	.49	1.74	.78	-2.93	3.90	97.86	28.22	.00	42.54	153.17	98.34	28.36	.00	42.75	153.93
	100	.93	3.58	.80	-6.09	7.95	200.69	58.26	.00	86.50	314.87	201.62	58.49	.00	86.97	316.27

Note. SE = Standard Error; CI_95 lower = Lower limit of 95% confidence interval; CI_95 upper = Upper limit of 95% confidence interval; Significant effects are printed bold.

messages. An example of each trend is illustrated in Fig. 5.

4. Discussion

In this study, we investigated the potential impact of emotional intensity in the effect of teachers' engaging messages on students' academic performance, both directly and indirectly through motivation to

learn. Guided by the research question "Do the emotional intensity levels of teachers' engaging messages moderate their direct effect on academic performance, as well as their indirect effect through student motivation to learn?" our study aimed to provide a more detailed understanding of the role that acoustic features may play in the influence of teachers' messages.

The results showed that messages' emotional intensity varied

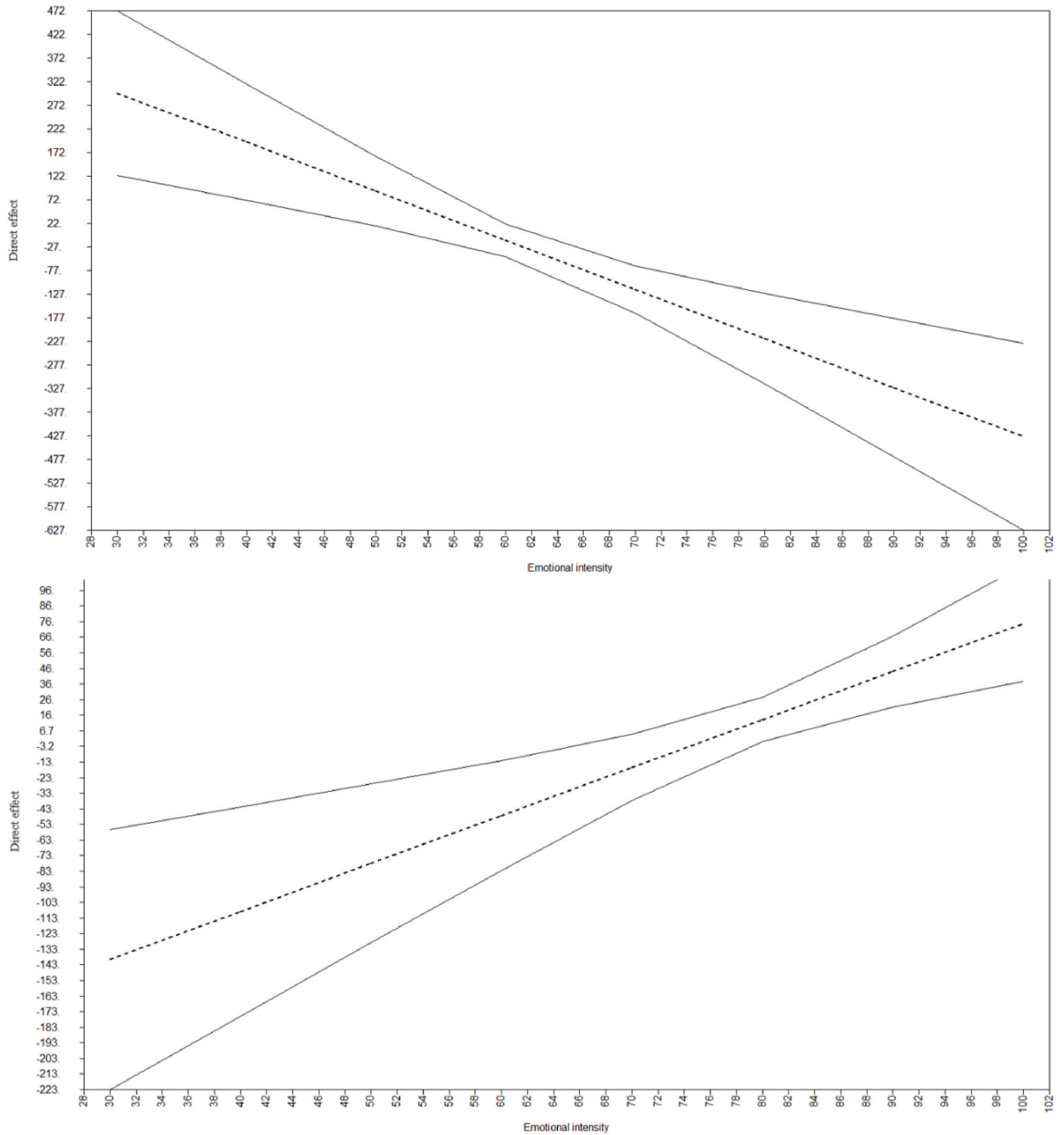


Fig. 5. Evolution of direct effects over different values of emotional intensity
 Note. Dashed lines = Direct effects; Solid lines = 95% Confidence intervals; Upper figure = Results of model using *gain-framed extrinsic-normal* messages, example of trend 1; Lower figure = Results of model using *gain-framed identified-achievement* messages, example of trend 2.

depending on the type of message used. The lowest value was found in *gain-framed extrinsic-achievement* messages and the highest value was observed in *loss-framed identified-achievement* messages. Additionally, we found that messages appealing to external stimulus (i.e., *extrinsic*, and *introjected*) have lower values of emotional intensity than those appealing to internal stimulus (i.e., *identified*). These findings are noteworthy, as they are the first to examine the levels of emotional intensity in teachers' engaging messages. In terms of the moderator role of emotional intensity, we also found interesting results that will be discussed in the following section.

4.1. Emotional intensity as a moderator

The results of this study indicate that emotional intensity plays a moderating role in the relationship between engaging messages and academic performance. This supports the idea that acoustic features, such as emotional intensity, have an impact on listeners (Paulmann, 2015; Zougkou, Weinstein, & Paulmann, 2017). It is notable that in almost all cases, as emotional intensity increased, the effect on performance decreased. This finding is consistent with that of Weinstein et al. (2020), who found that motivational messages with intense tones can be perceived as controlling, which causes defiant reactions. In turn, these defiant reactions can elicit opposite behaviours of what motivators are asking for. Translating these findings to our research, when teachers deliver engaging messages with high emotional intensity, they can lose their engaging effect (inverted U-shaped moderating effect).

Although we already knew that the type of engaging message plays a role in its effectiveness (Santana-Monagas et al., 2023; Santana-Monagas, Núñez, Loro, Huéscar, & León, 2022; Santana-Monagas, Putwain, et al., 2022), this study suggests that it is also important for educators to strike a balance between the level of intensity in their speech to achieve optimal results in terms of student engagement and academic performance. From our findings, we suggest that educators may benefit from toning down the emotional intensity when seeking to engage students, allowing the message to be better received and understood. However, further research would be valuable to provide more specific guidance to educators on effectively modulating emotional intensity in their messages.

It is also noteworthy that *identified-achievement* messages, both *gain-* and *loss-framed*, were the only ones that pertained to the second trend, where emotional intensity increases and the effect on performance also increases. This moderating effect is consistent with evidence linking information delivered with greater emotional intensity to an increase in attention paid to the speech (Anikin, 2020; Arnal et al., 2019; Holz et al., 2021). This finding, although preliminary, suggests that depending on the *appeal* category, emotional intensity might affect messages effectiveness in different ways. A potential explanation for this trend could be that *identified-achievement* messages that are delivered with more emotional intensity might resonate more strongly with students. The heightened intensity could create a sense of urgency or importance, which could inspire students to respond more positively. However, due to the small sample size, caution should be applied. Future studies on the implementation of emotional intensity while examining the effect of teachers' engaging messages on students are therefore recommended.

Finally, it is important to note the results regarding the indirect path through motivation to learn, as no significant relations were found. Unlike previous studies (Santana-Monagas, Putwain, et al., 2022), we did not find evidence of a mediational role of motivation to learn. This finding was unexpected and suggests that observations of engaging messages were not strongly related with students' motivation to learn. Students' perceptions of engaging messages, being an intrapersonal variable, can be more strongly related to motivation, also an intrapersonal variable, than observations (Harwood, Keegan, Smith, & Raine, 2015). If this is the case, our findings highlight the works of Urdan (2004) and Tempelaar et al. (2020) on the need to use direct observations when studying such relations. Further investigation combining

both methods of measurement is needed to account for the results obtained in this study.

4.2. Limitations and future perspectives

Despite the contributions of this study, certain limitations must be acknowledged. One limitation is the sample size. We asked teachers to record the eight lessons prior to the last exam of the term, as we expected most of the messages to be concentrated there (Putwain & Remedios, 2014). To improve upon this limitation, we plan to utilize advancements in natural language processing technology, such as Generative Pre-trained Transformer (GPT; Brown et al., 2020). This technology will enable us to analyse transcripts with deep learning techniques, making it easier to identify and classify engaging messages from the text. This will allow us to work with a larger sample, including more teachers and more lessons per term in future research.

Regarding the first limitation, it is important to note that these results were only drawn from Spanish teachers. Previous research has shown cultural differences in the way teachers motivate and engage their students (Cothran et al., 2005; Hagger et al., 2007). Therefore, a cross-cultural study including teachers from other countries is necessary to examine whether there are differences in their use of engaging messages.

There is abundant room for further progress in obtaining data from audio-recorded lessons. This study was limited to collecting information on emotional intensity only. Future works, however, should also explore other acoustic features such as prosodic cues (e.g., tempo, stress) and paralinguistic cues (e.g., voice quality, speaking rate) which are known to convey emotions and influence the listener (Scherer, 2005). Additionally, the use of deep learning techniques, such as Speech Emotion Recognition systems (Khalil et al., 2019), could allow to obtain information on the emotion type displayed by the teacher while delivering these messages. By incorporating these techniques, future research will be able to provide a more detailed and accurate picture of the teachers verbal behaviour and how it influences student outcomes (Falcon and Leon, 2023).

Finally, in light of the results obtained from examining the indirect effect of messages, it would be beneficial to conduct a study comparing the extent to which observed messages relate to students' perceptions of the engaging messages used by teachers. Specifically, this comparison could help to determine whether the relations found with motivation to learn were due to moderation of emotional intensity or to the assessment method of the messages. Conducting further studies that compare the extent to which observed messages relate to students' perceptions of the engaging messages will provide insight into the reliability of observational measures of teaching practices. These observational measures, in turn, could contribute to improve instruction and learning processes (Pianta & Hamre, 2009).

5. Conclusions

The focus of the present study was on investigating the moderating role of emotional intensity in the effect of teachers' engaging messages on students' academic performance via motivation to learn. To achieve our goal, we utilized the TBLA methodology. TBLA involved recording and transcribing the teachers' voices. This approach allowed us to directly measure the teachers' engaging messages. Additionally, it enabled us to analyse the emotional aspects of teacher speech using acoustic parameter analysis.

Our findings revealed that the emotional intensity of the messages varied based on the type of message employed, with the lowest value found in *gain-framed extrinsic-achievement* messages and the highest value seen in *loss-framed identified-achievement* messages. Additionally, we discovered that messages that appeal to external stimuli had lower values of emotional intensity than those that appeal to internal stimuli. In terms of the moderating effect, our results suggest that emotional

intensity level plays a role in the relation between engaging messages and academic performance. Specifically, when emotional intensity increases, the effect on performance decreases in most cases, except for *identified-achievement* messages, where emotional intensity increases and the effect on performance also increases. Furthermore, our results revealed a lack of significant relations in the indirect path through motivation to learn. This finding may be explained by the possibility that the observations of engaging messages are not strongly related with students' motivation to learn. This calls for future research that combines both measurement methods. Overall, this study provides a deeper understanding of the role that acoustic features may play in the influence of teachers' messages on students' academic performance and opens up possibilities for further research on other acoustic features.

Funding

This work is part of the project TED2021-129268B-I00, funded by MCIN/AEI/10.13039/501100011033 and by the European Union "NextGenerationEU"/PRTR. It has also been funded by the University of Las Palmas de Gran Canaria, Cabildo de Gran Canaria, and Banco Santander through the pre-doctoral training programme for research personnel.

Declaration of Competing interest

None.

Data availability

Data will be made available on request.

References

- Aelterman, N., Vansteenkiste, M., Haerens, L., Soenens, B., Fontaine, J. R. J., & Reeve, J. (2019). Toward an integrative and fine-grained insight in motivating and demotivating teaching styles: The merits of a circumplex approach. *Journal of Educational Psychology, 111*(3), 497–521. <https://doi.org/10.1037/edu0000293>
- Ahmadi, A., Noetel, M., Parker, P., Ryan, R., Ntoumanis, N., Reeve, J., et al. (2022). *A classification system for teachers' motivational behaviours recommended in self-determination theory interventions*. <https://doi.org/10.31234/osf.io/4vrym>
- Alonso, J. B., Cabrera, J., Medina, M., & Travieso, C. M. (2015). New approach in quantification of emotional intensity from the speech signal: Emotional temperature. *Expert Systems with Applications, 42*(24), 9554–9564. <https://doi.org/10.1016/j.eswa.2015.07.062>
- Anikin, A. (2020). The link between auditory salience and emotion intensity. *Cognition & Emotion, 34*(6), 1246–1259. <https://doi.org/10.1080/02699931.2020.1736992>
- Arani, M. R. S. (2017). Raising the quality of teaching through Kyouzai Kenkyuu – the study of teaching materials. *International Journal for Lesson and Learning Studies, 6*(1), 10–26. <https://doi.org/10.1108/IJLLS-07-2016-0018>
- Arnal, L. H., Kleinschmidt, A., Spinelli, L., Giraud, A. L., & Mégevand, P. (2019). The rough sound of salience enhances aversion through neural synchronisation. *Nature Communications, 10*(1). <https://doi.org/10.1038/s41467-019-11626-7>
- Babad, E., Bernieri, F., & Rosenthal, R. (1987). Nonverbal and verbal behavior of preschool, remedial, and elementary school teachers. *American Educational Research Journal, 24*(3), 405–415.
- Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*(6), 1173–1182.
- Brown, T. B., Mann, B., Ryder, N., Subbiah, M., Kaplan, J., Dhariwal, P., et al. (2020). *Language models are few-shot learners*. *Advances in Neural Information Processing Systems, 2020-December*.
- Chung, W. L., Jarmulowicz, L., & Bidelman, G. M. (2017). Auditory processing, linguistic prosody awareness, and word reading in Mandarin-speaking children learning English. *Reading and Writing, 30*(7), 1407–1429. <https://doi.org/10.1007/s1145-017-9730-8>
- Collie, R. J., Granziera, H., & Martin, A. J. (2019). Teachers' motivational approach: Links with students' basic psychological need frustration, maladaptive engagement, and academic outcomes. *Teaching and Teacher Education, 86*. <https://doi.org/10.1016/j.tate.2019.07.002>
- Comadena, M. E., Hunt, S. K., & Simonds, C. J. (2007). The effects of teacher clarity, nonverbal immediacy, and caring on student motivation, affective and cognitive learning. *Communication Research Reports, 24*(3), 241–248. <https://doi.org/10.1080/08824090701446617>
- Cothran, D. J., Kulinna, P. H., Banville, D., Choi, E., Amade-Escot, C., MacPhail, A., et al. (2005). A cross-cultural investigation of the use of teaching styles. *Research Quarterly for Exercise & Sport, 76*(2), 193–201. <https://doi.org/10.1080/02701367.2005.10599280>
- Dufaux, S. (2012). Assessment for qualification and certification in upper secondary education. A review of country practices and research evidence. *OECD Education Working Papers, 83*.
- Falcon, S., Admiraal, W., & Leon, J. (2023). *Teachers' engaging messages and the relationship with students' performance and teachers' enthusiasm, xxx*. *Learning and Instruction, Article 101750*.
- Falcon, S., & Leon, J. (2023). *How do teachers engaging messages affect students? A sentiment analysis*. *Educational Technology Research and Development*. <https://doi.org/10.1007/s11423-023-10230-3>
- Faubert, V. (2009). School evaluation: Current practices in OECD countries and a literature review. *OECD education working papers, No. 42*. *OECD Education Working Papers, 42*.
- Flores, M. T., Jenkins, L. N., Reinke, W. M., & McKown, L. (2018). General education teachers' natural rates of praise: A preliminary investigation. *Behavioral Disorders, 43*(4), 411–422. <https://doi.org/10.1177/0198742917709472>
- Gorham, J. (1988). The relationship between verbal teacher immediacy behaviors and student learning. *Communication Education, 37*(1), 40–53. <https://doi.org/10.1080/03634528809378702>
- Hagger, M. S., Chatzisarantis, N. L. D., Hein, V., Pihu, M., Soós, I., & Karsai, I. (2007). The perceived autonomy support scale for exercise settings (PASSES): Development, validity, and cross-cultural invariance in young people. *Psychology of Sport and Exercise, 8*(5), 632–653. <https://doi.org/10.1016/j.psychsport.2006.09.001>
- Harwood, C. G., Keegan, R. J., Smith, J. M. J., & Raine, A. S. (2015). A systematic review of the intrapersonal correlates of motivational climate perceptions in sport and physical activity. *Psychology of Sport and Exercise, 18*, 9–25. <https://doi.org/10.1016/j.psychsport.2014.11.005>
- Heene, M., Hilbert, S., Draxler, C., Ziegler, M., & Bühner, M. (2011). Masking misfit in confirmatory factor analysis by increasing unique variances: A cautionary note on the usefulness of cutoff values of fit indices. *Psychological Methods, 16*(3), 319–336. <https://doi.org/10.1037/a0024917>
- Holz, N., Larrouy-Maestri, P., & Poeppel, D. (2021). The paradoxical role of emotional intensity in the perception of vocal affect. *Scientific Reports, 11*(1). <https://doi.org/10.1038/s41598-021-88431-0>
- Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal, 6*(1), 1–55. <https://doi.org/10.1080/10705519909540118>
- Kearney, P., Plax, T. G., Richmond, V. P., & McCroskey, J. C. (1985). Power in the classroom III: Teacher communication techniques and messages. *Communication Education, 34*(1), 19–28. <https://doi.org/10.1080/03634528509378579>
- Khalil, R. A., Jones, E., Babar, M. I., Jan, T., Zafar, M. H., & Alhussain, T. (2019). Speech emotion recognition using deep learning techniques: A review. *IEEE Access, 7*, 117327–117345. <https://doi.org/10.1109/ACCESS.2019.2936124>
- Kiemer, K., Gröschner, A., Kunter, M., & Seidel, T. (2018). Instructional and motivational classroom discourse and their relationship with teacher autonomy and competence support—findings from teacher professional development. *European Journal of Psychology of Education, 33*(2), 377–402. <https://doi.org/10.1007/s10212-016-0324-7>
- Leon, J., Medina-Garrido, E., & Núñez, J. L. (2017). Teaching quality in math class: The development of a scale and the analysis of its relationship with engagement and achievement. *Frontiers in Psychology, 8*, 1–14. <https://doi.org/10.3389/fpsyg.2017.00895>
- Lim, S. Y., & Chapman, E. (2012). An investigation of the fennema-sherman mathematics anxiety subscale. *Measurement and Evaluation in Counseling and Development, 46*(1), 26–37. <https://doi.org/10.1177/0748175612459198>
- Mitchell, R. L. C., & Ross, E. D. (2013). Attitudinal prosody: What we know and directions for future study. *Neuroscience & Biobehavioral Reviews, 37*(3), 471–479. <https://doi.org/10.1016/j.neubiorev.2013.01.027>
- Muthén, B. O., & Asparouhov, T. (2015). Causal effects in mediation modeling: An introduction with applications to latent variables. *Structural Equation Modeling, 22*(1), 12–23. <https://doi.org/10.1080/10705511.2014.935843>
- Muthén, L. K., & Muthén, B. O. (2022). *Mplus: Statistical analysis with latent variables: User's Guide*. Version 8.8. Authors.
- Nickels, S., & Steinhauer, K. (2018). Prosody–syntax integration in a second language: Contrasting event-related potentials from German and Chinese learners of English using linear mixed effect models. *Second Language Research, 34*(1), 9–37. <https://doi.org/10.1177/0267658316649998>
- Ntoumanis, N., Quested, E., Reeve, J., & Cheon, S. H. (2017). Need supportive communication: Implications for motivation in sport, exercise, and physical activity. In *Persuasion and communication in sport, exercise, and physical activity*. <https://www.researchgate.net/publication/312296759>
- Núñez, J. L., Martín-Albo, L., & Navarro Izquierdo, J. G. (2005). Validación de la versión española de la Échelle de Motivation en Éducation. *Psicothema, 17*(2), 344–349. www.psicothema.com
- Nussbaum, E. M., Elsadat, S., & Khago, A. H. (2008). Best practices in analyzing count data Poisson regression. In *Best Practices in Quantitative methods (Issue June)* (pp. 306–323). SAGE Publications, Inc. <https://doi.org/10.4135/9781412995627.d26>
- O'Connor, C., Michaels, S., Chapin, S., & Harbaugh, A. G. (2017). The silent and the vocal: Participation and learning in whole-class discussion. *Learning and Instruction, 48*, 5–13. <https://doi.org/10.1016/j.learninstruc.2016.11.003>
- OECD. (2019). *TALIS 2018 results (Volume I): Teachers and school leaders as Lifelong learners*. TALIS. OECD Publishing.
- Paulmann, S. (2015). The neurocognition of prosody. In *Neurobiology of language* (pp. 1109–1120). Elsevier Inc. <https://doi.org/10.1016/B978-0-12-407794-2.00088-2>

- Paulmann, S., & Weinstein, N. (2022). Teachers' motivational prosody: A pre-registered experimental test of children's reactions to tone of voice used by teachers. *British Journal of Educational Psychology*. <https://doi.org/10.1111/bjep.12567>
- Pianta, R. C., & Hamre, B. K. (2009). Conceptualization, measurement, and improvement of classroom processes: Standardized observation can leverage capacity. *Educational Researcher*, 38(2), 109–119. <https://doi.org/10.3102/0013189X09332374>
- Piazza, G., Martin, C. D., & Kalashnikova, M. (2022). The acoustic features and didactic function of foreigner-directed speech: A scoping review. *Journal of Speech, Language, and Hearing Research: Journal of Speech Language Hearing Research*, 65(8), 2896–2918.
- Putwain, D. W., & Best, N. (2011). Fear appeals in the primary classroom: Effects on test anxiety and test grade. *Learning and Individual Differences*, 21(5), 580–584. <https://doi.org/10.1016/j.lindif.2011.07.007>
- Putwain, D. W., Nicholson, L., Pekrun, R., Becker, S., & Symes, W. (2019). Expectancy of success, attainment value, engagement, and achievement: A moderated mediation analysis. *Learning and Instruction*, 60, 117–125. <https://doi.org/10.1016/j.learninstruc.2018.11.005>
- Putwain, D. W., & Remedios, R. (2014). The scare tactic: Do fear appeals predict motivation and exam scores? *School Psychology Quarterly*, 29(4), 503–516. <https://doi.org/10.1037/spq0000048>
- Putwain, D. W., & Symes, W. (2011). Teachers' use of fear appeals in the Mathematics classroom: Worrying or motivating students? *British Journal of Educational Psychology*, 81, 456–474. <https://doi.org/10.1348/2044-8279.002005>
- Putwain, D. W., Symes, W., Nicholson, L. J., & Remedios, R. (2021). Teacher motivational messages used prior to examinations: What are they, how are they evaluated, and what are their educational outcomes?. In *Advances in motivation Science* (Vol. 8, pp. 63–103) Elsevier Ltd. <https://doi.org/10.1016/bs.adms.2020.01.001>.
- Rahayu, D. S., Rahmawan, S., Hendayana, S., Muslim, M., & Sendi, S. (2020). Pattern of analysis students' knowledge construction using Transcript-Based Lesson Analysis. *Advances in Social Science, Education and Humanities Research*, 438(Aes 2019), 140–144. <https://doi.org/10.2991/assehr.k.200513.032>
- Raine, J., Pisanski, K., Simmer, J., & Reby, D. (2019). Vocal communication of simulated pain. *Bioacoustics*, 28(5), 404–426. <https://doi.org/10.1080/09524622.2018.1463295>
- Rothman, A. J., & Salovey, P. (1997). Shaping perceptions to motivate healthy behavior: The role of message framing. *Psychological Bulletin*, 121(1), 3–19. <https://doi.org/10.1037/0033-2909.121.1.3>
- Ryan, R., & Brown, K. (2005). Legislating competence: High-stakes testing policies and their relations with psychological theories and research. In A. J. Elliot, & C. S. Dweck (Eds.), *Handbook of competence and motivation*. The Guilford Press.
- Ryan, R., & Deci, E. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology*, 25(1), 54–67. <https://doi.org/10.1006/ceps.1999.1020>
- Ryan, R., & Deci, E. (2017). Self-determination theory: Basic psychological needs in motivation, development, and wellness. In *Self-determination theory: Basic psychological needs in motivation, development, and wellness*. The Guilford Press. <https://doi.org/10.1521/978.14625/28806>.
- Ryan, R., & Deci, E. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary Educational Psychology*, 61, Article 101860. <https://doi.org/10.1016/j.cedpsych.2020.101860>
- Santana-Monagas, E., Núñez, J. L., Loro, J. F., Huéscar, E., & León, J. (2022). Teachers' engaging messages: The role of perceived autonomy, competence and relatedness. *Teaching and Teacher Education*, 109, Article 103556. <https://doi.org/10.1016/j.tate.2021.103556>
- Santana-Monagas, E., Núñez, J. L., Loro, J. F., Moreno-Murcia, J. A., & León, J. (2023). What makes a student feel vital? Links between teacher-student relatedness and teachers' engaging messages. *European Journal of Psychology of Education*. <https://doi.org/10.1007/s10212-022-00642-9>
- Santana-Monagas, E., Putwain, D. W., Núñez, J., Loro, J., & León, J. (2022). Do teachers' engaging messages predict motivation to learn and performance? *Revista de Psicodidáctica*, 27(1), 86–95. <https://doi.org/10.1016/j.psicoe.2021.11.001>
- Scherer, K. R. (2005). What are emotions? And how can they be measured? *Social Science Information*, 44(4), 695–729.
- Spilt, J. L., Leflot, G., Onghena, P., & Colpin, H. (2016). Use of praise and reprimands as critical ingredients of teacher behavior management: Effects on children's development in the context of a teacher-mediated classroom intervention. *Prevention Science*, 17(6), 732–742. <https://doi.org/10.1007/s1121-016-0667-y>
- Spooren, P., Brockx, B., & Mortelmans, D. (2013). On the validity of student evaluation of teaching: The state of the art. *Review of Educational Research*, 83(4), 598–642. <https://doi.org/10.3102/0034654313496870>
- Taylor, G., Jungert, T., Mageau, G. A., Schattke, K., Dedic, H., Rosenfield, S., et al. (2014). A self-determination theory approach to predicting school achievement over time: The unique role of intrinsic motivation. *Contemporary Educational Psychology*, 39(4), 342–358. <https://doi.org/10.1016/j.cedpsych.2014.08.002>
- Tempelaar, D., Rienties, B., & Nguyen, Q. (2020). Subjective data, objective data and the role of bias in predictive modelling: Lessons from a dispositional learning analytics application. *PLoS One*, 15(6), 1–29. <https://doi.org/10.1371/journal.pone.0233977>
- Titsworth, S., Quinlan, M. M., & Mazer, J. P. (2010). Emotion in teaching and learning: Development and validation of the classroom emotions scale. *Communication Education*, 59(4), 431–452. <https://doi.org/10.1080/03634521003746156>
- Urdu, T. (2004). Using multiple methods to assess students' perceptions of classroom goal structures. *European Psychologist*, 9(4), 222–231. <https://doi.org/10.1027/1016-9040.9.4.222>
- Valeri, L., & VanderWeele, T. J. (2013). Mediation analysis allowing for exposure–mediator interactions and causal interpretation: Theoretical assumptions and implementation with SAS and SPSS macros. *Psychological Methods*, 18(2), 137–150. <https://doi.org/10.1037/a0031034.supp>
- VanderWeele, T. J. (2015). *Explanation in causal Inference: Methods for mediation and interaction*. Oxford University Press.
- Vrikki, M., Kershner, R., Calcagni, E., Hennessy, S., Lee, L., Hernández, F., et al. (2019). The teacher scheme for educational dialogue analysis (T-SEDA): Developing a research-based observation tool for supporting teacher inquiry into pupils' participation in classroom dialogue. *International Journal of Research and Method in Education*, 42(2), 185–203. <https://doi.org/10.1080/1743727X.2018.1467890>
- Weinstein, N., Vansteenkiste, M., & Paulmann, S. (2019). Listen to your mother: Motivating tones of voice predict adolescents' reactions to mothers. *Developmental Psychology*, 55(12), 2534–2546. <https://doi.org/10.1037/dev0000827>
- Weinstein, N., Vansteenkiste, M., & Paulmann, S. (2020). Don't you say it that way! Experimental evidence that controlling voices elicit defiance. *Journal of Experimental Social Psychology*, 88, Article 103949. <https://doi.org/10.1016/j.jesp.2019.103949>
- Weinstein, N., Zougkou, K., & Paulmann, S. (2018). You "have" to hear this: Using tone of voice to motivate others. *Journal of Experimental Psychology: Human Perception and Performance*, 44(6), 898–913. <https://doi.org/10.1037/xhp0000502>
- Winarti, A., Saadi, P., & Rajiani, I. (2021). Applying transcript based lesson analysis in enhancing communication pattern between teacher and students in chemistry classroom. *European Journal of Educational Research*, 10(2), 975–987. <https://doi.org/10.12973/EU-JER.10.2.975>
- Zougkou, K., Weinstein, N., & Paulmann, S. (2017). ERP correlates of motivating voices: Quality of motivation and time-course matters. *Social Cognitive and Affective Neuroscience*, 12(10), 1687–1700. <https://doi.org/10.1093/scan/nsx064>