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Título de la Tesis

Un camino hacia la innovación basada en evidencias: explorando los mensajes que utilizan los docentes para implicar a su alumnado en las tareas escolares

Título de la Tesis en inglés

A pathway to evidence-based innovation: exploring teachers' engaging messages.

Tesis Doctoral presentada por D.

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Dirigida por el Dr. D.

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El Director,   El Doctorando,

Las Palmas de Gran Canaria, a __ de __ de 2024

D. Jaime José León González-Vélez, Profesor Titular de Universidad del Área de Métodos de Investigación y Diagnóstico en Educación de la Universidad de Las Palmas de Gran Canaria,

INFORMA:

Que el trabajo de investigación titulado "**Un camino hacia la innovación basada en evidencias: explorando los mensajes que utilizan los docentes para implicar a su alumnado en las tareas escolares**", ha sido realizado por **D. Samuel Falcón Pulido**, en el Departamento de Educación de la Universidad de Las Palmas de Gran Canaria, bajo su dirección y asesoramiento técnico y científico, y que, una vez revisada la presente Memoria, la encuentra apta para su defensa ante tribunal.

Y para que así conste y surta los efectos oportunos, extiende el presente certificado en Las Palmas de Gran Canaria a __ de __ de 2024.

El Director

Facultad de Economía, Empresa y Turismo

Escuela de Doctorado de la ULPGC

Departamento de Métodos Cuantitativos en Economía y Gestión

TESIS DOCTORAL

Un camino hacia la innovación basada en evidencias: explorando los mensajes que

utilizan los docentes para implicar a su alumnado en las tareas escolares.

A pathway to evidence-based innovation: exploring teachers' engaging messages.

Samuel Falcón Pulido

Las Palmas de Gran Canaria 2024

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Consideraciones preliminares

Ayudas recibidas

El doctorando, Samuel Falcón Pulido, ha sido beneficiario de un contrato predoctoral financiado por la Universidad de Las Palmas de Gran Canaria, el Ministerio de Ciencia e Innovación, el Banco Santander y el Cabildo de Gran Canaria. El contrato fue obtenido en concurrencia competitiva tal y como se indica en la convocatoria publicada en la Resolución 4525 de 14 de octubre de 2021 del Boletín Oficial de Canarias nº 221.

Prólogo

¿Quién me hubiera dicho que terminaría escribiendo estas palabras? A lo largo de mi vida, el doctorado ha sido un objetivo parpadeante, a veces presente y otras no. Sin embargo, lo que siempre ha estado ahí es mi pasión por la ciencia y el conocimiento, a lo cual estaré eternamente agradecido a mis padres y a mi tío por motivar y mantener. Los libros sobre los misterios del mundo y el cosmos y todas las excursiones a museos acabaron calando en mí y cristalizando en la idea de convertirme en astrofísico para desentrañar los misterios del universo.

Entonces, ¿por qué no estoy redactando este texto en las páginas de una tesis sobre astrofísica? Eso se lo debo a los maravillosos docentes que he tenido a lo largo de mi vida. En primaria, a la profesora de *Sciences de la Vie et de la Terre*, y en secundaria a los docentes de Biología y Geología. Ellos me impulsaron a tomar una de las decisiones más importantes de mi vida: estudiar el Grado en Biología.

Pero, entonces, ¿por qué no estoy redactando este texto en las páginas de una tesis sobre biología? A pesar de tener unos grandes docentes durante la carrera y del grandísimo apoyo que me brindaron mis queridos amigos de Tenerife y, por supuesto, mi compañera de piso, me di cuenta de que realmente no estaba enamorado de la biología, sino de la docencia. Si bien hasta ese momento hacer el doctorado había sido una de mis metas, esta epifanía hizo que la chispa investigadora se apagara y cambió el rumbo de mi porvenir por tercera vez.

Por eso, tras terminar mis estudios y tras unas breves experiencias laborales en el mundo docente, decidí matricularme en el Máster de Formación de Profesorado. Los días previos al comienzo de las clases estaba ilusionado porque se iba a cumplir mi plan perfecto y sin fisuras: estudiar el máster, aprobar las oposiciones y convertirme en

profesor de secundaria. Tenía unas ganas tremendas de ser docente para transmitirle a las futuras generaciones la pasión e interés por la ciencia que me habían transmitido a mí cuando era más joven. Sin embargo, algo curioso ocurrió unos días antes de comenzar las clases, una casualidad que cambiaría los años que vendrían por delante.

Jaime León me llamó desde un número muy largo que, fruto del azar, decidí contestar a pesar de estar batiendo mi récord en una partida de Tetris 99. En esa llamada, Jaime me proponía pedir una beca de colaboración para trabajar con él y su equipo durante la duración del máster, con posibilidad de continuar en el futuro. Solo necesité esa propuesta para que la chispa investigadora volviera a prenderse, pero esta vez más fuerte.

Desde ese momento, Jaime se convirtió en mi mentor y su equipo en el mío también. Juntos, hemos viajado, conocido a investigadores de otras partes del mundo, nos hemos peleado, nos hemos conciliado. En resumen, hemos vivido cientos de momentos que podrían dar lugar a un libro de anécdotas más o menos igual de grande que esta tesis. Pero, de todas estas experiencias, lo que siempre me quedará es el haber podido compartir estos años con un equipo de personas de una calidad humana e investigadora increíble, que no solo me han hecho crecer intelectualmente, sino también (y quizás más importante) personalmente. Por eso, les doy las gracias de todo corazón.

Sin embargo, no todo el mérito debe llevárselo mis compañeros. Mi círculo personal más cercano ha tenido que aguantar innumerables horas de dudas, bajones, subidas, irritabilidad y una larga lista de estados emocionales que no soy capaz ni de nombrar. A todos ellos, que saben quiénes son, gracias por ser mi ancla en este viaje.

Abstract

"Y estudiar y divertirse, aprender a aprender y aprender para aprender cambian

*el mundo, porque estos son los **motores del cambio***"

"And studying and having fun, learning to learn and learning to learn change

*the world, because these are the **engines of change***"

Engaging message number 734

Introduction

Academic performance is one of the most extensively studied factors in education due to its numerous consequences on students' lives (Fenollar et al., 2007; Hattie, 2009). High academic performance not only enhances students' employment opportunities and future earnings (Ming-Chia, 2005) but also leads to higher educational attainment, thus contributing to poverty reduction in countries (Hofmarcher, 2021). Conversely, low academic performance hinders students' educational trajectories, negatively affecting their long-term educational prospects (Crosnoe et al., 2007). It is also associated with the stigma of repeating a school year, which can detrimentally impact students' mental health (Molero-Jurado et al., 2021).

In Spain, studies suggest that many students perform below their potential (Veas et al., 2017). This is supported by recent data from the PISA 2022 report (OECD, 2023) and Save the Children (2022), which highlight high repetition rates, particularly in secondary education. The high number of repeaters in the Spanish education system, up to eleven times higher than neighbouring countries, entails considerable expenditure that could be redirected towards improving educational infrastructure, one of the best investments a country can make (Gemmell et al., 2016; Heckman, 2002). Given these issues, it is evident that strategies to improve academic performance must be explored, benefiting students and, ultimately, the socio-economic development of the country.

Improving academic performance is a complex challenge, as there are many approaches that pursue this goal (Hattie, 2009). Practically, these can be classified as targeting students, teachers, or families. However, among all available options, interventions focused on teachers are the most promising, as they can benefit a larger number of students per year (Allen et al., 2011; Gregory et al., 2017). Moreover, the effects of interventions aimed at teachers can extend even to students they do not directly

teach (Opper, 2019). This underscores the importance of investing in teacher development as a key strategy for improving secondary education students' performance.

Identifying key aspects of teacher development to enhance students' academic performance is challenging given the wide range of existing strategies (Hattie, 2009). Among all the teaching factors that can be improved, it would be beneficial to focus on concrete -rather than abstract- aspects that teachers can identify, as this contributes to making them easier to understand and modify (Soderberg et al., 2015). Furthermore, it should also be considered the limited time available to teachers for training. Spanish secondary teachers work more hours on average than their OECD counterparts and dedicate only about 4% of their working time to professional development activities (OECD, 2015). A factor that fulfills both of these requirements is teachers' discourse in the classroom (Hardman, 2016).

Teachers' discourse has a significant impact on student engagement, motivation, and academic performance (Caldarella et al., 2020; Howe, 2017; Putwain et al., 2021). It includes various types of teacher-student interactions, such as dialogue, feedback, and questioning (Howe y Abedin, 2013). However, among these interactions, the messages that teachers use to engage students in school tasks have gained attention due to their effects on performance, learning motivation, and mental health (Santana-Monagas et al., 2023; Santana-Monagas, Núñez, et al., 2022; Santana-Monagas, Putwain, et al., 2022; Santana-Monagas & Núñez, 2022).

The concept of engaging messages is guided by the Message Framing Theory (Rothman & Salovey, 1997) and the Self-Determination Theory (Ryan & Deci, 2017). Message Framing Theory explains the effects of messages based on whether they highlight the benefits of engaging in a task or the drawbacks of not doing so. Self-Determination Theory helps understand the effects of different motivational appeals

teachers rely on to engage their student. These motivations can range from more external ones, such as tangible rewards and punishments, or feelings of self or others, to more internal ones, such as the future value of studying or the personal satisfaction felt by engaging in a task. Combining the two possible ways of framing the message and the four types of motivational incentives results in eight main categories of messages (Table 1).

Table 1

Examples of theory-based engaging messages

Frame	Appeal	Example
Emphasis on benefits of engaging	Tangible rewards	*"If you pay attention in class, I'll let you spend the last few minutes of class on whatever you want."*
	Feelings of self or others	*"If you do your homework, you will feel satisfied."*
	Future value of studying	*"If you work hard, you will be able to choose what to study in the future."*
	Personal satisfaction	*"If you study, you will enjoy and have fun in this subject."*
Emphasis on disadvantages of not engaging	Tangible punishments	*"If you don't pay attention in class, you will be punished without recess."*
	Feelings of self or others	*"If you don't do your homework, you will disappoint me and your parents."*
	Future value of studying	*"If you don't work hard, you'll have to make do with studying less sought-after degrees."*
	Personal satisfaction	*"If you don't study, you will miss out on the beauty of this subject."*

These messages are conveyed primarily when teachers are not directly instructing, which is about 20% of class time (OECD, 2019a). Despite this limited time, research shows these messages play a crucial role in the classrooms. Santana-Monagas, Putwain, et al. (2022) found that teachers' engaging messages predict secondary students' performance by enhancing their motivation to learn, defined as the desire, drive, and persistence to engage in learning activities (Núñez et al., 2005; Vallerand et al., 1992). Messages appealing to internal motivations, like the future value of studies or the personal

satisfaction, positively affect teacher-student relationships and vitality (Santana-Monagas et al., 2023). Additionally, teachers' perceptions of autonomy influence the types of messages they use, with those highlighting the benefits of engagement linked to better academic results (Santana-Monagas, Núñez, et al., 2022).

All this evidence justifies the choice of engaging messages as the central theme of this thesis, although there are still many unresolved questions surrounding them. For instance, the mechanism by which perceived use of messages improves students' motivation to learn is still unclear. Studying these mechanisms can lead to better-targeted and adaptable interventions (Hamaker et al., 2020; Kazdin, 2007). Additionally, while the most beneficial types of messages are known, the factors influencing teachers to use these messages require further exploration. Understanding these predictors is important for developing interventions that promote gain-framed messages appealing to internal motivation. Finally, there are often overlooked elements, such as the acoustic characteristics of messages, which could also influence their impact and deserve further research.

Regarding the mechanism trough which greater perception in the use of messages improved students' motivation to learn, we found evidence suggesting that teachers' communication is related to students' satisfaction and sentiments (Dhillon & Kaur, 2021; Goodboy et al., 2009), and that these sentiments about teaching practices are linked to their motivation (Baños et al., 2017; Hasan et al., 2013; Shen et al., 2009). Based on this finding, it is plausible to hypothesise that the mechanism through which the effect of perceived message use on motivation to learn is transmitted might be students' sentiments towards their teachers' communication.

As for the antecedents of teachers' use of engaging messages, a relevant factor might be teacher enthusiasm. This enthusiasm is defined as a component of quality

teaching that includes subject interest, intrinsic motivation, positive emotions, and the improvement of the teaching process (Kunter et al., 2011). Several studies have shown the impact of this variable on teaching practices used to motivate students (Kunter et al., 2008; OECD, 2019b). Additionally, studies analysing how teachers adapt their practices based on student characteristics show that students' previous performance could also influence message use (Parsons et al., 2018). Therefore, it is worth examining the predictive role of these variables in teachers' use of engaging messages.

Lastly, an acoustic feature that may be influencing the effect of the messages is emotional intensity, which is related to the activation dimension of the perceived emotion (Alonso et al., 2015) and has been shown to affect attentional processes (Holz et al., 2021). By examining the emotional intensity of the messages, we can gain a deeper understanding of how these acoustic features influence the messages effectiveness. This knowledge could be used to inform interventions aimed at training teachers not only in message content but also in delivery techniques, ultimately improving student engagement and academic performance.

Methodology

To effectively explore the factors influencing the use and effects of teachers' engaging messages mentioned in the previous subsection, it would be useful to employ open-ended data collection methods that go beyond traditional Likert-type scales[1]. Using data derived from open-ended collection methods allows for comprehensive analyses that

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[1]

Instead of using the labels quantitative or qualitative, we have chosen to refer directly to the method of data collection. This approach recognises that qualitative and quantitative data exist on a continuum rather than as distinct categories (Libarkin & Kurdziel, 2002). For instance, data from even controlled experimental studies are never purely quantitative due to the context and perspective of the researcher. Conversely, even qualitative analyses often involve some quantitative elements such as counting the number of times certain words appear.

support abductive reasoning, facilitating the development or modification of theories based on empirical evidence (Walker & Myrick, 2006). Data collected through open-ended methods can also enhance understanding of contexts, allow exploration of new phenomena, identify emerging research questions, and uncover new patterns of change (Kegler et al., 2019). Lastly, these methods provide richer information for amplifying the lived experiences of individuals and informing interventions (Raskind et al., 2019). All of this highlights the adequacy of using open-ended collection methods to investigate in more detail the factors that influence the use and effect of messages.

For instance, to determine if the effect of students' perception of message use on their motivation to learn is mediated by students' sentiments towards their teacher's communication, using open-ended questions instead of scales may be more beneficial (Leech y Onwuegbuzie, 2008). Open-ended questions enable students to provide detailed opinions on their sentiments, offering richer data than fixed-response scales (Bailey, 2008). Although using open-ended questions present challenges like lengthy coding times that limit sample sizes and hinder generalisability (Rahman, 2016), recent technological advances offer a solution. Sentiment analysis tools can automatically extract sentiment values from responses (Zhou et al., 2020), allowing for more comprehensive and faster data analysis. By using these methods of data collection and analysis, we can enhance the understanding of the relation between message perception and motivation to learn (Burić, 2015; Tseng et al., 2018).

A similar situation applies to the study of factors influencing teachers' use of messages. To understand how prior academic performance and teachers' enthusiasm influence the use of engaging messages, it would be beneficial to employ data collection methods other than traditional students' self-reports, which primarily focus on students' perceptions rather than teachers' actual practices (Spooren et al., 2013; Urdan, 2004). In

this context, audio-recordings of lessons offer a viable alternative, as they allow us to record everything the teacher says. These recordings can be transcribed and analysed to observe the actual use of engaging messages (Boden et al., 2020). While this analysis can also be complex if done manually, the combination of automatic transcription (Dale et al., 2022) and keyword filtering (Winarti et al., 2021) can facilitate the process, enabling the analysis of large volumes of audio data to measure teachers' actual message use.

Finally, working with audio-recordings allows for the analysis of acoustic features, such as the emotional intensity of messages (Weinstein et al., 2018). This method facilitates for the extraction of audio clips for each identified message, which can then be analysed using algorithms to determine the emotional intensity value of each message (Alonso et al., 2015). Following this approach, we are able to examine the role emotional intensity plays in the effectiveness of messages, helping to ascertain whether messages are most effective when delivered with high, moderate, or low emotional intensity.

Objectives

This thesis aims to deepen the understanding of the factors influencing the use and effect of engaging messages, as well as the consequences of these messages, using open-ended data collection methods. Therefore, the general objectives of this dissertation are as follows: 1. To examine the role of students' sentiments about their teacher's communication in the relation between the perceived use of engaging messages and students' motivation to learn; 2. To analyse the role of teachers' enthusiasm and prior academic performance as predictors of engaging messages' use; and 3. To investigate the role of emotional intensity in the effect of engaging messages.

Results

In order to address the objectives of this thesis, we conducted three studies. A brief summary of each one is presented below.

The first study focused on exploring the role of students' sentiments towards their teachers' communication in the relation between perceived use of messages and motivation to learn. To this end, we used an open-ended question and sentiment analysis to analyse students' answers. Then, we performed a multilevel structural equation model to test if the relation between messages and students' motivation to learn, shown in previous studies, could be mediated by students' sentiments about their teachers' communication. The results showed that the higher the perception of message use, the more positive the students' sentiments about teacher communication. Additionally, these sentiments partially mediated the relation between perceived message use and students' motivation to learn. The study also highlighted the utility of sentiment analysis for automatically extracting information from large sets of open-ended responses, saving time and resources compared to manual coding.

The second study examined the factors that lead teachers to use or not use messages and, if used, how these factors influence the number of messages per teacher. Specifically, the factors analysed as predictors included teachers' enthusiasm for teaching and students' prior performance. To conduct this study, we collected direct observations of engaging messages use through audio-recordings of lessons. Then, we conducted the data analysis using a two-part model. Results showed that both teacher enthusiasm and student prior performance are related to message use. The higher the teacher enthusiasm and the better the student performance, the greater the number of messages used. Additionally, better student performance increased the likelihood of using messages that appeal to external incentives. This research not only improved understanding of the

factors influencing message use but also developed a methodology for effectively analysing teacher discourse and obtain direct observations on engaging messages. The findings could help develop future interventions aimed at enhancing teachers' use of messages and ultimately improving student performance.

The third study explored the impact of teacher messages on student academic performance, focusing on the moderating role of emotional intensity of messages extracted from audio-recordings. We tested a moderated mediation model, hypothesizing that different types of messages might predict student performance either directly or indirectly through motivation to learn, with these relations being moderated by different levels of emotional intensity. The findings revealed that emotional intensity moderates the direct relation between engaging messages and academic performance, with moderate levels of emotional intensity being the most effective for conveying the impact of messages on performance. These results highlight the significance of not only the types of messages but also their acoustic features beyond mere words, opening new research avenues on acoustic aspects of teacher communication that could significantly impact their effectiveness.

Conclusions

In summary, this thesis has made theoretical and methodological contributions to the field of teachers' discourse, particularly regarding engaging messages. Theoretically, the results show that students' perception of increased use of messages fosters positive sentiments about teacher communication, enhancing their motivation to learn. Additionally, we found that both students' prior performance and teachers' enthusiasm for teaching can predict the likelihood and quantity of the use of engaging message. Furthermore, we observed that not only the content but also the manner of delivery matters; using messages with moderate levels of emotional intensity can better convey

their effects on performance. This knowledge adds to the scientific understanding of teacher messages and lays the groundwork for an intervention aimed at improving their use. If effective, this intervention could impact hundreds of students each year, ultimately helping to address the issue of low performance and its associated consequences.

Methodologically, we showed that using tools like sentiment analysis, automatic transcriptions, and keyword-based filtering allows for the optimised analysis of large amounts of data from open-ended questions and audio-recordings of classes. The results also suggest that future studies in teachers' discourse and other fields should begin collecting data using open-ended methods to complement scale-based data.

Resumen en español

*"Verán cuando resuelvan el problema, cuando a alguien le salga, **la satisfacción que es encontrar las soluciones de un problema**"*

*"You will see when you solve the problem, when someone comes out, **the satisfaction it is to find solutions to a problem**"*

Engaging message number 522

Introducción

El rendimiento académico es uno de los factores más ampliamente estudiados en educación debido a sus numerosas consecuencias en la vida de los estudiantes (Fenollar et al., 2007; Hattie, 2009). Un alto rendimiento académico no solo mejora las oportunidades de empleo y los ingresos futuros de los estudiantes (Ming-Chia, 2005), sino que también puede llevarlos a alcanzar niveles educativos superiores, contribuyendo así a la reducción de la pobreza en los países (Hofmarcher, 2021). Por el contrario, un bajo rendimiento académico deteriora las trayectorias educativas de los estudiantes, influyendo negativamente en sus perspectivas educativas a largo plazo (Crosnoe et al., 2007). Además, este se asocia con el estigma de repetir un año escolar, lo que puede llevar a un detrimento de la salud mental de los estudiantes (Molero-Jurado et al., 2021).

En el caso concreto de España, hay estudios que sugieren que muchos estudiantes rinden por debajo de su potencial (Veas et al., 2017). Esto se ve apoyado por datos recientes como los del informe PISA 2022 (OECD, 2023) y el de Save the Children (2022), que destacan las altas tasas de repetición, sobre todo en secundaria. La elevada cantidad de repetidores en el sistema educativo español, hasta once veces superior que la de países vecinos, conlleva un gasto considerable que podría reorientarse hacia mejoras en la infraestructura educativa, siendo esta una de las mejores inversiones que puede llegar a cabo el estado (Gemmell et al., 2016; Heckman, 2002). A la vista de estos problemas, se hace patente la necesidad de investigar estrategias para mejorar el rendimiento académico, beneficiando así al estudiante y, en última instancia, al desarrollo socioeconómico del país.

La mejora del rendimiento académico es un desafío complejo, ya que existen una gran cantidad de aproximaciones que persiguen este fin (Hattie, 2009). Desde un punto de vista práctico, estas se podrían clasificar según estén dirigidas a estudiantes, a docentes

o a familias. Sin embargo, de entre todas las opciones disponibles, las intervenciones enfocadas en los docentes son las más prometedoras, ya que pueden beneficiar a un mayor número estudiantes por curso (Allen et al., 2011; Gregory et al., 2017). Pero es que, además, el efecto de las intervenciones destinadas a los docentes puede expandirse incluso a estudiantes a los que no imparten clase (Opper, 2019). Todo esto pone de manifiesto la importancia de invertir en el desarrollo docente como estrategia clave para mejorar el rendimiento de los estudiantes en educación secundaria.

Identificar los aspectos clave del desarrollo docente que puedan mejorar el rendimiento académico de los estudiantes es un desafío, dada la amplitud de enfoques existentes (Hattie, 2009). Entre todos los factores docentes susceptibles de mejora, sería útil centrar los esfuerzos en aquellos aspectos concretos que puedan ser reconocidos por los docentes, ya que esto contribuye a que sean más fáciles de comprender y de modificar (Soderberg et al., 2015). Además, también se debe tener en cuenta el tiempo limitado del que disponen los docentes para su formación. Los docentes españoles de secundaria trabajan más horas en promedio que sus homólogos de la OCDE, y solo dedican aproximadamente el 4% de su tiempo laboral a actividades de desarrollo profesional (OECD, 2015). Un área que cumple con estos requisitos es el discurso del docente en el aula (Hardman, 2016).

El discurso del docente en el aula ha demostrado tener un impacto importante sobre la implicación, la motivación y el rendimiento académico de los estudiantes (Caldarella et al., 2020; Howe, 2017; Putwain et al., 2021). Este discurso incluye diferentes tipos de interacciones docente-estudiante, tales como el diálogo, el *feedback* y las preguntas a los estudiantes (Howe y Abedin, 2013). Sin embargo, de entre todas las interacciones existentes, los mensajes que utilizan los docentes para implicar a los estudiantes en las tareas escolares han ganado atención en los últimos años, debido las

evidencias sobre su efecto en el rendimiento, la motivación para aprender y diversos aspectos de la salud mental de los estudiantes (Santana-Monagas et al., 2023; Santana-Monagas, Núñez, et al., 2022; Santana-Monagas, Putwain, et al., 2022; Santana-Monagas & Núñez, 2022).

El estudio de estos mensajes se ha llevado a cabo desde dos aproximaciones teóricas como son la Teoría del Enfoque del Mensaje (Rothman y Salovey, 1997) y en la Teoría de la Autodeterminación (Ryan y Deci, 2017). Por una parte, la Teoría del Enfoque del Mensaje explica los efectos de los mensajes en base a si estos resaltan los beneficios de realizar una tarea o las desventajas de no hacerla. Por la otra, la Teoría de la Autodeterminación ayuda a comprender los efectos de los distintos incentivos motivacionales que utilizan los docentes para implicar a sus estudiantes. Estos incentivos pueden ir desde lo más externo, como las recompensas y castigos tangibles, o los sentimientos hacia uno mismo o hacia los demás, hasta lo más interno, como el valor a futuro de los estudios o la satisfacción personal que se siente al implicarse en una tarea. Combinando las dos formas de enfocar el mensaje y los cuatro tipos de incentivos motivacionales se obtienen las ocho categorías principales de mensajes (Tabla 1).

Tabla 1

Ejemplos de los mensajes que emplean los docentes para implicar a su alumnado en las tareas escolares.

Enfoque	Incentivo motivacional	Ejemplo
Énfasis en los beneficios de implicarse	Recompensas tangibles	*"Si prestas atención en clase, dejaré que le dediques los últimos minutos de clase a lo que quieras."*
	Sentimientos propios o ajenos	*"Si haces los deberes, te sentirás satisfecho."*
	Valor a futuro de los estudios	*"Si te esfuerzas, podrás elegir qué estudiar en el futuro."*
	Satisfacción personal	*"Si estudias, disfrutarás y te divertirás en esta asignatura."*

	Castigos tangibles	*"Si no prestas atención en clase, te voy a castigar sin recreo."*
Énfasis en las desventajas de no implicarse	Sentimientos propios o ajenos	*"Si no haces los deberes, me decepcionarás a mí y a tus padres."*
	Valor a futuro de los estudios	*"Si no te esfuerzas, tendrás que conformarte con estudiar carreras menos solicitadas."*
	Satisfacción personal	*"Si no estudias, te perderás la belleza de esta asignatura."*

Este tipo de mensaje se transmite principalmente cuando los docentes no están inmersos en la instrucción directa, lo que representa aproximadamente el 20% del tiempo de clase (OECD, 2019a). Sin embargo, a pesar del escaso tiempo en el que se utilizan, las investigaciones previas han aportado evidencias de que juegan un papel importante en las aulas. Santana-Monagas, Putwain, et al. (2022) mostraron que los mensajes de los docentes predicen el rendimiento de los estudiantes de secundaria al mejorar su motivación para aprender, un constructo que se refiere al deseo, el impulso y la persistencia para participar en actividades que fomenten el aprendizaje (Núñez et al., 2005; Vallerand et al., 1992). Además, también se ha observado que los mensajes que apelan a incentivos motivacionales más internos tienen un efecto positivo en las relaciones entre docentes y estudiantes, mejorando la vitalidad de los estudiantes (Santana-Monagas et al., 2023). Debido a los efectos diferenciales de los distintos tipos de mensajes, otros estudios se han centrado en los antecedentes de los mensajes. Santana-Monagas, Núñez, et al. (2022) observaron que la percepción de autonomía de los docentes influye en los tipos de mensajes que utilizan, siendo aquellos que resaltan los beneficios de implicarse en las tareas los vinculados a mejores resultados académicos.

Estas evidencias justifican la elección de los mensajes que usan los docentes para implicar a los estudiantes en las tareas escolares como tema central de esta tesis, aunque

aún quedan muchas preguntas sin resolver sobre ellos. Por ejemplo, el mecanismo por el cual la percepción del uso de mensajes mejora la motivación para aprender de los estudiantes sigue sin estar claro. Estudiar estos mecanismos puede llevar a intervenciones mejor dirigidas y adaptables (Hamaker et al., 2020; Kazdin, 2007). Además, aunque se conoce qué tipo de mensajes es más beneficioso para los estudiantes, los factores que influyen en el uso que hacen los docentes de ellos requieren una mayor exploración. Comprender los antecedentes de su uso es importante para desarrollar intervenciones que promuevan mensajes que resalten los beneficios y apelen a motivaciones internas. Finalmente, existen algunos elementos que se suelen pasar por alto, como las características acústicas de los mensajes, que también podrían influir en su impacto y merecen ser investigados.

Respecto al mecanismo por el cual una mayor percepción en el uso de mensajes mejora la motivación para aprender de los estudiantes, existen evidencias de que la comunicación del docente influye en la satisfacción y los sentimientos de los estudiantes (Dhillon y Kaur, 2021; Goodboy et al., 2009), que a su vez están vinculados a una motivación de mayor calidad (Baños et al., 2017; Hasan et al., 2013; Shen et al., 2009). Dada esta evidencia, es posible pensar que los sentimientos de los estudiantes hacia la comunicación de su docente pueden estar mediando la relación entre el uso percibido de los mensajes y la motivación para aprender.

En cuanto a los antecedentes del uso de mensajes motivadores por parte de los profesores, un factor clave podría ser el entusiasmo de los docentes. Este entusiasmo abarca el interés por la asignatura, la motivación intrínseca, las emociones positivas y la búsqueda de la mejora de la enseñanza, influye en las prácticas docentes, incluyendo las estrategias que emplean para motivar a los estudiantes (Kunter et al., 2008; OECD, 2019b). Además, el rendimiento previo de los estudiantes también puede influir en el uso

de mensajes por parte de los docentes (Parsons et al., 2018). Por lo tanto, es pertinente examinar cómo estos dos factores, el entusiasmo de los profesores y el rendimiento previo de los estudiantes, predicen el uso de mensajes para implicar a los estudiantes.

Por último, una característica acústica que puede estar influyendo en el efecto de los mensajes es la intensidad emocional, que está relacionada con la dimensión de activación de la emoción percibida (Alonso et al., 2015) y ha demostrado afectar a los procesos atencionales (Holz et al., 2021). Al estudiar el rol de la intensidad emocional de los mensajes, es posible comprender mejor cómo estas características acústicas influyen en la eficacia de los mensajes. Este conocimiento podría utilizarse para desarrollar intervenciones dirigidas a formar a los docentes, no solo en el contenido de los mensajes, sino también en cómo transmitirlos, mejorando en última instancia la implicación de los estudiantes y su rendimiento académico.

Metodología

Para explorar los factores que influyen en el uso y efecto de los mensajes mencionados en el apartado anterior, sería de utilidad emplear métodos de recogida de datos abiertos que vayan más allá de las tradicionales escalas tipo Likert[2]. El uso de datos obtenidos a través de métodos de recogida abiertos permite realizar análisis más profundos que permiten un razonamiento abductivo, facilitando el desarrollo o la modificación de teorías en base a datos empíricos (Walker & Myrick, 2006). Estos datos también pueden mejorar la comprensión de los contextos y permitir la exploración de

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[2] En lugar de utilizar las etiquetas cuantitativo o cualitativo, hemos optado por referirnos directamente al método de recogida de datos. Este enfoque tiene en cuenta que los datos cualitativos y cuantitativos existen en un continuo y no como categorías diferenciadas (Libarkin & Kurdziel, 2002). Por ejemplo, incluso los datos que provienen de los estudios experimentales nunca son puramente cuantitativos debido al contexto y la perspectiva del investigador. Por el contrario, hasta los análisis cualitativos suelen incluir algunos elementos cuantitativos, como el recuento del número de veces que aparecen determinadas palabras.

nuevos fenómenos, el desarrollo de nuevas preguntas de investigación y el descubrimiento de nuevos patrones (Kegler et al., 2019). Además, los datos obtenidos a partir de métodos de recolección abiertos facilitan a los individuos explicar mejor sus experiencias y proporcionar información útil para desarrollar mejores intervenciones (Raskind et al., 2019). Todo esto pone de manifiesto la pertinencia de utilizar métodos de recogida abiertos para investigar con más detalle los factores que influyen en el uso y el efecto de los mensajes.

Por ejemplo, para determinar si el efecto de la percepción de los estudiantes acerca del uso de mensajes sobre su motivación para aprender está mediado por sus sentimientos hacia la comunicación del docente, puede ser más útil usar preguntas abiertas en lugar de escalas (Leech y Onwuegbuzie, 2008). Las preguntas abiertas permiten a los estudiantes expresar opiniones más detalladas sobre sus sentimientos, ofreciendo datos más completos que las escalas de respuesta fija (Bailey, 2008). Aunque el uso de preguntas abiertas presenta algunos desafíos importantes, como los largos tiempos de codificación que limitan el tamaño de las muestras y dificultan la generalización (Rahman, 2016), los últimos avances tecnológicos ofrecen una solución. Las herramientas de análisis de sentimientos pueden extraer automáticamente valores de sentimiento de las respuestas (Zhou et al., 2020), lo que permite un análisis de datos más rápido. Utilizando estos métodos de recogida y análisis de datos, es posible comprender mejor la relación entre el uso percibido de los mensajes y la motivación para aprender de los estudiantes (Burić, 2015; Tseng et al., 2018).

Una situación similar se aplica al estudio de los factores que influyen en el uso que hacen los docentes de los mensajes. Para comprender cómo influyen el entusiasmo de los docentes y el rendimiento académico previo de los estudiantes en el uso de los mensajes, sería útil emplear métodos de recolección de datos distintos de los tradicionales

autoinformes de los estudiantes, que se centran en sus percepciones y no en las prácticas reales de los docentes (Spooren et al., 2013; Urdan, 2004). En este contexto, las grabaciones en audio de las clases ofrecen una alternativa viable, ya que permiten registrar todo lo que dice el docente. Estas grabaciones pueden transcribirse y analizarse para observar el uso real que hacen los docentes de los mensajes (Boden et al., 2020). Aunque este análisis puede ser complejo si se realiza manualmente, la combinación de transcripción automática (Dale et al., 2022) y filtrado basado en palabras clave (Winarti et al., 2021) puede facilitar el proceso, permitiendo el análisis de grandes volúmenes de datos para medir el uso real que hacen los docentes de los mensajes.

Por último, trabajar con grabaciones en audio de las clases permite analizar las características acústicas de los mensajes, como su intensidad emocional (Weinstein et al., 2018). A través de este método es posible obtener clips de audio de cada mensaje identificado, que luego pueden analizarse mediante algoritmos que permitan determinar su valor de intensidad emocional (Alonso et al., 2015). Siguiendo este enfoque, se puede examinar el papel que desempeña la intensidad emocional en el efecto de los mensajes, ayudando a determinar si los mensajes son más eficaces cuando se transmiten con una intensidad emocional alta, moderada o baja.

Objetivos

Esta tesis busca profundizar en el conocimiento de los factores que influyen en el uso y efecto de los mensajes empleados por los docentes para implicar a su alumnado, así como en las consecuencias de dichos mensajes, utilizando para ello métodos de recogida de datos abiertos. De esta forma, se establecen los siguientes objetivos generales para esta tesis:

1. Examinar el papel de los sentimientos de los estudiantes sobre la comunicación de sus docentes en la relación entre el uso percibido de mensajes y la motivación para aprender.

2. Analizar el papel del entusiasmo de los docentes y del rendimiento académico previo de los estudiantes como predictores del uso de mensajes.

3. Investigar el papel de la intensidad emocional en el efecto de los mensajes.

Para alcanzar estos objetivos, cada uno de los estudios que componen esta tesis persiguió los siguientes objetivos específicos:

- Estudio 1:

  o Comprobar la utilidad del análisis de sentimiento como método para extraer información de las respuestas de los estudiantes a preguntas abiertas sobre la comunicación de sus docentes.

  o Comprobar la relación entre las percepciones de los estudiantes sobre el uso que hacen los docentes de los mensajes y sus sentimientos hacia la comunicación de sus docentes.

  o Examinar el rol mediador de los sentimientos de los estudiantes en la relación entre el uso percibido de mensajes y la motivación para aprender.

- Estudio 2:

  o Medir los mensajes utilizados por los docentes a través de observaciones directas y examinar cómo el entusiasmo de los docentes por enseñar afecta la probabilidad de que utilicen estos mensajes.

  o Entre los docentes que usan mensajes, explorar la influencia de su entusiasmo por enseñar en la cantidad de mensajes utilizados.

- o Evaluar cómo el rendimiento previo de los estudiantes afecta a la probabilidad de usar mensajes.

- o Entre los docentes que usan mensajes, examinar la influencia del rendimiento previo de los estudiantes en la cantidad de mensajes utilizados.

- Estudio 3:

- o Comprobar si los niveles de intensidad emocional de los mensajes moderan el efecto directo de estos mensajes en el rendimiento académico, así como el efecto indirecto a través de la motivación para aprender.

Resultados

Para abordar los objetivos de esta tesis se llevaron a cabo tres estudios centrados en el análisis de los mensajes que utilizan los docentes para implicar a su alumnado y su relación con diversas variables de interés. A continuación, se presenta un breve resumen de cada uno.

El primer estudio se centró en explorar el papel de los sentimientos de los estudiantes hacia la comunicación de sus docentes en la relación entre el uso percibido de los mensajes y la motivación para aprender. Para ello, se utilizó una pregunta abierta y un análisis de sentimientos para analizar las respuestas de los estudiantes. A continuación, se realizó un modelo de ecuaciones estructurales multinivel para comprobar si la relación demostrada en estudios anteriores entre los mensajes y la motivación para aprender de los estudiantes podía estar mediada por los sentimientos de los estudiantes hacia la comunicación de sus docentes. Los resultados mostraron que cuanto mayor era la percepción del uso de mensajes, más positivos eran los sentimientos de los estudiantes hacia la comunicación de los docentes. Además, estos sentimientos mediaban

parcialmente la relación entre la percepción del uso de mensajes y la motivación para aprender de los estudiantes. El estudio también puso de manifiesto la utilidad del análisis de sentimientos para extraer automáticamente información de grandes cantidades de respuestas abiertas, suponiendo un ahorro en tiempo y recursos en comparación con la codificación manual.

El segundo estudio se centró en examinar los factores que llevan a los docentes a utilizar o no mensajes y, en caso de utilizarlos, en analizar la influencia de estos factores en el número de mensajes utilizados. En concreto, se analizó el papel predictor del entusiasmo de los docentes por enseñar y del rendimiento previo de los estudiantes. Para llevar a cabo este estudio, se obtuvieron observaciones directas del uso de los mensajes mediante grabaciones en audio de las clases. A continuación, se analizaron los datos mediante un modelo de dos partes. Los resultados mostraron que tanto el entusiasmo de los docentes como el rendimiento previo de los estudiantes están relacionados con el uso de mensajes. Cuanto mayor era el entusiasmo del docente y mejor era el rendimiento previo de los estudiantes, mayor era el número de mensajes utilizados. Además, un mejor rendimiento previo aumentaba la probabilidad de utilizar mensajes que apelaban a incentivos externos. Este estudio no sólo mejoró la comprensión de los factores que influyen en el uso de mensajes, sino que también contribuyó al desarrollo de una metodología que permite analizar eficazmente el discurso de los docentes y obtener observaciones directas sobre el uso que hacen de los mensajes. Las conclusiones podrían ayudar a desarrollar futuras intervenciones destinadas a mejorar el uso de los mensajes por parte de los docentes y, en última instancia, a mejorar el rendimiento de los estudiantes.

El tercer estudio exploró el impacto de los mensajes en el rendimiento académico de los estudiantes, centrándose en el papel moderador de la intensidad emocional de los

mensajes. Se probó un modelo de mediación moderada para comprobar si los diferentes tipos de mensajes predicen el rendimiento de los estudiantes de forma directa o de forma indirecta a través de la motivación para aprender, siendo estas relaciones moderadas por la intensidad emocional. Los resultados indicaron que la intensidad emocional modera la relación directa entre los mensajes y el rendimiento académico, siendo los niveles moderados de intensidad emocional los más eficaces para transmitir el efecto de los mensajes en el rendimiento. Estos hallazgos ponen de manifiesto la importancia no sólo de los tipos de mensajes, sino también de las características acústicas que los acompañan, lo que abre nuevas vías de investigación sobre los aspectos acústicos de la comunicación de los docentes que podrían influir en su eficacia.

Conclusiones

En base a los hallazgos de los tres estudios que componen esta tesis y a los objetivos que se propuso cumplir, se pueden extraer las siguientes conclusiones:

1. El análisis de sentimientos es una herramienta útil en la investigación educativa para transformar grandes cantidades de información textual en datos analizables.

2. Una alta percepción del uso de mensajes llevó a sentimientos más positivos entre los estudiantes hacia la comunicación de sus docentes.

3. Los sentimientos de los estudiantes hacia la comunicación de sus docentes explican parcialmente el efecto del uso percibido de mensajes sobre la motivación para aprender.

4. La combinación de la transcripción automática de clases grabadas en audio con el filtrado en base a palabras clave es una metodología útil para analizar el discurso docente de forma eficiente y obtener información relevante de los mensajes.

5. Un mayor entusiasmo por enseñar está asociado con una menor probabilidad de usar mensajes.

6. Entre los docentes que ya utilizan mensajes, los más entusiasmados tienden a utilizar un mayor número de mensajes de casi todos los tipos.

7. Un mejor rendimiento académico previo de los estudiantes aumenta la probabilidad de que los docentes usen mensajes que apelan a incentivos motivacionales que hacen referencia a recompensas o castigos tangibles.

8. Entre los docentes que usan mensajes, un mejor rendimiento académico previo de los estudiantes aumenta el número de mensajes utilizados de casi todos los tipos.

9. El efecto directo de los mensajes sobre el rendimiento académico de los estudiantes está moderado por la intensidad emocional, siendo los niveles moderados de intensidad emocional los más eficaces para transmitir el impacto de los mensajes en el rendimiento.

En resumen, esta tesis ha permitido realizar contribuciones tanto teóricas como metodológicas como al campo del discurso docente en general, y en el de los mensajes en particular. Desde el punto de vista teórico, los resultados permitieron observar cómo la percepción de un mayor uso de mensajes fomenta sentimientos positivos en las opiniones de los estudiantes sobre la comunicación del docente, lo cual a su vez mejora la motivación para aprender. Además, se puso de manifiesto que tanto el entusiasmo por enseñar del docente como el rendimiento previo de los estudiantes pueden actuar como factores predictores en la probabilidad de usar mensajes y de la cantidad de mensajes utilizada. Finalmente, se observó que no solo importa el contenido del mensaje, sino también la manera en la que se dice. Utilizar mensajes con intensidades emocionales moderadas podría ser beneficioso para una mejor transmisión de sus efectos sobre el

rendimiento. Todo este conocimiento contribuye al corpus científico sobre los mensajes docentes y prepara el terreno para desarrollar una intervención que tenga como objetivo mejorar el uso de estos mensajes. Si es efectiva, esta intervención podría influir en cientos de estudiantes cada año, ayudando en última instancia a abordar el problema del bajo rendimiento y sus consecuencias asociadas.

Desde el punto de vista metodológico, se comprobó que, al utilizar herramientas como el análisis de sentimientos, las transcripciones automáticas y el filtrado basado en palabras clave, es posible analizar de forma eficiente grandes cantidades de datos provenientes de preguntas abiertas y grabaciones en audio de las clases. Además, los resultados invitan a que futuros estudios en el campo del discurso docente, así como en otros campos, comiencen a recopilar grandes cantidades de información con métodos de recogida abiertos para complementar los datos recogidos a través de escalas.

Chapter 1. Theoretical framework

*"Saber un poquito de matemáticas nos hace menos ignorantes y **entender mejor***

la realidad que nos rodea"

*"Knowing a little bit of mathematics makes us less ignorant and **better***

understand the reality around us"

Engaging message number 362

1.1. Introduction

Academic performance is one of the most extensively studied factors in education (Fenollar et al., 2007). Decades of evidence highlight the significant consequences of students' performance across various dimensions, both at the personal and societal levels. On the one hand, high academic performance not only influences students' economic and social prospects, affecting employment opportunities and future earnings (Ming-Chia, 2005), but also can lead to higher educational attainment, contributing to poverty reduction in countries (Hofmarcher, 2021). Conversely, poor academic performance has a negative effect on students' self-perceptions and educational trajectories, which undermines their long-term educational prospects (Crosnoe et al., 2007). Additionally, there is a notable relation between poor academic performance and escalated healthcare costs, with studies indicating that declines in performance are associated with an increased risk of developing mental health issues during adolescence and adulthood (Kendler et al., 2016a, 2016b; Levpušček et al., 2013; MacCabe et al., 2013).

In Spain, the need to improve student academic performance is particularly serious, given the evidence suggesting that many students are not achieving their potential (Veas et al., 2017). This concern is reinforced by the recent data from the PISA 2022 report (OECD, 2023), which shows that Spain is performing below the Organisation for Economic Co-operation and Development (OECD) average in many assessed areas. Furthermore, a report by Save the Children (2022) highlights several issues, particularly around the country's notably high repetition rates within developed nations. Specifically, in compulsory secondary education, Spain leads the OECD and the European Union (EU) with a repetition rate of 8.5%, significantly higher than EU and OECD averages of below 3%. This rate doubles that of Austria and Italy, quadruples those of Ireland, New Zealand,

Australia, and Slovakia, is eight times that of Finland and Sweden, and eleven times greater than the United Kingdom.

These alarming statistics are not only concerning because repetition itself negatively impacts students' lives, but also because it represents 6.2% of public spending on primary and secondary education, approximately 1411 million euros (Save the Children, 2022). This amount could potentially be redirected towards after-school support or improvements in educational infrastructure, which has been shown to be one of the best investments countries can make (Gemmell et al., 2016; Heckman, 2002). Given these challenges, there is a compelling need to investigate more deeply the factors affecting secondary students' academic performance, in order to enhance it. By addressing these issues, we would be able to contribute to the improvement of individual and social well-being, as well as to optimising national spending on education.

Improving academic performance is a complex challenge, as there are a multitude of approaches that pursue this goal (Hattie, 2009). From a practical point of view, interventions can focus on students, teachers, or families, each offering unique benefits and facing distinct challenges. While family-based interventions have shown positive effects on student performance (Dennis et al., 2016; Smith et al., 2020), barriers such as time constraints, organizational difficulties, and varying levels of engagement can hinder their effectiveness (Gerzel-Short, 2018). On the other hand, if we had to choose between interventions aimed at learners and those aimed at teachers, the latter offer a particularly promising avenue for substantial impact.

Since teachers interact with hundreds of students annually, improvements in teaching practices can benefit a large number of students each year. Research has already demonstrated that interventions targeting teachers can significantly enhance student performance in an optimised way (Allen et al., 2011; Gregory et al., 2017). Moreover, the

cost-effectiveness of such interventions is not the only reason to focus on teachers. Studies have found that teachers who implement effective teaching practices can influence not just their own students but also the broader educational environment, potentially improving outcomes for students they have never directly taught (Opper, 2019). This ripple effect underscores the value of investing in teacher development to improve student performance, especially in secondary education. Therefore, examining and enhancing the factors within teaching practices susceptible to intervention emerges as a key strategy for improving students' academic performance.

Identifying the most effective factors for teacher interventions to improve student academic performance requires a strategic approach, especially considering the limited time teachers have for professional development. Spanish teachers, for instance, work more hours on average than their OECD counterparts in secondary education (OECD, 2011, 2016) and allocate only about 4% of their work time to professional development activities (OECD, 2015). This scarce time allocation highlights the need to focus on easily modifiable factors. Furthermore, studies have demonstrated that individuals process information more effectively when presented with concrete rather than abstract variables (Soderberg et al., 2015). For this reason, it is preferable to focus on concrete factors, making it easier for teachers to understand and implement changes. A factor that fulfills both of these requirements is teachers' discourse in the classroom (Hardman, 2016).

1.2. Teachers' discourse

Teachers' discourse is a fundamental aspect of education that has been extensively explored over the decades (Howe & Abedin, 2013). In the classroom, this discourse can be broadly divided into instructional time, where the focus is on delivering academic content, and non-instructional time, which involves interactions with students that are not directly related to teaching the curriculum (Dale et al., 2022; Nurmi, 2012; Parsons et al.,

2018). Although instructional time is crucial, the interactions during non-instructional time, which constitute about 20% of teachers' discourse (OECD, 2019a), also play a significant role in the overall educational experience (Wubbels & Brekelmans, 2005).

Some of the interactions that occur during non-instructional time have become a compelling topic for researchers, as they impact various aspects of students' outcomes (Hattie, 2009). For instance, oral feedback, where teachers provide comments based on student activities, doubts, or answers, is necessary for reinforcing knowledge and fostering both academic and emotional growth (Brooks et al., 2019, 2021). Another significant discourse interaction is the use of oral questions, which encourages students to refine their thinking, attention, and understanding of the subject (Rahayu et al., 2020; Teo, 2013). These examples represent only a fraction of the aspects of teacher discourse that have an impact on educational success (Amadi & Paul, 2017; Caldarella et al., 2023). Among these, the different types of messages teachers use with students have gained particular attention in recent years.

Teacher's messages include a wide range of teacher-student interactions that go beyond specific feedback or questions, playing an important role in influencing educational outcomes (Cochran-Smith, 2001). The types of messages that teachers can use is extensive and adapted to specific objectives. For instance, Putwain and Remedios (2014) in a longitudinal study, explored the impact of messages highlighting the consequences of failure in high-stakes exams, revealing that such messages could demotivate students and lead to poorer performance. Conversely, studies by Spilt et al. (2016) and Caldarella et al. (2020) found that positive messages, such as praise, improved student behaviour and classroom management. Similarly, Floress et al. (2018) found that an increased use of praise could reduce students' off-task behaviour. Other researchers have focused on studying messages such as achievement goals (Boden et al., 2020) or

efficacy appeals (Wilkinson, 2023), underscoring the role of teachers' messages in shaping student motivation and engagement.

Despite the growing body of research on the diverse types and effects of teacher messages, the field remains relatively nascent and confronts several challenges. First, the field struggles with the jingle-jangle fallacy, where overlapping definitions of messages that can be classified as the same can lead to confusion and misinterpretation of research results (Marsh, 1994; Marsh et al., 2003). Second, although numerous studies explore various types of teacher messages, there is a lack of focus on different types of motivational incentives that a teacher might appeal to with these messages, which could also significantly influence student outcomes (Aelterman et al., 2019; Collie et al., 2019; Santana-Monagas & Núñez, 2022). This has underscored the necessity for clearer categorisation and deeper investigation into teacher messages, particularly avoiding redundant labelling of similar constructs and focusing on their motivational incentives. It is in this context where teachers engaging messages emerged.

1.3. Teachers' engaging messages

The concept of teachers' engaging messages refer to the messages that teachers use to engage students in school tasks, such as doing homework or studying. This concept is guided by the Message Framing Theory (Rothman & Salovey, 1997) and the Self-Determination Theory (Ryan & Deci, 2017), both robust frameworks that have demonstrated consistent validity and replicability across various contexts (O'Keefe & Jensen, 2008; Ryan, 2024), including education (Ahmadi et al., 2023; Putwain et al., 2016).

Message Framing Theory explores the impact of messages by determining whether they emphasise the benefits of engaging in a task (gain-framed) or the drawbacks

of not doing so (loss-framed). Research indicates that gain-framed messages are generally more effective in encouraging people to engage in a task (Kahneman & Tversky, 2000). On the other hand, Self-Determination Theory aids in understanding the effects of different motivational appeals teachers rely on to engage their student. These motivations can range from more external ones, such as tangible rewards and punishments (extrinsic), or feelings of self or others (introjected), to more internal ones, such as the future value of studying (identified) or the personal satisfaction felt by engaging in a task (intrinsic). Studies have consistently shown that internal motivations are more effective in driving people's behaviour to engage in tasks and perform better than external motivations (Ryan & Deci, 2017).

Santana-Monagas, Putwain, et al. (2022) observed that these two theories are not mutually exclusive but can complement each other to address their respective limitations. For instance, while Message Framing Theory focuses on how messages are framed, it overlooks the types of motivation within those messages, which can significantly affect students' outcomes. Conversely, Self-Determination Theory considers motivational appeals but not the framing of messages, which could amplify or diminish their impact. Integrating these theories allows for a deeper understanding of how both the frame and motivational appeals in teacher messages contribute to their overall effect on students. Therefore, in line with Gigerenzer's (2017) suggestions for creating more robust theoretical frameworks, Santana-Monagas, Putwain, et al. (2022) combined both theories to develop the concept of teacher engaging messages.

Consequently, because of its origins in two major theories, engaging messages have two dimensions. The frame dimension, derived from Message Framing Theory, distinguishes between messages that highlight the benefits (gain-framed) or disadvantages (loss-framed) of engaging or not in a school task. The appeal dimension,

based on Self-Determination Theory, categorises messages by the type of motivational appeal used by the teacher (extrinsic, introjected, identified, or intrinsic). This results in eight main categories of engaging messages, as detailed in Table 1 (see Section 1.1). Additionally, recognising that teachers often use grading and passing or failing as motivational appeals, Falcon et al. (2023) introduced a sub-category within the appeal dimension, focusing on whether the message centres on achievement aspects or not. This expansion increases the potential classifications to sixteen if this aspect is considered. By integrating these elements, engaging messages address previous limitations by considering the motivational dimension of the messages and by unifying multiple message types into a single overarching concept, thereby reducing redundancy.

1.3.1. Prior results on engaging messages

As mentioned previously, engaging messages are used when teachers are not involved in direct instruction, approximately 20% of the class time (OECD, 2019a). However, despite the limited time for their use, previous research has shown the potential impact of these messages.

For instance, Santana-Monagas, Putwain, et al. (2022) demonstrated how students' perceptions of the engaging messages used by their teachers predict their motivation to learn, a complex psychological construct that refers to the desire, drive, and persistence to engage in learning activities (Núñez et al., 2005; Vallerand et al., 1992). Specifically, greater perceived use of messages that appealed to internal motivations was associated with greater motivation to learn, which in turn predicted a higher students' performance.

Other studies indicate that students' perceptions of teachers' use of gain-framed messages appealing to internal motivations enhanced student vitality (Santana-Monagas et al., 2023). These messages foster a sense of support and acceptance from teachers,

creating a supportive environment. Then, this environment boosts students' feelings of energy, enthusiasm, and well-being as they feel more connected to their teachers and motivated by internal factors rather than external pressures.

Finally, other research focused on studying the antecedents of message use. In this context, Santana-Monagas, Núñez, et al. (2022) found that teachers' perceptions of autonomy in their workplace influenced students' perceptions of the use of messages. Specifically, the authors could identify different teacher profiles that were influenced by their perceived autonomy: one profile that mainly used gain-framed messages, one that used all types of messages, and one that used no messages at all, with students experiencing higher academic performance under teachers who used more gain-framed messages.

All this evidence justifies the choice of engaging messages as the central theme of this thesis, although there are still many unresolved questions surrounding them. For instance, the mechanism through which greater perception in the use of messages improved students' motivation to learn remained uncertain. Studying these mechanisms is important as it can lead to better-targeted interventions, and it helps adapt interventions when circumstances change (Hamaker et al., 2020; Kazdin, 2007). Additionally, while the most beneficial types of messages for students are known, much remains to be explored regarding the factors that lead teachers to use these messages. Understanding these predictors is crucial for creating interventions to encourage the use of gain-framed messages appealing to internal motivation. Finally, besides the differential effects of various types of messages, other elements, such as the acoustic characteristics of the messages, might also influence their impact and warrant further investigation.

Regarding the mechanism trough which greater perception in the use of messages improved students' motivation to learn, we found evidence suggesting that teachers'

communication is related to students' satisfaction and sentiments (Dhillon & Kaur, 2021; Goodboy et al., 2009), and that these sentiments about teaching practices are linked to their motivation (Baños et al., 2017; Hasan et al., 2013; Shen et al., 2009). Based on this finding, it is plausible to hypothesise that the mechanism through which the effect of perceived message use on motivation to learn is transmitted might be students' sentiments towards their teachers' communication.

As for the antecedents of teachers' use of engaging messages, recent studies provide some clues about possible factors that may influence it, apart from the feeling of sufficient autonomy at work. For instance, a relevant factor might be teacher enthusiasm, defined as a component of quality teaching that includes subject interest, intrinsic motivation, positive emotions, and the improvement of the teaching process (Kunter et al., 2011). Several studies have shown the impact of this variable on teaching practices used to motivate students (Kunter et al., 2008; OECD, 2019b). Additionally, studies analysing how teachers adapt their practices based on student characteristics show that students' previous performance could also influence message use (Parsons et al., 2018). Therefore, it is worth examining the predictive role of these variables in teachers' use of engaging messages.

Lastly, an acoustic feature that may be influencing the effect of the messages is emotional intensity, which is related to the activation dimension of the perceived emotion (Alonso et al., 2015). Recent studies suggest that emotional intensity may interact with attention processes, whereby information delivered with heightened emotional intensity increases salience and attention (Anikin, 2020; Arnal et al., 2019; Holz et al., 2021; Raine et al., 2019). In an educational setting, this implies that messages delivered with higher emotional intensity might be more effectively received by students. Yet, there is also evidence suggesting an inverted U-shaped effect of emotional intensity on engagement,

indicating that moderate levels may be optimal for maximizing message impact and retention (Weinstein et al., 2020). Thus, these findings raise the possibility that emotional intensity significantly influences the effectiveness of engaging messages, highlighting the need to further investigate how it affects student performance. By examining the emotional intensity of the messages, we can gain a deeper understanding of how these acoustic features influence the messages effectiveness. This knowledge could be used to inform interventions aimed at training teachers not only in message content but also in delivery techniques, ultimately improving student engagement and academic performance.

To effectively explore the factors above-mentioned that can be influencing the use and effects of teachers' engaging messages, it would be useful to employ open-ended data collection methods that go beyond traditional Likert-type scales[3]. Therefore, the following section will expand on the topic of data collection through open-ended methods and its analysis.

1.4. Gathering data with open-ended methods

Information collected through open-ended methods is essential for understanding human behaviour (Johnson & Onwuegbuzie, 2007). The methods for gathering this type of data allows subjects to express their opinions more deeply than closed data collection methods, such as Likert-type scales, which usually restrict responses to a set level of agreement or disagreement. In addition, by examining this type of data, researchers can

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[3] Instead of using the labels quantitative or qualitative, we have chosen to refer directly to the method of data collection. This approach recognises that qualitative and quantitative data exist on a continuum rather than as distinct categories (Libarkin & Kurdziel, 2002). For instance, data from even controlled experimental studies are never purely quantitative due to the context and perspective of the researcher. Conversely, even qualitative analyses often involve some quantitative elements such as counting the number of times certain words appear.

perform in-depth analysis, which fosters abductive reasoning that aids in the development of new theories, or the modification of existing ones based on tangible empirical evidence (Walker & Myrick, 2006). Data collected through open-ended methods also allows understanding contexts, exploring new phenomena, identifying new research questions, and uncovering novel change models (Kegler et al., 2019). In this way, it is possible to obtain more information that helps grounding interventions and giving voice to individuals' lived experiences (Raskind et al., 2019).

For instance, to test the role of students' sentiments towards their teachers' communication in the relation between perceived message use and motivation to learn, using a scale to gather students' sentiments is an option, but open-ended methods may be more beneficial (Leech y Onwuegbuzie, 2008). Open-ended questions allow students to express more elaborate opinions, providing data depth that fixed-response scales might overlook (Bailey, 2008). This can help reveal insights regarding students' perception of their teachers' communication that might otherwise remain undetected. Additionally, research has shown that open-ended questions in student evaluations of teaching yield valuable data for assessing teaching practices that complement those obtained through scales (Aznar-Mas et al., 2023; Cunningham & White, 2022; Marshall, 2021). This highlights the appropriateness of using open-ended questions to collect data on students' sentiments towards their teachers' communication.

Regarding the study of teachers' use of engaging messages and their antecedents, as well as the acoustic features of these messages, it would be beneficial to employ methods beyond traditional student self-reports. While self-reports provide information about students' perceptions of teachers' message use, they do not offer data on the actual use of these messages by teachers (Spooren et al., 2013; Urdan, 2004). To address this gap, using audio-recordings of lessons becomes relevant, as they allow for a more

objective and accurate analysis of the frequency and manner in which teachers use engaging messages. In turn, these direct observations also help educators better understand their actions, facilitating significant improvements in their professional development (Chen et al., 2014; Richards & Farrell, 2011; Soderberg et al., 2015).

In addition to the specific benefits of open-ended questions for studying students' sentiments and audio-recordings for examining the use and acoustic characteristics of engaging messages, the information gathered using these methods of data collection offers other advantages. Specifically, the information obtained can be analysed without the need for fieldwork, which demands more resources and time (Morgan, 2022). Additionally, this type of data allows for deferred analysis, which can be revisited and cross-verified with different coders (Hennessy et al., 2020; Vrikki et al., 2019). This flexibility allows thorough review and ensures the validity of interpretations through multiple researchers' corroboration (Pope et al., 2000), making these methods of data collection ideal for this thesis.

Despite the benefits offered by these methods, they have some limitations. The primary limitation is the labour-intensive nature of manual coding, which often requires the involvement of multiple coders when dealing with huge amounts of data, which is time-consuming and typically results in smaller sample sizes (Marshall et al., 2013). This limitation can restrict the scope of data analysis to simpler forms like descriptive analysis, thereby diminishing the depth and generalisability of research findings (Kim et al., 2017; Lennon et al., 2021). This situation highlights the need for data analysis methodologies that retain the strengths of open-ended data -such as capturing deep, spontaneous information- while also facilitating the analysis of larger sample sizes suitable for more advanced statistical analyses that allow more robust inferences to be made.

The following pages will explain the two methods that will be used to analyse the data obtained through the open-ended collection methods. These methods of analysis facilitate the examination of large volumes of responses to open-ended questions and audio-recordings of the lessons, addressing challenges posed by these data sources in gathering information on engaging messages employed by teachers.

1.4.1. Analysis of answers to open-ended questions

There are numerous ways to analyse responses to open-ended questions, with traditional methods encompassing content analysis, semiotics, comparative analysis, and keywords-in-context analysis (Leech & Onwuegbuzie, 2008). These approaches, however, can be resource-intensive and time-consuming when dealing with large datasets. Consequently, recent years have seen the adoption of natural language processing in text analysis (Kumar et al., 2020; Lytvyn et al., 2018; Yan et al., 2014).

Natural language processing is an area of machine learning that focuses on the interaction between computers and humans through language. It enables computers to understand, interpret, and generate human language in ways that are both valuable and meaningful (Agarwal, 2019). This field has led to the development of numerous tools that can perform a wide range of text processing tasks, such as semi-automatic classification, chatbots, automated report generation, and even creative writing assistance (Brown et al., 2020; Demszky et al., 2023). These tools facilitate a more optimised analysis of text, leading to significant savings in resources, time, and the ability to handle larger datasets.

Among all natural language processing applications, one of the most robust and commonly used is sentiment analysis (Zhou et al., 2020). Sentiment analysis is technique that allows the exploration of opinions, sentiments, evaluations, attitudes, moods, and emotions within texts (Liu, 2017). In educational research, sentiment analysis has been increasingly employed to analyse large datasets of student comments evaluating teaching

in higher education and massive open online courses (Geng et al., 2020; Rybinski & Kopciuszewska, 2021; Zhou et al., 2020). These studies have demonstrated that information gleaned from sentiment analysis can be valuable in assessing course impressions, improving course offerings, and evaluating teacher performance (Cunningham-Nelson et al., 2019; Leong et al., 2012; Pong-inwong & Songpan, 2019).

Despite the utility of sentiment analysis, only a few studies have used it to investigate explanatory models of students' performance (Zhou et al., 2020). Among these, Liu et al. (2018) found that positive sentiments extracted from student feedback correlated with their academic performance in online settings, proving the utility of using sentiment analysis results to enhance understanding of student experiences and outcomes. This study underlines the importance of testing the relation between sentiment scores and other educational outcomes, as the results could shed light on the behaviours of exceptional teachers and provide insights into effective educational strategies. Given these results, using sentiment analysis to automatically examine hundreds of textual responses can save us coding time, while generating a substantial dataset that can be used for advanced data analysis to enable generalisation of the results (Burić, 2015; Tseng et al., 2018).

Concerning data analysis, it is first important to clarify what kind of data is obtained when analysing information with this tool. After analysing a response to an open-ended question with sentiment analysis, researchers obtain both a sentiment label (positive, negative, or neutral) and three sentiment scores indicating the degree of each sentiment from 0 to 1 as a pseudo-probability (Hujala et al., 2020). For instance, if a student writes a positive response about their teacher's communication, the label will be "positive", and the sentiment score for the "positive" category will be close to 1, while for the rest of the categories it will be close to 0. While labels provide descriptive

information, the categorical nature of the data might limit the extent of statistical data analysis that can be performed.

Therefore, in the first study of this thesis we analysed the sentiment scores of students' responses to open-ended questions about their perceptions of their teachers' communication. After obtaining these sentiment scores, we tested a multilevel mediation model (Morin et al., 2014) to determine whether the relation found in previous studies (Santana-Monagas, Putwain, et al., 2022) between students' perception of their teacher's message use and their motivation to learn could be mediated by students' sentiment about their teacher's communication.

1.4.2. Analysis of audio-recorded lessons

Audio-recorded lessons can be analysed in several ways, including direct observation by listening to the recordings, but a more popular method is analysing their transcripts. This approach, known as transcript-based lessons analysis (Arani, 2017), involves transcribing audio-recorded lessons to examine teachers' discourse. Transcript-based lesson analysis has become a crucial tool in educational research, allowing for more efficient analysis of teachers' discourse compared to traditional methods of direct observation or listening to audio-recordings (Demszky & Hill, 2022; Winarti et al., 2021).

This methodology has been used to assess the effectiveness of instructional practice by evaluating communication patterns between teachers and students, particularly focusing on the quality of teacher-student interactions (Arani, 2017). Researchers have also utilized this methodology to analyse teaching strategies and reflect on teaching methods, enhancing educational practices, and improving the learning experience for students (Susetyarini et al., 2021). By allowing the analysis of teachers' discourse, transcript-based lesson analysis offers insights into teachers' actual practices, potentially contributing to enhance their teaching quality and the students' learning

experience. Therefore, working under this methodology to examine engaging messages seems appropriate, since it allow us to obtain a more objective measure of the message's teachers use in their classes.

The first step in transcript-based lesson analysis involves transcribing classroom discourse into text. Traditionally, this transcription has been performed manually, but this method is not optimal due to its time-consuming nature. Transcribing a single 45-minute class can take from two to four hours (Dale et al., 2022), making the analysis of large volumes of information challenging for inferential statistical analysis. Consequently, most researchers now opt for automatic transcription using automatic speech recognition systems. For instance, Demszky & Hill (2022) collected and automatically transcribed a dataset of 1660 elementary mathematics lessons to analyse discourse features based on the Classroom Assessment Scoring System (CLASS; Pianta et al., 2008). Similarly, Dale et al. (2022) used this technique to record and automatically transcribe 127 English Language Arts lessons, allowing for a more efficient analysis of teacher talk. These researchers could analyse the teachers' discourse much more efficiently than would have been possible with manual transcriptions. Therefore, in this thesis we adopted this methodology for transcribing the audio-recorded lessons.

Despite the efficiency of automatic transcription, manual coding of these transcripts is still common, where researchers may spend several hours coding information from a single class (Dale et al., 2022). A common practice for overcoming this problem is to train several research assistants for coding. This can optimise the analysis of transcripts distributing the workload among multiple individuals, potentially streamlining the transcription analysis process (Rahayu et al., 2020). However, there are inherent limitations to this method. The first one is the reliance on the availability of multiple assistants, which is not always possible. Moreover, the process can be lengthy,

and decision fatigue may compromise the quality of the analysis (Vohs et al., 2005). This highlights the need to further optimise transcript analysis to handle even larger datasets more efficiently.

In search of more efficient alternatives, the recent study conducted by Winarti et al. (2021) employed a method whereby transcripts are filtered to examine only sentences in which specific keywords appear in the teacher's discourse. This approach, known as keyword-based filtering, uses lexical rules to filter data and has demonstrated to significantly reduce the time spent in the coding process (Gómez-Hidalgo et al., 2006). The keyword-based filtering method has been effectively applied across various fields and tasks, proving useful for extracting specific information from text (Khorsi, 2007). For this reason, in addition to the automatic speech recognition system to automatically transcribe lessons we adopted the keyword-based filtering method to facilitate coding.

Therefore, in the second study of this thesis, we used an automatic speech recognition system to automatically transcribe lessons, and then employed a list of keywords commonly found in the messages and less common un the rest of the text to perform a keyword-based filtering on the transcripts to reduce their length. After coding the audio-recordings of the lessons and obtaining a count of the actual messages used, we examined whether the students' prior performance and the teachers' enthusiasm influenced the likelihood of using or not using messages, and the number of messages used. To conduct the data analysis, we employed a two-part model (Belotti et al., 2015) because they provide two sets of outcomes: the association -in probabilistic terms- between the predictors and the use of engaging messages (i.e., non-occurrence or occurrence) and the association of these predictors -via regression coefficients- with increased use of messages (i.e., the number of messages used). Using this analysis, we

were able to test the predictive role of students' prior performance and teachers' enthusiasm for teaching in their use of messages.

Lastly, by using the previous methodology for collecting direct observations of engaging messages in the audio-recordings of the lessons, we can go beyond the analysis of the textual information in the transcripts. Once the messages are coded, it is possible to extract and analyse audio clips of each message with an algorithm capable of extracting the emotional intensity of the audio, such as the Emotional Temperature Model (Alonso et al., 2015). After the analysis, this model returns an emotional intensity value for each audio clip ranging from 0 to 100. Messages that exhibit a higher emotional intensity, indicated by elevated pitch, energy, and tempo, score closer to 100 and vice versa. In this way, we can analyse whether emotional intensity plays an important role in the effect of messages on performance and motivation to learn.

Based on this, in the third study of this thesis we extracted the emotional intensity of the engaging messages and tested a moderated mediation analysis with it acting as a moderator (Muthén & Asparouhov, 2015; Valeri & VanderWeele, 2013; VanderWeele, 2015). Specifically, we examined the same mediation model verified in the study by Santana-Monagas, Putwain, et al. (2022), where students' perception of messages use predicted their performance and this relation was mediated by motivation to learn, but with some modifications. Firstly, instead of using the Teachers Engaging Messages Scale to collect data on students' perceptions of the messages used by their teachers, we used the count of the actual use of messages collected through audio-recordings. Secondly, we examined the moderating effect of emotional intensity on the relation between the messages used and the performance and between the messages used and motivation to learn. This analysis enabled us to determine whether emotional intensity acts as a moderator and, if it does, whether higher emotional intensity enhances the effectiveness

of the messages (Holz et al., 2021), or if moderate levels of emotional intensity are more effective in transmitting their impact (Weinstein et al., 2020).

1.5. Objectives

This thesis aims to deepen the understanding of the factors influencing the use and effect of engaging messages, as well as the consequences of these messages, using open-ended data collection methods. In this way, we establish the following general objectives:

1. To examine the role of students' sentiments about their teacher's communication in the relation between the perceived use of engaging messages and students' motivation to learn.

2. To analyse the role of teachers' enthusiasm and prior academic performance as predictors of engaging messages' use.

3. To investigate the role of emotional intensity in the effect of engaging messages.

To achieve these objectives, each of the studies comprising this thesis aimed to meet the following specific objectives:

- Study 1:
  - Verify the utility of sentiment analysis as a method for extracting information from student responses to open-ended questions about their teachers' communication.
  - Test the relation between students' perceptions of the use of engaging messages and their sentiments towards their teachers' communication.
  - Examine the mediating role of students' sentiments in the relation between the perceived use of engaging messages and students' motivation to learn.

- Study 2:

    o Measure the actual engaging messages used by teachers and examine how teachers' enthusiasm for teaching affects the teachers' likelihood of using them.

    o Among teachers who use messages, explore the influence of their enthusiasm for teaching on the number of engaging messages used.

    o Assess how students' prior performance affects their likelihood of using engaging messages.

    o Among teachers who use messages, examine the influence of students' prior performance on the number of engaging messages used.

- Study 3:

    o Test whether the levels of emotional intensity in teachers' engaging messages moderate the direct effect of these messages on academic performance, as well as the indirect effect through motivation to learn.

Chapter 2. How do teachers engaging messages affect students? A sentiment analysis.

*"**Las clases así son amenas**, cuando estudian y vienen aquí y preguntan dudas"*

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*"**Classes like this are enjoyable**, when you study and come here and ask*

questions"

Engaging message number 74

2.1. Study 1.

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RESEARCH ARTICLE

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How do teachers engaging messages affect students? A sentiment analysis

Samuel Falcon[1] · Jaime Leon[1]

Abstract
Gathering information from students' answers to open-ended questions helps to assess the quality of teachers' practices and its relations with students' motivation. The present study aimed to use sentiment analysis, an artificial intelligence-based tool, to examine students' responses to open-ended questions about their teacher's communication. Using the obtained sentiment scores, we studied the effect of teachers engaging messages on students' sentiment. Subsequently, we analysed the mediating role of this sentiment on the relation between teachers' messages and students' motivation to learn. Results showed that the higher the students' perceived use of engaging messages, the more positive their sentiments towards their teacher's communication. This is an important issue for future research as it shows the usefulness of sentiment analysis for studying teachers' verbal behaviours. Findings also showed that sentiment partially mediates the effect of teachers engaging messages on students' motivation to learn. This research paves the way for using sentiment analysis to better study the relations of teachers' behaviours, students' sentiments and opinions, and their outcomes.

Keywords Teaching behaviour · Teachers' messages · Students' motivation · Sentiment analysis · Mediation analysis

Introduction

Teachers can engage in a variety of classroom practices to improve the quality of their teaching and have a positive impact on students' learning and performance (Smith & Baik, 2021). Among these practices there is evidence that communication during class plays a key role, as it influences students' well-being, behaviour, engagement, academic performance, and motivation (Caldarella et al., 2020; Chickering & Gamson, 1987; Hattie, 2008; Putwain & Best, 2011; Putwain & Remedios, 2014; Putwain & Roberts, 2009; Ramsden, 2003). To date, several studies have investigated dialogue, rules, feedback, and teacher's questions to students (Brooks et al., 2019; Howe & Abedin, 2013;

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Lipnevich & Panadero, 2021). Recently, researchers have shown increased interest in the effect of teachers' messages on students' outcomes (Buma & Nyamupangedengu, 2020; Floress et al., 2018; Putwain et al., 2021). Evidence suggests that these messages influence students' academic performance, motivation to learn and anxiety (Belcher et al., 2021; Nicholson et al., 2019; Santana-Monagas, Putwain, et al., 2022). Consequently, the study of teachers' messages is a growing concern, as improving teachers' use of them could lead to learners' positive outcomes (Gregory et al., 2017).

Studying the mediators that explain the relation between variables allow researchers to focus on the transmission of effects, to find causal relationships, understood as the relationship in which a change in the independent variable causes a change in the dependent variable, and to conduct more effective interventions (Hamaker et al., 2020; Kazdin, 2007; Preacher & Kelley, 2011; VanderWeele, 2015). Although several investigations have been carried out on the association between teachers' practices, students' perceptions of those practices, and different student outcomes (Adediwura & Tayo, 2007; De Meyer et al., 2014; Geier, 2022; Haerens et al., 2015), much less is known about which variables are mediating these relations. Recent studies have established that one of the factors that students focus on most when assessing and expressing their sentiments and opinions towards teachers' practices is communication (Catano & Harvey, 2011). In turn, students' sentiments and opinions about their learning experience have been found to be related to their motivation (Hasan et al., 2013; Shen et al., 2009). Taken together, these studies support the hypothesis that students' sentiments on teachers' communication may be mediating the effect that teachers' messages have on students' motivation.

Research on the subject has been mostly restricted to self-reported measures (Nicholson et al., 2019; Putwain & Remedios, 2014; Santana-Monagas et al., 2023; Santana–Monagas, Núñez, SantanaMonagas et al., 2022a, b). However, gathering information from students' answers to open-ended helps to assess the quality of teachers' practices, students' motivation and even establishing causality (Maxwell, 2012; Stupans et al., 2016). Thanks to advances in natural language processing (Hirschberg & Manning, 2015), a considerable amount of literature has been published on the use of sentiment analysis to examine students' feedback. This artificial intelligence-based tool has been mainly used to assess learners' satisfaction with teachers or content in massive open online courses (Zhou et al., 2020). Nevertheless, few studies have analysed the relations between the sentiment, defined in this study as the positive, negative, or neutral opinion of the students, and other variables (Nimala & Jebakumar, 2021). The empirical work presented here provides one of the first investigations into the exploration of the mediating role of students' sentiments about their teachers' communication using open-ended questions that have been coded using sentiment analysis.

This study aims to contribute to this growing area of research through the following two objectives: (1) using sentiment analysis on students' responses to an open-ended question to analyse whether teachers' messages affect students' sentiment; and (2) testing the mediating role of sentiment in the effect of teachers engaging messages on students' motivation to learn. The first subsections of this paper will provide information about teachers engaging messages and students' motivation to learn; a more in-depth conceptualisation of sentiment analysis and in its use on the educational field; how to study the relations between these variables; and the research questions of the study.

Teachers engaging messages: the link to students' motivation to learn

'If you work hard, you will feel fulfilled', 'Unless you work hard, you will be disappointed with yourself'. Those are some examples of teachers engaging messages (TEM). TEM push pupils to engage in school tasks (Santana–Monagas, Putwain, et al., 2022), rather than posing questions that facilitate learning, giving them information about how they performed on a task, or instructing them. They are characterised by focusing on the positive consequences and highlighting the benefits of engaging in a task or warning the students if the task is not carried out (Rothman & Salovey, 1997). In addition, these messages also focus on different types of learners' motivation (Santana-Monagas, Núñez, et al., 2022). Teachers can appeal to external forms of motivation 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). Therefore, TEM can be contextualised following two theories: Message Framing Theory (MFT; Rothman & Salovey 1997) and Self-Determination Theory (SDT; Deci & Ryan 2016; Ryan & Deci, 2000, 2020).

Research on teachers' messages based on these theories found that messages focussed on warning the students can have positive effects on students' anxiety, behavioural engagement, and performance (Putwain et al., 2019, 2021; Putwain & Symes, 2011). Moreover, research has found that students who are internally motivated are more engaged, perform better, and acquire higher-quality learning (Taylor et al., 2014).

Prior research has established that teachers' messages are related to students' motivation to learn (MTL; Collie et al., 2019; Vansteenkiste et al., 2012). Students' MTL is a complex psychological construct that refers to the desire, drive, and persistence to engage in learning activities (Núñez et al., 2005; Vallerand et al., 1992). One perspective that has been used to study MTL is also SDT, which suggests that students' MTL can be classified as intrinsic (i.e., sign of competence and self-determination), extrinsic (i.e., participation in an activity to obtain rewards or avoid punishments), or amotivated (i.e., lack of interest or engagement), depending on the level of self-determination and autonomy involved.

Teachers can use different messages to appeal to and influence students' MTL, for example, when they ask students to study to make their parents proud, appealing to an introjected motivation (Deci & Ryan, 2016). Up to now, studies that explored the impact of TEM on students' MTL have found that TEM predicted students' MTL, and this, in turn, predicted students' performance (Santana-Monagas, Putwain, et al., 2022). These findings made an important contribution to establishing the importance of teachers' messages, as they impact motivation, which plays a fundamental role in students' lives (Ryan & Deci, 2017). When students are motivated, they do not only change their behaviour, but there are also benefits in other essential aspects of their lives (Behzadnia et al., 2018; Liu et al., 2017; Marshik et al., 2017; Oostdam et al., 2019). Consequently, improving students' MTL through effective interventions focused on enhancing the use of TEM is a potential need that could be realised.

To design effective interventions, it is important to detect the variables that mediate the relations between the independent and the dependent variables. Knowledge of mediators helps to achieve the expected results after the causes modification, especially when contexts vary (Preacher & Kelley, 2011). When it comes to selecting the mediating variables, Hamarker et al. (2020) recommend a theory-based approach. We have therefore decided to rely on the aforementioned MFT and SDT, since they indicate that students' motivation depends on how they feel, which is also determined by their environment.

Several studies have shown associations between teachers' practices, students' perceptions and opinions with these practices, and different outcomes (Adediwura & Tayo, 2007; Behzadnia et al., 2018; De Meyer et al., 2014; Haerens et al., 2015), yet little attention has been paid to the mediating role that one of them may be playing. Many recent studies have shown that teachers' communication is related to students' satisfaction and sentiments (Dhillon & Kaur, 2021; Goodboy et al., 2009). In an analysis to determine which teachers' dimensions are most highly valued by students, Catano and Harvey (2011) found that communication is one of the competences that students focus on the most. In turn, research on students' motivation show the impact of their satisfaction and sentiments towards the teacher and the learning experience (Baños et al., 2017; Shen et al., 2009). For instance, the study conducted by Hasan et al. (2013) concluded that students' satisfaction with teachers' performance was among the strongest predictors of students' motivation. The evidence presented in this section suggests that students' sentiment about how their teachers communicate could be an intervening variable that may account for the relation between TEM and students' MTL.

Previous research measuring these variables are limited to the use of self-reports as the method of data collection. Questionnaires allow for quick and accessible measurements (Robins et al., 2007), but they have limitations or may be biased (Álvarez–Álvarez et al., 2019; Putwain & Roberts, 2009). Likert scale questions are restricted to a predefined set of options, which may not fully capture the range of students' opinions and sentiments (Bielick, 2017; Joshi et al., 2015). For example, students may not fully agree or disagree with a statement, but instead have a more nuanced opinion that cannot be captured by a simple one to five or to seven option answer. Recently, a considerable amount of literature has emerged around the use of mixed methods of data collection because they allow researchers to gain a greater understanding of the problem studied (Greene, 2005; Molina–Azorin, 2016). However, much of the research that has been carried out until now has been limited due to the complexity of analysing and coding the data collected through open methods (Rodgers & Cowles, 1993; Walker, 1989).

Nowadays, advances in the field of natural language processing have made possible to easily and reliably carry out the analysis and coding of the information gathered (Hirschberg & Manning, 2015). One example of these advances is sentiment analysis, a tool widely used to study satisfaction and opinions through the analysis of responses to open-ended questions or comments (Feldman, 2013). Sentiment analysis enables the analysis of a vast amount of text data from answers to open-ended questions, which allows for a more detailed and nuanced understanding of students' opinions and sentiments. Additionally, the analysis of a large amount of data allows the identification of patterns and trends that are not easily apparent through manual analysis, which can provide insights that would have been missed with traditional methods. Prior studies have already used this tool for students' evaluation of teaching, proving its usefulness (Rybinski & Kopciuszewska, 2021). This study follows this approach and uses sentiment analysis to obtain information about students' opinions and sentiments about their teachers' communication.

The potential of sentiment analysis in education

Sentiment analysis (SA) is an artificial intelligence-based tool used to extract sentiment, referred to the positive, negative, or neutral emotional state or opinion that a person expresses towards a particular subject, from large amounts of text (Rani & Kumar, 2017). To date, it is already integrated into many applications such as chatbots or transcription

services (Solangi et al., 2018). SA is also widely used to monitor users' opinions and sentiments about products, as it allows companies to select which products are worth investing in (Feldman, 2013). There are three main methods for using SA: creating and training your own model (Kang et al., 2018), fine-tuning a pre-trained one (Rybinski & Kopciuszewska, 2021), or using a non-fine-tuned pre-trained model (Andersson et al., 2018). Each method involves a certain amount of time for creation and training, and different reliabilities (Kagklis et al., 2015). The first two lead to reliable results in terms of Cohen's Kappa, Fleiss' Kappa, and average pairwise percent agreement (Lin et al., 2019). Unfortunately, these methods come with some drawbacks: part of the data is used to train the model and then it cannot be used in analyses; results are not replicable; and they require time to be created and trained. Although smaller reliability values are obtained, non-fine-tuned pre-trained models can also be used. For instance, Andersson et al. (2018) used this type of model, and they were able to compare the average hours of study outside the class and the sentiment of student feedback, founding a moderate negative correlation between them. They concluded that, although it would have been more reliable to train a model, this method was less time-consuming. Thereby, the most useful option for applied researchers interested in the analysis of relations between sentiment and other variables seems to be non-fine-tuned pre-trained models. Additionally, when analysing the sentiment polarity, results can be the sentiment labels (positive, negative, or neutral), or the score of belonging to each sentiment (Hujala et al., 2020; Nimala & Jebakumar, 2021). Based on the aim of this study, analysing sentiment polarity scores of students' responses can be a good way to examine their sentiments and its relations with other variables.

So far, several studies have investigated the use of SA in education. They have mainly dealt with students' evaluation of teaching in higher education and massive open online courses (Geng et al., 2020; Rybinski & Kopciuszewska, 2021; Zhou et al., 2020). Prior research suggest that information obtained with SA is helpful in examining the impression of the courses (Cunningham-Nelson et al., 2019), improving the courses (Leong et al., 2012), and evaluating the teachers (Pong-inwong & Songpan, 2019). Nevertheless, few studies have ventured to use SA as a method of data collection when the goal is to test an explanatory model of achievement and performance (Nimala & Jebakumar, 2021). Among these, Liu et al. (2018) found relations between the positive sentiments extracted from students' feedback and their academic performance in online courses. As noted by Burić et al. (2016) it is necessary to test explanatory models, as the results could be used to explain the behaviour of outstanding teachers (Tseng et al., 2018). The evidence reviewed here seems to suggest the pertinence of using SA to analyse students' sentiments on their teachers' communication using an open-ended question. By doing so, we can test whether teachers' messages influence students' sentiment, and then examine the mediating effect of the sentiment polarity scores on the impact of TEM on students' MTL. Following Zhou et al. (2020) advice, this work will provide new insights into the relations between sentiment, teacher behaviours and students' outcomes.

TEM, students' sentiment, and MTL: a multilevel analysis

The type of design and data analysis must be considered when trying to understand the effect of TEM on students' MTL and the mediating role of the students' sentiment. A teacher may use different messages with each student, thus, each learner report differently on the engaging messages used by their teacher. However, this variable does not assess a characteristic of the student but that of the teacher. For studying these kinds of variables,

it is necessary to follow a multilevel approach, in which a variable can be situated at two levels (Marsh et al., 2012; Morin et al., 2014). At the teachers' level (L2) we would find the overall tendency of teachers' use of TEM, which would allow us to test whether TEM affect the average classroom sentiment. At the students' level (L1) we would find TEM, students' sentiments and their MTL, thus enabling us to examine the mediating role of sentiments in the impact of TEM on MTL. Consequently, the methodological approach adopted in this study is a multilevel analysis since this is the most appropriate way to analyse the data.

Research questions

This research proposed the following research questions:

RQ1   Is sentiment analysis a useful tool for assessing teachers' verbal behaviours in the educational context?
RQ2   Do teachers engaging messages affect students' sentiment about their teachers' communication?
RQ3   Does students' sentiment mediate the effect of teachers engaging messages on students' motivation to learn?

Materials and methods

Participants

A total of 39 teachers (22 females and 17 males; mean age = 45.98, $SD = 7.99$) and their 963 students (468 females, 494 males and 1 unspecified; mean age = 16.39, $SD = 1.27$) participated in the study. They belonged to 16 secondary schools in both urban and rural settings of Gran Canaria, Tenerife, and Santander (Spain). To reduce potential bias, all participating teachers taught mathematics, and all students attended the same number of hours per week.

Procedure

Data collection took place in the first and second trimesters of the school year. Although the results pertain to data from the second term, measures of students' MTL from the first term were taken to control for their MTL in the second term. The aims of the study were explained to teachers and students, emphasising that their participation was voluntary and confidential. Variables were evaluated by using two questionnaires provided through Google Forms and conducted in the classroom under the teacher's supervision.

Instruments

Teachers engaging messages

Teachers engaging messages were assessed through the Teachers' Engaging Messages Scale (Santana-Monagas, Putwain, et al., 2022; Appendix A). The scale contains a total

of 36 items preceded by the phrase '*My teacher tells me that…*'. An example of an item to which students were asked to respond was, '*My teacher tells me that…If I work hard, I will feel important*'. Using a 7-point Likert scale, students were asked to report on their teacher's use of TEM. A 7 indicates that students strongly agree with the fact that their teacher uses a considerable amount of these messages, while a 1 indicates the opposite. In this study, we only selected the items from the subscale of introjected messages focused on the benefits of engaging in tasks. McDonald's Omega was used to examine the reliability of the instrument; it is more accurate than Cronbach's alpha (McNeish, 2018). McDonald's Omega was estimated using factor loadings from a congeneric CFA for each variable. The reliability and validity of this scale have been confirmed, with values of McDonald's Omega above 0.81 for each factor. In the present study, McDonald's Omega was 0.91 for the factor analysed.

Students' motivation to learn

Motivation to learn was measured using the Spanish version of the *Échelle de Motivation en Éducation* (Núñez et al., 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 make me feel important*' 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). We selected the items from the subscale of introjected motivation. McDonald's Omega was also used to examine the reliability of the instrument, and it was estimated using factor loadings from a congeneric CFA for each variable. In this case, McDonald's Omega was 0.89 for the first term items and 0.88 for the second term items.

Students' sentiment

Following previous studies that ask questions to examine specific elements with SA (Hynninen et al., 2019), and that have provided guidance on crafting effective open-ended questions (Bielick, 2017; Shilo, 2015), we took great care in creating an open-ended question that was not ambiguous and minimized the potential for bias in students' chances to give a Yes/No or a brief answer. The question, which was asked at the beginning of the Teachers' Engaging Messages Scale, was: '*If you had to tell a classmate how your teacher talks to you, what would you say?*'. To ensure the question was suitably framed, we also consulted with experts in the field and considered the potential sources of bias in the question (lack of specificity, social desirability bias, etc.).

We decided to use the pre-trained model provided by Microsoft (2022) to perform sentiment analysis in our study. The model uses a combination of n-gram and word embeddings features as classification techniques to analyse text data. It has been pre-trained on a large dataset of text data, and it uses natural language processing techniques, such as tokenization, to extract features from text data. This technique breaks down the text into smaller units called tokens, and then use mathematical algorithms to understand the context and meaning of the text and classify it into different sentiments.

To use the service, we created an executable file using the API key provided by Microsoft. The input was an Excel worksheet with one column containing all the students' answers to the open-ended question. After analysing the data, it returns another Excel worksheet with the original column plus a sentiment label (i.e., positive, negative, and neutral), and a numeric sentiment score between 0 and 1, where sentiment

scores closer to 1 represents highly positive comments and scores closer to 0 represent highly negative comments. We analysed a total of 6072 words, with no cost because this amount of data is sufficiently small for Microsoft to not charge any cost. The time taken to analyse that amount of data was approximately 10 min, which is much less time-consuming than coding the data by hand.

Once the data were analysed, it was first necessary to test the reliability of the SA model. To determine it, two researchers independently classified the messages according to the sentiment label. We then compared their results with the Microsoft's model results and examined the inter-annotator agreement by calculating the average pairwise percent agreement, the Fleiss' Kappa, and the Cohen's Kappa coefficient using ReCal3: Reliability Calculator for 3 or more annotators (Freelon, 2010). Results showed an average pairwise percent agreement of 80%, which is quite satisfactory. The value observed for the average pairwise Cohen's Kappa was 0.51 and for the Fleiss' Kappa was 0.50, which are moderately good results (Fleiss, 1971; Landis & Koch, 1977).

Data analysis

All data analyses were conducted with Mplus 8.6 (Muthén & Muthén, 2021). The mean, standard deviation and correlations among variables were carried out before analysing the statistical models.

To determine the relations between variables at the two different levels, we used a multilevel structural equation model (ML-SEM) approach (Morin et al., 2014). This model helps us control for measurement error at the students' and teachers' levels and for sampling error by aggregating individual students' responses to represent teacher's level constructs. As it was previously mentioned, when performing a ML-SEM, students' responses from teachers' related questions can be aggregated to serve as a measure of the teachers' tendency. For gathering evidence that a variable pertains to the teachers' level, we expect students' responses about one teacher to be similar. Following Lüdtke et al. (2009) recommendations, we decided to use the intraclass correlation coefficient (ICC) to inform about the similarity observed across student ratings of TEM and sentiment. The multilevel analysis was carried out using the following variables: TEM, students' sentiment, and students' MTL at students' level (L1); and TEM and students' sentiments at teachers' level (L2).

We conducted an analysis of mediation at L1 to test if students' sentiments mediated the relation between TEM and students' MTL. To establish whether the mediation effect was full or partial (Morin et al., 2014), we tested two alternative models. L2 of both models was the same: TEM predicted students' sentiments about their teacher's communication. At level 1, when introducing the variable students' MTL, relations changed between the models. In the first one (Fig. 1), TEM effects on students' MTL were postulated to be fully mediated by the students' sentiment. In the second model (Fig. 2), these effects were partially mediated by the student's sentiment.

To search for evidence of mediation, we compared both models using a χ^2 test and fit indexes (Morin et al., 2014). If there were no differences between both models, we would hold the most parsimonious result. Finally, we calculated the indirect effect and standard error using the delta method (Sobel, 1982).
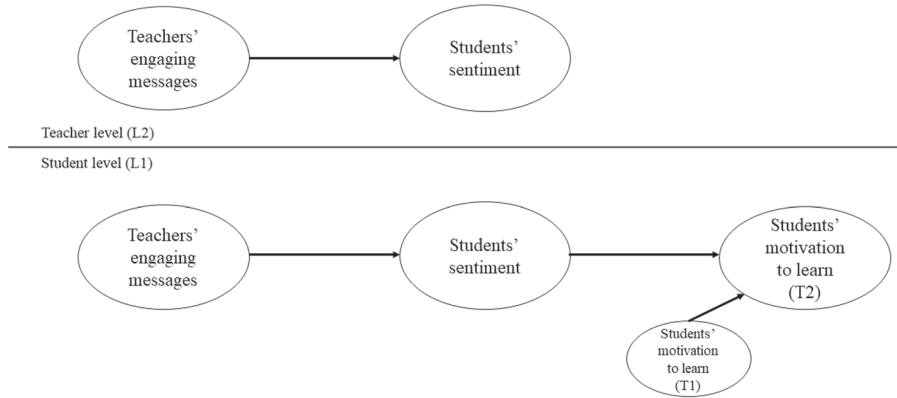
Fig. 1 Full mediation model
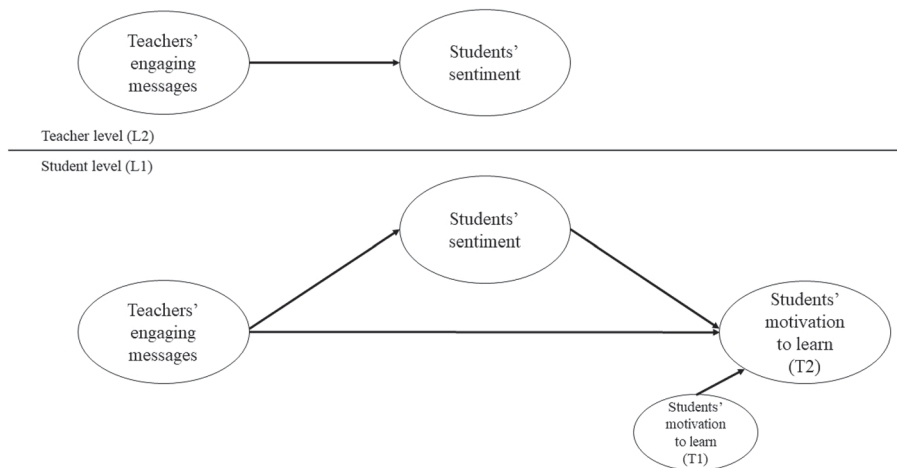
Fig. 2 Partial mediation model

Results

Table 1 shows relevant examples of the results obtained after analysing the students' answers with sentiment analysis:

Answers 1 and 6 are elaborated and well classified. In answer 2, although there is a spelling mistake, the model could successfully classify it. Responses 3 and 7 are examples of sentences that convey two things in the same message, which can be well appreciated in the score of number 3 (neutral score). Answers 4 and 5 are poorly elaborated feedback, which could sometimes be misinterpreted (9.42%). Finally, response 8 denotes other factors of teachers' communication not covered in this study (4.90%).

Table 1 Examples of sentiment analysis results after analysing the students' answers

Student's answers	Sentiment score
1. She knows how to explain herself, is clear and makes everything easier for you	.68
2. She *speks* very well	.87
3. He explains well but sends us a lot of exercises and worksheets	.48
4. She talks calmly	.73
5. My teacher talks fluid	.35
6. She talks well, respectfully and she is understood in class	.70
7. You understand things well, but sometimes you get disconnected from the class because he gets too involved	.28
8. My teacher talks in a vocabulary that is easy and adapted for us to understand	.66

The above answers are some of the most representative examples answered by students.

Preliminary analyses

Descriptive statistics (mean, *SD*, and ICC) of TEM, students' sentiment, and students' MTL are represented in Table 2. ICC values observed for the sentiment (0.07) and the teachers' engaging messages (0.06) were acceptable (Marsh et al., 2008).

Bivariate correlations between sentiment, TEM, and students' MTL are displayed in Table 3. All variables were positively and significantly correlated at level 1 (below the diagonal). However, at level 2 (above the diagonal), only sentiment and TEM, and these with students' MTL, were significantly correlated, showing a positive correlation.

Multilevel mediation analysis

Fit indices comparison of the full and partial mediation models is displayed in the table below (Table 4).

Table 2 Descriptive Statistics and Intraclass Correlations of Variables

	M	SD	ICC
Sentiment	.56	.07	.07
TEM	4.03	.40	.06
MTL	4.43	.45	–

M Mean, *SD* Standard deviation, *ICC* Intraclass correlation coefficient, *TEM* teachers' engaging messages, *MTL* students' motivation to learn

Table 3 Bivariate Correlations Among Variables

	1	2	3
Sentiment	–	0.56***	0.22
TEM	0.15***	–	0.45**
MTL	0.15***	0.49***	–

*$p < .05$. ** $p < .01$. *** $p < .001$; $N = 963$ (below diagonal), $N = 61$ (above diagonal), *TEM* teachers' engaging messages, *MTL* students' motivation to learn

Comparisons of these two models in terms of fits favours the partial mediation model in all aspects. Adding partial mediation resulted in a decrease in information criteria values: AIC (Akaike, 1974) and BIC (Schwarz, 1978) were lower in the partial mediation model (4295.33 and 4339.18) than in the full mediation model (4353.97 and 4393.44). RMSEA value in full mediation model (0.25) indicates that this model's fit is too poor as it is higher than 0.10 (Browne & Cudeck, 1992), while partial mediation model takes a value of 0.10, which indicates a much better fit than the first one. When comparing CFI and TLI, the full mediation model has values too low to be considered good or acceptable for both indices, while the partial mediation model has values considered good for both as they are above 0.90 (Bentler & Bonett, 1980; Schreiber et al., 2006). We observed that the SRMR at the students' level of the full mediation model is higher than 0.08. In contrast, in the partial mediation model, for both the students' and teachers' levels, the SRMR takes values below 0.08, indicating an approximate fit (Asparouhov & Muthén, 2018). These results suggest that the best fitting ML-SEM model is the partial mediation model, as it provided an adequate representation of relations among the variables (Morin et al., 2014).

After comparing fit indices of both models and observing that the partial mediation model fitted better, its results were examined (Table 5).

As shown in Table 5, all hypothesised relations (see Fig. 2) were significant in both levels 1 and 2. In general terms, it can be observed that TEM predict students' sentiment well, especially at level 2, where the β takes values of 0.95. At level 1, all relations were also positive, with the strongest relationship between TEM and students' MTL ($\beta = 0.28$). The standardised indirect effect between TEM and students' MTL was significantly different from 0 ($\beta = 0.012$; S.E. $= 0.006$; $p = .041$).

Discussion

The present study aimed to prove that sentiment analysis is a useful tool for assessing teachers' verbal behaviour in the educational context (RQ1), and to use it for studying the relations between students' sentiments and teachers engaging messages (RQ2) as well as the mediating role of students' sentiment in the effect of TEM on students' motivation to learn (RQ3). Firstly, the reliability of the model used was analysed and it was found to be moderately good. With respect to the first research question, we have provided evidence of the utility of the SA to measure students' sentiments about their teacher's communication. Specifically, we found that SA can accurately capture the positive, negative, and neutral opinions of students about their teacher's communication, and this information can be used to improve the quality of teachers' practices and enhance students' motivation to learn.

Regarding RQ2 and RQ3, it was discovered that when teachers rely on more engaging messages, students manifest more positive sentiments when asked about their teacher's communication. In addition, we found that sentiment partially mediates the effect of TEM on students' MTL. The following sections will discuss these results.

The role of students' sentiment in engaging messages and motivation to learn

An initial objective of the study was to examine the relations of TEM, students' sentiment, and students' MTL, for which we compared two models (Morin et al., 2014). Answering the RQ2, model results showed that student sentiment is strongly influenced by teachers' use of TEM ($\beta = 0.95$). We found that the higher the students' perceived use of TEM, the

Table 4 Model Fit Indices for the ML-SEMs

Mediational model	χ^2			AIC	BIC	RMSEA	CFI	TLI	SRMR (Within)	SRMR (Between)
	Parameters	Value	p							
Full	9	75.77	.00	4353.97	4393.44	.25	.80	.40	.08	.00
Partial	10	6.57	.01	4295.33	4339.18	.10	.99	.91	.02	.01

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Table 5 Partial mediation model ML-SEM results

	Level	Estimate (β)	S.E.	p
TEM ➔ sentiment	2	.95	.26	.00
	1	.16	.04	.00
sentiment ➔ MTL	1	.07	.03	.03
TEM ➔ MTL	1	.28	.04	.00

Standardized results; *SE* Standard error, *TEM* teachers' engaging messages, *MTL* students' motivation to learn.

more positive their sentiments towards their teacher's communication. This finding broadly supports the work of prior studies in SA linking students' sentiment with students' evaluation of teachers' performance and behaviours (Nimala & Jebakumar, 2021; Pong-inwong & Songpan, 2019; Sindhu et al., 2019; Tseng et al., 2018). Our findings support the idea that valuable information can also be gathered from students' feedback from open-ended questions to gain insights into teacher behaviours and performance using AI-based tools.

The RQ3 sought to determine whether students' sentiment was mediating the effect of TEM on students' MTL. Results indicated that the best fitting model was the one in which sentiment acted as a partial mediator (Fig. 2). We observed that both paths, from TEM to students' sentiments and from sentiments to students' MTL, were in line with our hypotheses, providing evidence of mediation. As the direct path from TEM to the students' MTL is strong we cannot rule out other possible mediators, thus our results do not provide evidence of a total mediation, but only partially (MacKinnon et al., 2007). This finding was unexpected and suggests that sentiment is not the only option to focus on when developing interventions that seek to improve students' MTL. Actually, this reinforces the idea that motivation is a complex psychological construct and can have a variety of causes (Judd & Kenny, 1981). The findings of this study are, however, significant in at least two major respects: we have provided evidence of the utility of the SA to measure students' sentiments about their teacher's communication; and we have proved that this variable is relevant to study relations between teacher and student variables.

Limitations and future perspectives

Despite the contributions of this study, some limitations need to be addressed. First, the sentiment classification reliability was found to be moderate. One possible explanation for these results is the simplicity of students' answers. Due to the fact that the SA model has not been specifically trained for the educational model, it sometimes interpreted simple responses incorrectly. Similarly, sarcastic, and metaphorical responses to the questions were not correctly assessed by the model. However, researchers were able to understand the context of these responses and they classified them correctly. In this study, we have established that the use of non-fine-tuned pre-trained models, despite having lower reliability values than more complex models, has some important advantages: they are more accessible, and they also save time. Future studies using this type of model, however, could take some actions to increase the reliability of SA. Among these is to pay attention to how open-ended questions are formulated to prevent students from writing too simple, sarcastic, or metaphorical responses. We must also pay special attention to potential bias in students' feedback when analysing its relations with other variables. Other researchers cited potential bias towards the positive evaluation of teaching (Alhija & Fresko, 2009;

Cunningham-Nelson et al., 2019; Sengkey et al., 2019), which is also seen when applying sentiment analysis (Hynninen et al., 2020).

There is abundant room for further progress in determining the mediators that influence the relations between TEM and MTL. It is possible to consider the students' MTL as the mediator between TEM and the students' sentiment (Bronstein et al., 2005; Morin et al., 2014). Contrary to our cross-sectional study, a longitudinal study could help examine the directions of the relations (Arens et al., 2015). Further research is also needed to explore other partial mediators when examining teachers' behaviours and students' motivation (Kunter et al., 2007; Moran, 2023). The possibility of moderators influencing the strength and shape of the mediated effect should be considered as well (MacKinnon et al., 2007). In this regard, Zhou & Ye, (2020) recommend investigating the role and impact of demographic variables (gender, age, group, academic background, etc.) on students' emotions and performance using SA.

Lastly, when students assess their teachers' engaging messages, they are informing about their perceptions, and the indirect nature of the data can lead to potential bias. When using students' reports to assess a classroom characteristic (e.g., teachers' verbal behaviours), it is recommended to combine the indirect data with objective observational data (Urdan, 2004). For this reason, future studies can incorporate direct observations inside the classroom to measure teachers' engaging messages (Falcon et al., 2023).

Conclusions

The present study performed a sentiment analysis on students' responses to open-ended questions about their teacher's communication. We then examined if teachers engaging messages affected students' sentiment and the mediating role of this sentiment in the relation between teachers' messages and students' motivation to learn. Results showed that sentiment analysis is a useful tool for measuring students' opinions and sentiments towards a teacher verbal behaviour, particularly engaging messages. We also found that students' sentiment of their teacher's communication was strongly influenced by teachers' use of engaging messages. Specifically, we found that the higher the students' perceived use of engaging messages, the more positive their sentiments towards their teacher's communication ($\beta = 0.95$). Another major finding was that sentiment partially mediates the effect of teachers' engaging messages on students' motivation to learn. We observed that both paths, direct and indirect, were in line with our hypotheses, providing evidence of mediation, but as the direct path from engaging messages to the motivation to learn was strong ($\beta = 0.28$), we could not rule out other possible mediators. These findings open the path to the usage of sentiment analysis to study the relations of the students' sentiment and their outcomes. The findings will also be of interest to design interventions focused on improving teachers' use of engaging messages. Improving teachers' comprehension and perception of their engaging messages could lead to great progress in students' outcomes, such as their feedbacks' sentiments and motivation to learn.

Appendix

See Table 6

Table 6 Teachers' engaging messages scale

Focus	Motivation	Item
		My teacher tells me that if I work hard…
Positive effects	Intrinsic	1. I will enjoy this subject
		2. I will appreciate new discoveries
		3. I will learn interesting facts
		4. I will have fun doing class work
	Identified	5. I will be able to choose what to study
		6. I will be prepared for high-qualified jobs
		7. I will be able to work on what I would like
		8. I will be prepared for my future studies
	Introjected	9. I will feel important
		10. I will feel proud of myself
		11. I will feel satisfied
		12. I will feel appreciated
	Extrinsic	13. I will have free time
		14. I will receive a reward (sticker, star, etc.)
		15. I will be able to do in class the activities I want
		16. I will receive compliments
		My teacher tells me that unless I work hard …
Negative effects	Intrinsic	17. I will miss the opportunity to understand interesting issues
		18. I will miss the beauty of this subject
		19. I will miss the joy of finishing exercises
		20. I will miss the opportunity to increase my knowledge
	Identified	21. I will not get anywhere in life
		22. I will only be able to get low paid jobs
		23. I will have a tough life
		24. I will have to study the less demanded degrees
	Introjected	25. I will feel like a failure
		26. I will feel disappointed
		27. I will feel sad
		28. I will feel ashamed
	Extrinsic	29. I will get in trouble
		30. I will be punished
		31. I will miss my break
		32. I will get my parents angry
		My teacher tells me that it does not matter if…
	Amotivation	33. I work hard, I will fail anyway
		34. I come to class, I will fail anyway
		35. I do the homework, I will fail anyway
		36. I pay attention in class, I will fail anyway

Declarations

Conflict of interest The authors have no relevant financial or non-financial interests to disclose.

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Chapter 3. Teachers' engaging messages and the relationship with students' performance and teachers' enthusiasm.

*"Ustedes no van a aprender, pues no aprendan, **que sepan que se lo están perdiendo**"*

*"You are not going to learn, so don't learn, **know that you are missing out**"*

Engaging message number 640

3.1. Study 2.

Teachers' engaging messages and the relationship with students' performance and teachers' enthusiasm

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ABSTRACT

The current study examined the relation of students' performance and teachers' enthusiasm with teachers' use of engaging messages in class. These messages can focus on the benefits or disadvantages of engaging in a school task, and appeal to controlled (i.e., extrinsic, or introjected) or autonomous (i.e., identified, or intrinsic) incentives to engage students. Engaging messages were gathered through audio-recorded lessons of 39 teachers in 59 student groups during the second term of the academic year. Results showed that both students' performance and teachers' enthusiasm are related to teacher's use of engaging messages. The better the students' performance, and the higher the teachers' enthusiasm, the larger the number of messages used. Moreover, the better the students' performance, the greater the likelihood of using messages that appeal to extrinsic incentives. By assessing engaging messages through objective observations, we discovered relationships that can help us better understand teachers' use of engaging message.

1. Introduction

Teachers and students' interactions are a major area of interest within the field of educational research (Harper, 2018; Vandenbroucke et al., 2018). Interactions have been found to be a major component of teachers' well-being and influence (Spilt et al., 2011; Wubbels & Brekelmans, 2005). In addition, they play a key role in student learning and engagement (Nguyen et al., 2018; Perry et al., 2002). Among the practices that teachers can develop during these interactions, communication is central (Chickering & Gamson, 1987; Ramsden, 2003).

The last decades have seen a growing trend towards the study of this wide topic that encompasses dialogue, teacher's questions to students, and teachers' messages (Howe & Abedin, 2013). The latter is an increasingly studied area in teacher communication: evidence has shown that teachers' messages influence students' engagement, anxiety, and behaviour (Caldarella et al., 2020; Floress et al., 2018; Jenkins et al., 2015; Ntoumanis et al., 2017; Putwain et al., 2021; Symes & Putwain, 2016). However, these studies often focus on different dimensions of messages. While some examine the consequences of engaging or not engaging expressed in the messages (e.g., threats, praise, etc.), others focus on the motivation that the messages appeal to (e.g., value-promoting messages, etc.). In this context and following

Gigerenzer's (2017) recommendations on the integration of different theories, teachers' engaging messages emerged as a term that encompasses different types of value-promoting messages (Santana-Monagas et al., 2022). Engaging messages are those explicitly directed towards students with the purpose to engage them in their school tasks. These messages are characterised by emphasising the benefits or the disadvantages of engaging or not in a school task, and by appealing to different motivational incentives to engage students. These are delivered when teachers are not engaged in pure instruction, which is usually 20–30% of the lesson time (OECD, 2019a). However, these have been found to influence students in several ways. Using messages that emphasise the benefits, instead of the disadvantages, and that appeal to internal motivational incentives, instead of external incentives, have a positive impact on students' learning, vitality, motivation to learn and performance (Santana-Monagas et al., 2023; Santana-Monagas et al., 2022).

Prior research has also examined why teachers use different types of engaging messages with their students, concluding that autonomy for teaching fulfilment plays an important role (Santana-Monagas, Núñez, et al., 2022). However, these studies have two major limitations: (1) they assess teachers' engaging messages only through students' reports, which can lead to potential bias (Spooren et al., 2013; Urdan, 2004); and

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(2) they have only focused on autonomy, without considering other variables, whether external or internal, that may influence teachers' use of messages (Collie & Martin, 2017; Granziera et al., 2019). In this research, we aim to address these two limitations by (1) collecting direct observations of teachers' messages through audio recordings and (2) studying the relation of students' performance and teachers' enthusiasm with their use of engaging messages, both of which have been found to influence teachers' behaviour (Keller et al., 2016; Parsons et al., 2018). This study aims to contribute to this growing area of research by applying an optimised direct collection method to the study of teachers' verbal practice. Furthermore, it explores the antecedents that might play a role in teachers' use of engaging messages.

1.1. Teachers' engaging messages

Engaging messages are a term for different types of value-promoting messages that teachers use to engage students in their school tasks (Santana-Monagas et al., 2022). They emerged as the result of the integration of two major theories: the Message Framing Theory (MFT; Rothman & Salovey, 1997), and the Self-Determination Theory (SDT; Deci & Ryan, 2016; Ryan & Deci, 2000b, 2020). The aim of engaging messages is to encompass these two theories in order to better understand how teachers engage learners.

The MFT focuses on messages' frame, which emphasises the benefits of doing an activity (*gain-framed*) or the disadvantages of not doing it (*loss-framed*). Research on teachers' messages based on this theory found that *loss-framed* messages can have positive effects on students' anxiety, behavioural engagement, and performance (Putwain et al., 2019; Putwain & Symes, 2011; Putwain, Symes, & Wilkinson, 2017). The SDT focuses on the different types of motivational incentives that drive people to engage in activities. For instance, teachers can appeal to external forms of motivation like rewards and punishments (i.e., *extrinsic* motivation) or feelings (i.e., *introjected* motivations), or to internal forms like the value of studies (i.e., *identified* motivation) or the pleasure of engaging (i.e., *intrinsic* motivations). Research on SDT has found that students who are internally motivated are more involved, perform better, and acquire higher quality learning (Taylor et al., 2014; Yamauchi & Tanaka, 1998). Under the umbrella of these theories, prior studies (Santana-Monagas et al., 2022) have conceptualized engaging messages in the following two dimensions: a '*frame*' and an '*appeal*' (Fig. 1).

Previous studies have shown that teachers, regardless of the motivation they are appealing to, tend to emphasise the importance of achievement (i.e., GPA, grade retention, etc.) to engage students (Boden et al., 2020; Dufaux, 2012; Faubert, 2009; Ryan & Brown, 2005; Ryan & Deci, 2000a). 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 to 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). 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. However, in the school context, passing a subject or getting a good grade can be a potential goal that students are typically expected to identify with, because their future learning goals depend on it (Lim & Chapman, 2012). Thus, a message that appeals to external motivations, but emphasises achievement, may also have a different effect than a typical one. 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: *gain*- and *loss-framed* both combined with one of the four *appeal* dimensions described in Fig. 1 and their four subcategories focused on *achievement*.

1.2. Previous studies on engaging messages

Research on teachers' engaging messages has shown that *gain-framed identified* and *gain-framed intrinsic* messages predict students' performance positively via their motivation to learn (Santana-Monagas et al., 2022). When teachers rely on messages that emphasise the benefits of engaging, appealing to what students can benefit from their studies and how much they can enjoy it, students become more motivated to learn. These authors also found the opposite, showing that loss-framed messages appealing to external motives had a negative influence on performance, corroborating the study by Putwain and Remedios (2014) on teachers' messages. In addition, Santana-Monagas et al. (2023) also found that *gain-framed identified* and *intrinsic* messages were related positively to teacher-student relatedness and students' vitality. Given these results, another study set out to determine why teachers used one type of message or another, showing that the teachers' autonomy for teaching fulfilment was related to the messages used (Santana-Monagas, Núñez, et al., 2022).

Such previous approaches, however, have only assessed teachers' engaging messages through students' reports, which can be biased when assessing teachers' use of messages (Putwain & Roberts, 2009). For instance, students' success, class attendance, or effort, and teachers'
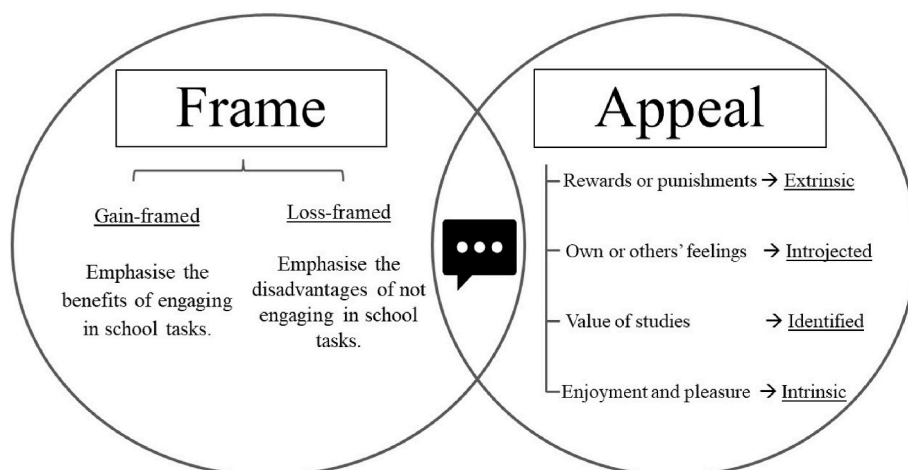
Fig. 1. Dimensions of teachers' engaging messages.

gender, reputation, or personal traits, might influence students' evaluation of the teacher (Spooren et al., 2013). Methodological research recommends the use of objective observational data to examine teacher behaviour in class (Muñoz et al., 2023; Tempelaar et al., 2020; Urdan, 2004).

1.3. Influence of students' performance

Teachers' behaviour and practices influence students' interest, engagement, learning, and academic performance (Smith & Baik, 2021; Vercellotti, 2018). However, much less is known about why teachers choose to adopt one type of practice over another. Research has found that teachers adapt their teaching based on characteristics and performance of their students (Parsons & Vaughn, 2016). For example, teachers have an ability to adapt their teaching practices with new students in a new school year, adjusting their practices to the learning needs of students (Granziera et al., 2019; Loughland & Alonzo, 2018; Martin et al., 2012).

As noted by Parsons et al. (2018), teachers adaptive behaviour include questioning, assessing, modelling, and challenging their students. Teachers can use their students' performance as an indicator to encourage them and try to influence their engagement and, in turn, their performance. Based on these results, it is pertinent to consider whether students' performance is associated with teachers' use of diverse types of engaging messages. As high performing students are likely to be already engaged (Lee, 2014), it might be expected that teachers use fewer engaging messages with high performing students.

1.4. Influence of teachers' enthusiasm

Research on what influences teachers' behaviour has also shown that the 'inner side' of the teacher (beliefs, well-being, and attitudes) influences their behaviour and performance, also known as their 'outer side' (Bandura, 1978; Hwang et al., 2017; Shen et al., 2015). For example, teachers' emotions and self-efficacy, inner side factors, have proven to influence their teaching quality and relations with students (Seligman & Csikszentmihalyi, 2000; Zwart et al., 2014). A recent study conducted by Hayashi and Sasaki (2022) found that the type of leadership teachers show influences their framing of the message. Authoritarian leaders were inclined to use *loss-framed* messages to motivate people, whereas transformational leaders tended to choose *gain-framed* messages. There is also strong evidence on the effects that teachers' autonomy fulfilment plays on teachers' behaviours in general (Korthagen & Evelein, 2016), and on their use of engaging messages, in particular (Santana-Monagas, Núñez, et al., 2022).

Regarding the study of inner variables influencing teachers' use of messages, we have to highlight Putwain's works. For example, Putwain and von der Embse (2018) found that teacher self-efficacy and belief that students would appraise messages as a threat, both inner variables, influenced teachers' use of messages. More related to our study is Putwain and Roberts' (2012) work, in which they examined the relation between teachers' beliefs about students and their use of fear appeals. They found that teachers rely more on this type of messages if they think students will find them motivating. This suggests that teachers with lower-achieving students may use these messages more than teachers with higher-achieving students. We also found Putwain et al.'s (2017) work relevant to our study as these authors found that teachers use more fear appeals if they perceive low engagement from their students. This further supports the idea that fear appeals are more likely to be used with lower-achieving students.

In recent years, there has been a growing interest in studying teachers' enthusiasm (OECD, 2019b). As noted by Keller et al. (2016) in their review, teachers' enthusiasm plays a fundamental role in their personal and professional lives, teaching effectiveness, and instructional quality. Teacher enthusiasm is conceptualized by Kunter et al. (2011) as a component of high-quality teaching that implies interest in the subject,

intrinsic motivation, positive emotions, and an improved teaching process. The authors also observed that enthusiasm for teaching was related to teachers' self-efficacy, professional well-being, and job satisfaction. In turn, these variables have already been shown to have a positive impact on teacher performance and behaviour (Bandura et al., 1977; Belcher et al., 2021; Day & Qing, 2009; Stephanou & Oikonomou, 2018). Enthusiasm is an important factor in a teacher's ability to motivate their students because it helps to create a positive and engaging learning environment (OECD, 2019b). When teachers are enthusiastic, they are more likely to effectively communicate their passion to their students and inspire them to learn. Enthusiasm also positively impacts different teachers' behaviour and practices in the classroom (Kunter et al., 2008), which, in turn, can increase students' motivation and engagement leading to improved learning outcomes. Finally, enthusiasm has been shown to be contagious (Sy et al., 2005), so a teacher who is enthusiastic can inspire their students to be enthusiastic as well. These findings suggest that teacher enthusiasm could be an important predictor of engaging messages and therefore warrants further examination.

1.5. The present study

This prospective study set out to assess the relation of students' performance and teachers' enthusiasm with teachers' use of engaging messages in high schools in Spain. Based on the established categories of engaging messages (Santana-Monagas, Núñez et al., 2022; Santana-Monagas et al., 2023; Santana-Monagas, Putwain et al., 2022), we examined the relationship between these variables to see whether they could predict the likelihood of teachers using different types of messages, and if so, to what extent they are related to the number of messages they use.

This can be achieved through a two-part model (Farewell et al., 2017). This type of analysis has been used before in meteorological, medical, and economical research when gathering naturalistic data on events that might have many zero observations (i.e., days of rain in the desert, prevalence of rare diseases in medicine, etc.) (Belotti et al., 2015). By doing so, two-part models allow to first analyse the probability of the event occurring according to certain factors, and then, if it does occur, how these factors are related to the number of times the event occurs. Engaging messages measured through direct observations are amenable to analysis with these models, as some teachers do not commonly use all types of messages (Santana-Monagas, Putwain et al., 2022). With this statistical technique, a logistic regression is performed in order to find out the probability of teachers using messages, followed by a linear regression, which shows how the number of messages teachers use is related to an input variable (Fig. 2).

We adopted a methodological approach framed within the line of audio recording, transcription, and codification of lessons, also known as of Transcript-Based Lesson Analysis (TBLA; Arani, 2017; Rahayu et al., 2020; Winarti et al., 2021). The TBLA methodology has several advantages, including more accurate data analysis, the opportunity to review data, and pauses for coders to think (Vrikki et al., 2019). With this methodology, we expected to surpass the limitations of previous studies and to gather more reliable evidence of relations between the teachers' use of different types of engaging messages and the variables that might be influencing this use.

The paper poses the following research questions.

RQ1: How will student performance interact with the likelihood of using engaging messages?
RQ2: Among teachers who use engaging messages, how will their students' performance be related to the number of engaging messages used?
RQ3: How will teacher enthusiasm for teaching interact with the likelihood of using engaging messages?
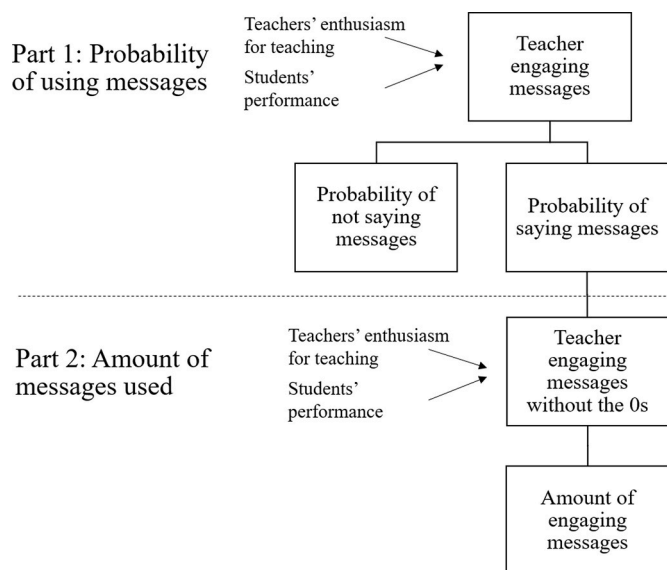
Fig. 2. Two-part model.

RQ4: Among teachers who use engaging messages, how will their enthusiasm for teaching be related to the number of engaging messages used?

We hypothesise that teachers with high-performing students will be less likely to use engaging messages than teachers of low-performing students (H1). For teachers who use messages, we expect student performance to be positively related to the number of messages used (H2). Similarly, we expect enthusiastic teachers to have a higher probability of using engaging messages (H3), and that among teacher who do use messages, enthusiastic teachers will have a higher use (H4).

The findings should make an important contribution to the field of teachers' messages. We hope that the innovative data collection and analysis methods will make it possible to collect naturalistic data more easily and to examine these efficiently. If so, these methods could be extended to other studies on teachers' verbal practices. Furthermore, we expect to contribute to the literature by revealing the relations of students' performance and teachers' enthusiasm with teachers' use of messages. This could be useful in designing future interventions aimed at modifying teachers' use of messages.

2. Material and methods

2.1. Participants

Participants were 39 teachers (22 females and 17 males; mean age = 45.98, *SD* = 7.99) and their 963 students (468 females, 494 males and 1 unspecified; mean age = 16.39, *SD* = 1.27). They belonged to 16 secondary schools in both urban and rural settings of Gran Canaria, Tenerife, and Santander (Spain). School populations were similar with respect to ethnic, socioeconomic status and achievement.

Teachers could choose to participate with one or more of the groups they taught leading to a total number of 59 groups recorded. The average number of students per group was 17.80 (*SD* = 5.14). Students were Grade 9 (mean age = 14.71, *SD* = .68) to 12 (mean age = 17.84, *SD* = .76). Students' mean grades were 5.64 (*SD* = 2.43) out of ten and varied from 3.23 (*SD* = 2.52) in the lowest performing group to 9.47 (*SD* = .64) in the highest performing. To reduce potential bias, all teachers taught Mathematics and all students attended Math lessons with the same intensity (i.e., four lessons per week).

We explained the aims of the study to participants, emphasising that their participation was voluntary and confidential, and asked for their consent through an 'informed consent form'. The ethics section of the study was reviewed by an external committee and complied with data protection acts, directives, and opinions, both at the national and the European levels.

2.2. Procedure

Teachers' engaging messages were assessed through direct observation in audios that were recorded by the teachers. They recorded eight lessons at the end of the second term in each group, close to the final exams. It is important to note that the teachers in the study were working within an accountability structure that places high importance on student grades. This suggests that the teachers may have been more motivated to use engaging messages near the final exams in order to improve student performance on these tests.

We transcribed the audios with an artificial intelligence-based transcription service. In this way, the eight audios per student group were converted into approximately 100 pages of text. These transcripts were then filtered using a python script to detect a list of keywords that were very common in the messages, but less common in the rest of the text. The list of keywords was based on the questions of the validated Teachers' Engaging Messages Scale (Santana-Monagas, Putwain et al., 2022). Some of the keywords in this list were: "*work*", "*pass*", "*daily*", "*learn*", etc. The filtered transcript contained only 10% of the original transcript, which had a concentration of teachers' messages and false positives. Finally, we identified and codified messages of the filtered transcript. Students' performance from the first term was collected from high schools' official records. Teachers' enthusiasm for teaching was evaluated for each group on the first term by a questionnaire provided through Google Forms.

2.3. Instruments

2.3.1. Teachers' engaging messages

To assess teachers' engaging messages from the filtered transcripts, three coders identified the messages and discarded the false positives. Coders had to select all those messages from the teacher that were aimed at engaging students in school tasks. In addition, these messages had to fulfil three conditions: (1) have a *frame*, either *gain* or *loss*, (2) *appeal* to a motivational incentive, and (3) be meaningful in their own sense (could be one or more sentences). Researchers provided them with examples of engaging messages until they were able to recognise them. Results of reliability showed a satisfactory average inter-coder agreement percentage of 98.71%. Cases where there was no agreement were settled by the researchers. Finally, after identifying the engaging messages in the filtered transcripts and following the methodology of other studies (Creswell, 2012), one researcher classified the messages into their categories while being supervised by another.

Messages were classified based on the two dimensions defined in the introduction: "*frame*" and "*appeal*". The resulting sixteen categories were: (1) *gain-framed extrinsic,* (2) *loss-framed extrinsic,* (3) *gain-framed extrinsic-achievement,* (4) *loss-framed extrinsic-achievement,* (5) *gain-framed introjected,* (6) *loss-framed introjected,* (7) *gain-framed introjected-achievement,* (8) *loss-framed introjected-achievement,* (9) *gain-framed identified,* (10) *loss-framed identified,* (11) *gain-framed identified-achievement,* (12) *loss-framed identified-achievement,* (13) *gain-framed intrinsic,* (14) *loss-framed intrinsic,* (15) *gain-framed intrinsic-achievement,* and (16) *loss-framed intrinsic-achievement.*

2.3.2. Students' performance

Students' academic performance was measured through their grades in Mathematics, 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 (Leon 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.

2.3.3. Teachers' enthusiasm for teaching

Teachers' enthusiasm for teaching was measured by one of the two subscales of the Teacher Enthusiasm Scale (Kunter et al., 2011). The subscale of enthusiasm for teaching was composed of 5 items (e.g., "*I teach mathematics in this class with great enthusiasm*") to which teachers were asked to respond on a Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). McDonald's Omega was used to examine the reliability of the instrument as it is more accurate than Cronbach's alpha (McNeish, 2018). McDonald's Omega was estimated using factor loadings from a congeneric CFA ($\chi^2 = 16.21$, *df* = 5, *p*-value = .006, RMSEA = .045, CFI = .970, TLI = .94, SRMR = .040), showing a satisfactory .930. This variable was entered in the models as mean item scores.

2.4. Data analysis

For the statistical analysis, we transformed message counts into ratios. Following the methodology of previous research (Winarti et al., 2021), the most accurate way to obtain the ratios in this case was by dividing the number of messages of each category by the number of words spoken by the teacher. It enables to compare teachers who speak more and those who speak less (e.g., a teacher who said 15 *gain-framed extrinsic* messages in 50 000 words is not the same as another teacher who said 15 *gain-framed extrinsic* messages in 20 000 words).

This means the first teacher used .0003 messages from that category throughout all the words he said during his speech. 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: 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.

The ratios obtained had a zero-inflated distribution (Fig. 3). To overcome this problem, we tested a two-part model (Belotti et al., 2015; Farewell et al., 2017; Muthén & Muthén, 2022). By applying this technique, we create a new binary and a new continuous variable from an original continuous variable. If the value of the original variable is equal to zero (no messages of that category have been said by that teacher in that student group), the new binary variable value is zero and the new continuous variable value is missing. On the contrary, if the value of the original variable is greater than zero (at least one message has been said

by that teacher in that student group), the new binary variable value is one and the new continuous variable value is the log of the original.

A logistic regression is then performed with the new binary variables, and a linear regression with the new continuous variables. As a result of the logistic regression, we obtain two indicators: an odds ratio, which inform us about the probability of a nonzero response compared to a zero response; and the logit (represented by β), which is the natural logarithm of the odds ratio (Wooldridge, 2012). In this way, multiple logistic regression allows us to answer RQ1 and RQ3, while multiple linear regression allows us to answer RQ2 and RQ4. The resulting model is shown in Fig. 4.

All data analysis was performed with Mplus 8.8 (Muthén & Muthén, 2022). There were no missing data on either engaging messages or teacher enthusiasm. There was minor missing data (<5%) in students' performance because some teachers did not send their grades to us. These cases were excluded from the analyses.

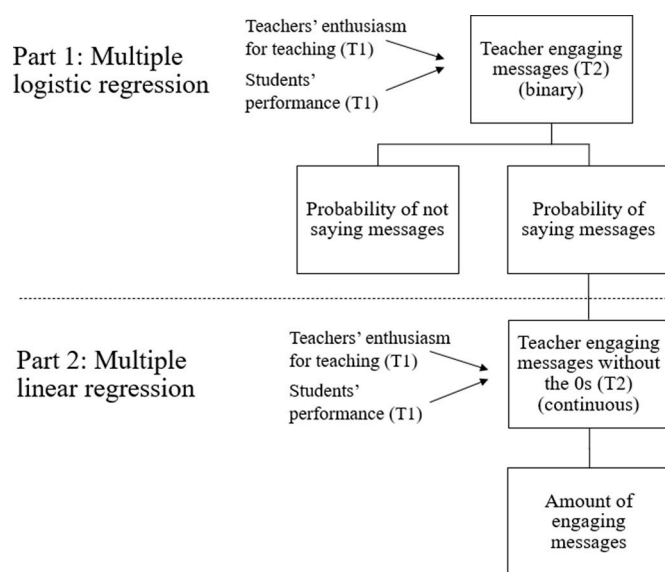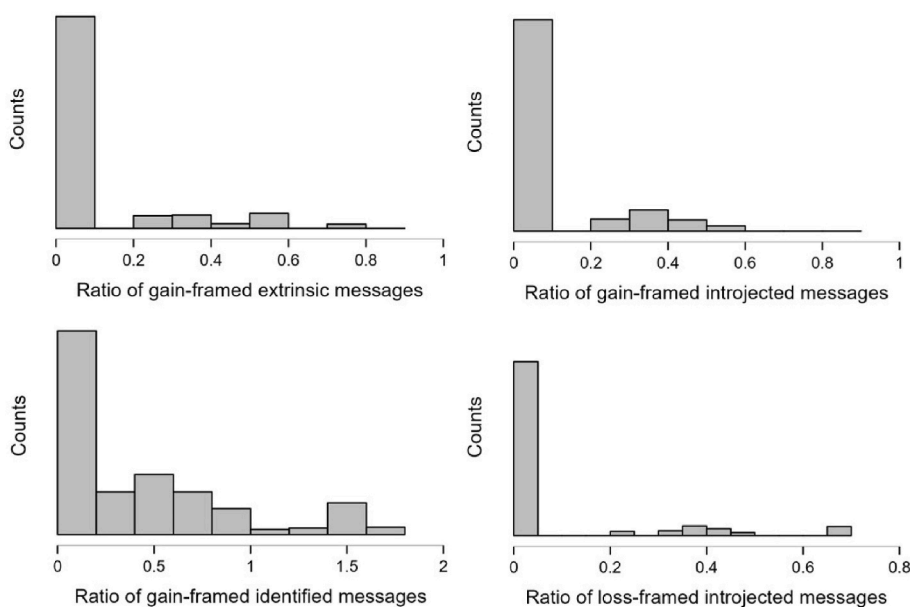**Fig. 4.** Tested two-part model. *Note.* T1 = First term; T2 = Second term.

Fig. 3. Distribution of some of the message categories. *Note.* Distribution of the ratios of (1) *gain-framed extrinsic* messages, (2) *gain-framed introjected* messages, (3) *gain-framed identified* messages, and (4) *loss-framed introjected* messages. In all cases it can be observed the zero-inflated distribution of the data.

3. Results

After analysing the recordings, we identified and classified a total of 239 messages on the second term. The first set of analyses examined the descriptive statistics of these messages (Table 1).

As can be seen from Table 1, *gain-framed* and *loss-framed identified* and *identified-achievement* messages were the most frequently used by teachers. In other words, teachers mostly relied on messages that appeal to the value of studies, through achievement or other incentives, emphasising both the benefits of engaging and the disadvantages of not engaging in the school tasks.

On the other hand, *gain-framed* and *loss-framed intrinsic, intrinsic-achievement* and *introjected-achievement* messages were the least used. This means that teachers almost did not try to engage their students by appealing to the enjoyment of the activity itself, or by appealing to how they will feel because of their achievements.

3.1. Two-part model

Due to the low number of observations of *gain-framed* and *loss-framed intrinsic, intrinsic-achievement* and *introjected-achievement* messages, we were unable to carry out statistical analyses with these categories. The rest of the categories could be analysed with a two-part model and the results are shown in the following table (Table 2).

3.1.1. Relation between students' performance and teachers' use of engaging messages

From the left side of Table 2, we can see that the greater the students' performance, controlling for teachers' enthusiasm for teaching, the greater the likelihood of using *gain-framed* and *loss-framed extrinsic* messages. On the other hand, we can also see that the greater the students' performance, the lesser the probability of using *gain-framed extrinsic-achievement, identified,* and *identified-achievement* messages, and *loss-framed introjected,* and *identified-achievement* messages.

Focusing now on the linear regression (see the right part of Table 2), when teachers do use messages, the higher their students' performance (controlling for teaching enthusiasm), the higher their use of *gain-framed extrinsic* and *extrinsic-achievement* messages, and of *loss-framed extrinsic, extrinsic-achievement, introjected* and *identified* messages.

3.1.2. Relation between teachers' enthusiasm for teaching and their use of engaging messages

Table 2 also shows the estimated effects of teachers' enthusiasm for teaching on their use of engaging messages, controlling for student performance. We can observe that the greater the teachers' enthusiasm for teaching, the lesser the likelihood of using *gain-framed extrinsic, identified* and *identified-achievement* messages, and *loss-framed identified* messages (see the left part of Table 2).

In the linear regression (see results at the left side of Table 2), when it comes to teachers who do use messages, the greater their enthusiasm for teaching (controlling for student performance), the greater their use of *gain-framed extrinsic-achievement, identified* and *identified-achievement* messages, and *loss-framed introjected, identified* and *identified-achievement* messages. However, there is one rather remarkable result when we look at the *loss-framed extrinsic-achievement* messages: it is the only case where the higher the teachers' enthusiasm, the lower their use of messages.

4. Discussion

The research questions of this study sought to determine the relation of students' academic performance and teachers' enthusiasm with teachers' use of engaging messages. We hypothesized that teachers with high-performing students would be less likely to use engaging messages (H1), and for teachers who used messages, we expected student performance to be positively related to the number of messages used (H2). We also expected enthusiastic teachers to have a higher probability of using engaging messages (H3), and that among teacher who did used messages, enthusiastic teachers would have a higher use (H4).

Regarding the research questions, results showed that when students have a higher performance, the likelihood of using *extrinsic* messages increases for both *frame* categories, while the likelihood of using other types of messages decreases (RQ1). However, when teachers do use messages, the higher their students' performance, the higher the use of almost all types of messages (e.g., *gain-framed extrinsic* and *extrinsic-achievement* messages, and of *loss-framed extrinsic, extrinsic-achievement, introjected* and *identified* messages; RQ2). When it comes to the enthusiasm for teaching, the greater the enthusiasm, the lesser the likelihood of using different types of messages (RQ3). When we focus on teachers who do use messages, results showed that the higher their enthusiasm, the higher the use of messages of almost all categories analysed, except for the *loss-framed extrinsic-achievement,* whose use decreased (RQ4).

Before discussing these results, it is important to mention that we could not find any *gain-framed* or *loss-framed intrinsic-achievement,* nor any *loss-framed intrinsic* messages. These results reflect those of Ryan and Deci (2017), who noted that teachers do not focus on intrinsically motivating students, and instead focus on external motivational appeals. We also found few messages from other categories (e.g., *gain-framed intrinsic* or *introjected-achievement*), even when the number of observations was high (approximately 8 h of audio in each of the 59 participating groups). This can be caused by, on the one hand, not all teachers using all types of messages (Santana-Monagas, Putwain et al., 2022) and, on the other hand, to the fact that teachers in Spain spend between 70 and 80% of the lesson time on instruction (OECD, 2019a). This means that the time in which engaging messages can be used is about 20–30% of each lesson. Together with the fact that we could not record lessons from the whole term, this may have been the reason for finding this number of messages in some categories. However, these data could be analysed using a two-part model, which is particularly useful for this type of situation, allowing all the research questions to be answered. The following sections will discuss the results obtained from the two-part models.

4.1. Relation with students' performance

Regarding the RQ1, results shown positive relations between students' performance and the likelihood of using *gain-framed* and *loss-framed extrinsic* messages. Teachers with high performing students are more likely to rely on rewards and punishments to engage students in

Table 1

Descriptive statistics of the messages detected in T2.

Messages		N	%
Appeal	Frame		
Extrinsic	*Gain*	17	7.11
Extrinsic	*Loss*	7	2.93
Extrinsic-achievement	*Gain*	7	2.93
Extrinsic-achievement	*Loss*	15	6.28
Introjected	*Gain*	10	4.18
Introjected	*Loss*	15	6.28
Introjected-achievement	*Gain*	1	.42
Introjected-achievement	*Loss*	1	.42
Identified	*Gain*	53	22.18
Identified	*Loss*	47	19.67
Identified-achievement	*Gain*	25	10.46
Identified-achievement	*Loss*	40	16.74
Intrinsic	*Gain*	1	.42
Intrinsic	*Loss*	0	.00
Intrinsic-achievement	*Gain*	0	.00
Intrinsic-achievement	*Loss*	0	.00
Total		239	100

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

Table 2
Two-part model results.

Independent variables	Logistic regression						Linear regression				
	β	SE	P-value	OR	95% CI for OR		β	SE	P-value	95% CI for β	
					LL	UL				LL	UL
Gain-framed extrinsic											
Intercept							−1.60	.239	.000*	−2.07	−1.13
Teachers' enthusiasm for teaching	**−.272**	**.114**	**.017***	**.762**	**.610**	**.952**	−.008	.037	.839	−.080	.065
Students' performance	**.116**	**.034**	**.001***	**1.12**	**1.05**	**1.20**	**.123**	**.015**	**.000***	**.094**	**.153**
Loss-framed extrinsic											
Intercept							−.134	2.01	.947	−4.08	3.81
Teachers' enthusiasm for teaching	.030	.109	.782	1.03	.832	1.28	−.151	.313	.629	−.763	.462
Students' performance	**.112**	**.037**	**.002***	**1.12**	**1.04**	**1.20**	.111	.057	.050	.000	.222
Gain-framed extrinsic-achievement											
Intercept							**−12.17**	**1.87**	**.000***	**−15.84**	**−8.50**
Teachers' enthusiasm for teaching	−.181	.111	.103	.835	.672	1.04	**1.58**	**.266**	**.000***	**1.06**	**2.10**
Students' performance	**−.153**	**.055**	**.005***	**.858**	**.771**	**.955**	**.181**	**.054**	**.001***	**.075**	**.288**
Loss-framed extrinsic-achievement											
Intercept							.396	.433	.360	−.453	1.25
Teachers' enthusiasm for teaching	.143	.119	.231	1.15	.913	1.46	**−.248**	**.063**	**.000***	**−.371**	**−.125**
Students' performance	−.055	.037	.139	.947	.881	1.02	**.057**	**.011**	**.000***	**.036**	**.078**
Gain-framed introjected											
Intercept							−1.22	.571	.033	−2.34	−.101
Teachers' enthusiasm for teaching	−.005	.126	.968	.995	.777	1.27	.011	.087	.898	−.159	.181
Students' performance	.015	.042	.725	1.02	.935	1.10	.026	.016	.098	−.005	.058
Loss-framed introjected											
Intercept							**−4.68**	**.843**	**.000***	**−6.33**	**−3.02**
Teachers' enthusiasm for teaching	.315	.163	.054	1.37	.995	1.89	**.506**	**.125**	**.000***	**.262**	**.751**
Students' performance	**−.095**	**.038**	**.011***	**.909**	**.845**	**.979**	**.084**	**.028**	**.003***	**.028**	**.139**
Gain-framed identified											
Intercept							**−2.14**	**.120**	**.000***	**−2.37**	**−1.90**
Teachers' enthusiasm for teaching	**−.864**	**.153**	**.000***	**.422**	**.312**	**.569**	**.233**	**.018**	**.000***	**.198**	**.267**
Students' performance	**−.202**	**.032**	**.000***	**.817**	**.768**	**.870**	.023	.012	.051	.000	.046
Loss-framed identified											
Intercept							**−1.96**	**.269**	**.000***	**−2.48**	**−1.43**
Teachers' enthusiasm for teaching	**−.630**	**.121**	**.000***	**.533**	**.420**	**.675**	**.168**	**.041**	**.000***	**.087**	**.249**
Students' performance	−.046	.030	.127	.955	.899	1.01	**.072**	**.020**	**.000***	**.032**	**.112**
Gain-framed identified-achievement											
Intercept							**−1.88**	**.156**	**000***	**−2.19**	**−1.48**
Teachers' enthusiasm for teaching	**−2.18**	**.206**	**.000***	**.113**	**.075**	**.169**	**.185**	**.024**	**.000***	**.139**	**.246**
Students' performance	**−.110**	**.036**	**.002***	**.896**	**.835**	**.961**	.009	.018	.612	−.026	.055
Loss-framed identified-achievement											
Intercept							**−2.85**	**.424**	**.000***	**−3.68**	**−2.02**
Teachers' enthusiasm for teaching	.084	.103	.414	1.09	.889	1.33	**.336**	**.070**	**.000***	**.200**	**.473**
Students' performance	**−.097**	**.031**	**.002***	**.908**	**.853**	**.965**	−.003	.017	.873	−.036	.031

Note. SE = standard error; OR = odds ratio; CI = confidence interval; LL = lower limit; UL = upper limit; *$p < 0.05$. Significant effects are printed bold.

school tasks. However, we also found a negative relation with the likelihood of using *gain-framed extrinsic-achievement, identified,* and *identified-achievement* messages, and *loss-framed introjected,* and *identified-achievement* messages. This means that teachers with high performing students are not likely to appeal to rewards or punishments in terms of achievement, to feelings, and to the value of studies. At the same time, these results can also be understood in the opposite way: teachers who have students with low academic performance tend to use less *gain-framed* and *loss-framed extrinsic* messages and more of the other types of messages to engage them.

This finding is in line with our hypothesis (H1) and may be explained by the fact that students who have a good performance are already engaged in the subject (Lee, 2014). Under these circumstances, the teacher might not feel the need to use messages to engage them further. However, they still use *extrinsic* messages because teachers are used to rely on external appeals to engage students (Ryan & Brown, 2005; Ryan & Deci, 2000a, 2017), especially when they are already performing well.

Answering the RQ2, we found positive relations between students' performance and teachers' use of messages. Specifically, we found that the better the students' performance, the greater the use of *gain-framed extrinsic* and *extrinsic-achievement* messages, and of *loss-framed extrinsic, extrinsic-achievement, introjected* and *identified* messages. Thus, we can observe that as student performance increases, teachers who do use messages, use them more, by emphasising both the benefits of engaging

and the disadvantages of not doing so, and by appealing to both external and internal forms of motivation.

It is interesting to note that this partially repeats what was observed in the logistic regression. As performance increases, teachers use more *extrinsic* messages that focus on rewards and punishments as well as achievement. Another finding was that the better the students' performance, the higher the use of *loss-framed* messages that emphasise the disadvantages of not engaging in school tasks in almost all *appeal* categories. These results confirm hypothesis 2 and seem to be consistent with studies that have found that teachers usually rely on *loss-framed* messages to engage and motivate students (Nicholson et al., 2019; Putwain & Symes, 2011). Overall, the findings are consistent with previous research that has shown how teachers adapt their behaviours based on the performance of students to engage them (Parsons et al., 2018). In addition, they show the need to train teachers in the use of *gain-framed* messages that appeal to internal motivations, as these have been found to be the most beneficial in improving students' vitality, motivation, and performance (Santana-Monagas et al., 2023; Santana-Monagas, Putwain et al., 2022).

4.2. Relation with enthusiasm for teaching

Regarding RQ3, we found a negative relation between enthusiasm for teaching and the likelihood of using *gain-framed extrinsic, identified*

and *identified-achievement* messages, and *loss-framed identified* messages. This suggests that the greater the enthusiasm for teaching, the less likely it is to use engaging messages. What is interesting about these findings is that we expected the opposite (H3). A possible explanation for this might be the false-consensus effect (Ross et al., 1977). Enthusiastic teachers may find their enthusiasm generalised, expanding it to students as well. In this way, thinking that students are already enthusiastic, they may believe that there is no reason to use messages to engage them. Another possible explanation may be that when teachers are enthusiastic, they transmit their enthusiasm to their students, improving their motivation and perseverance (OECD, 2019b; Sy et al., 2005). Under these conditions, the teacher may feel that it is not necessary to use explicit messages to engage students.

Answering the RQ4, among teachers who do use messages, we found a positive relation with the use of *gain-framed extrinsic-achievement, identified* and *identified-achievement* messages, and *loss-framed introjected, identified* and *identified-achievement* messages. In addition, we also observed a negative relation with the use of *loss-framed extrinsic-achievement* messages. In other words, if teachers use messages, the more enthusiastic, the more messages of almost all types they use. The only exception to this is found in the *loss-framed extrinsic-achievement* messages. The more enthusiastic teachers are, the less they try to engage students using messages that emphasise the disadvantages of not engaging in terms of obtaining grades or passing the subject as a reward or a punishment. These findings are in line with our hypothesis (H4) and with previous studies (Korthagen & Evelein, 2016; Kunter et al., 2011; Santana-Monagas, Núñez, et al., 2022; Shen et al., 2015): when teachers are more enthusiastic, they are also more satisfied and have higher self-efficacy, which in turn has a positive impact on their inner side and facilitates the use of engaging messages.

At first sight, the results obtained regarding the enthusiasm seem counterintuitive as they appear to contradict each other. When teachers are more enthusiastic, they are less likely to use engaging messages, but when they use them, the more enthusiastic, the more messages they use. However, these results are of a similar kind than the ones obtained by Olsen and Schafer (2001). They found that girls with less parental control were less likely to consume alcohol over time. However, when girls ingest alcohol, the less parental control the more alcohol they consumed. The relation found in our research between enthusiasm and the use of engaging messages follow a similar pattern and raises many questions. A further study focused on the mechanism is therefore suggested. This could allow researchers to find and better understand causal relations (Baron & Kenny, 1986; Hamaker et al., 2020; Kazdin, 2007). In addition, these results highlight the high potential of two-part models in educational research to study naturalistic data collected through direct observations with zero-inflated distributions.

4.3. Limitations and future perspectives

Despite the contributions of this study, some limitations need to be addressed. First, this study was limited by the small sample size. Working with audio data, even with an optimised processing, is challenging and generates large amounts of data. The final step of codification of the filtered transcripts proved to be very laborious, as is often the case with studies of this kind (Rahman, 2016). However, thanks to advances in natural language processing (Hirschberg & Manning, 2015), we hope to further optimise the process. In future studies, text generative models such as GPT-3 (Brown et al., 2020) could be implemented to achieve the full automatization of the message processing. This could allow us to analyse more classes per term and to record teachers from other subjects as well.

Related to this first limitation is the number of messages found. We have already mentioned that not all teachers use all types of messages (Santana-Monagas, Putwain et al., 2022) and these can only be found in approximately 20–30% of the teachers' lesson time (OECD, 2019a). It is probable that in future studies, where more lessons will be analysed (e.

g., a whole term), a larger number of messages can be found. This will allow more robust statements to be made about the relationships found between objectively measured messages and other variables.

Since the study was limited to Spain, it was not possible to account for the cultural differences in the way teachers motivate and engage their students (Cothran et al., 2005; Hagger et al., 2007). A cross-cultural study including teachers from other countries is needed to examine whether there are differences in their use of engaging messages. For this purpose, it would also be helpful to have an automatic coding procedure such as the one mentioned above.

Following Putwain et al.'s (2018) findings on the impact of different types of pressures on teachers' use of fear appeals and timing reminders, it would be helpful for future studies to investigate the importance and consequences of final exams for students. By doing so, we can gain a better understanding of the situation's similarities to other contexts in which these messages are used, such as final exams that determine future educational or employment opportunities. Specifically, elaborating on the importance of final exams for students and how it may affect the use of engaging messages by teachers could contextualize the study better. For example, Grade 12 marks might be more crucial to students than Grade 9 marks because students in the final year before university are more aware of their GPA's significance. Additionally, exploring the accountability pressure that teachers feel to use messages to improve student outcomes could be an interesting aspect to analyse in future studies.

Several other questions remain to be answered. For instance, while we hypothesized that teacher enthusiasm would influence message use, further research is needed to fully understand the relation of enthusiasm for teaching with the use of engaging messages found in this study. One possible approach would be to conduct a survey of teachers to gather their beliefs about students' enthusiasm and test whether teachers believe that their own enthusiasm extends to students, which may be a false-consensus effect. By doing so, we may gain a better understanding of the counterintuitive results obtained.

In this study, we only considered the *gain* and *loss* categories in the frame dimension. However, it is important to note that prior research has found that *loss-framed* messages can have different effects on students depending on how the message is appraised (Putwain, Symes, & Wilkinson, 2017). If the message is perceived as threatening by students, their anxiety increases while engagement and performance decrease. Conversely, other studies found positive effects of *loss-framed* messages on students' outcomes, an effect that could be due to the teacher-student relatedness (Santana-Monagas, et al., 2023). From these studies, it seems that the key is for students to identify teachers as supportive persons. Therefore, future studies should explore whether the effects of *loss-framed* messages on anxiety and grades may be moderated by student-teacher relatedness and the perceived level of teacher support.

In addition, further research can analyse the role played by other professional and personal dimensions on the use of engaging messages. For example, the class size has proved to influence teachers' behaviour (Blatchford et al., 2011). Furthermore, teachers' beliefs, self-efficacy and well-being, have also proven to be related with their behaviour and performance (Li, 1999; Madsen & Olson, 2005; Spilt et al., 2011; Stephanou & Oikonomou, 2018). One starting point for this might be studying teachers' self-efficacy and their beliefs and perceptions of students, as was done by Putwain and Roberts (2012), Putwain, Nakhla, et al. (2017), and Putwain and von der Embse (2018). Future studies could integrate these dimensions, both personal and professional, to further explore why teachers use different types of engaging messages.

The methodology we have followed has proven to be useful for studying a teacher's verbal practice through direct observations. Similarly, we believe that many other studies focusing on teaching practices can make use of the TBLA methodology coupled with keyword filtering. We encourage researchers to use this methodology to study other teacher's verbal practices directly and to compare the results with those obtained through reports.

The results of this study align with those of prior research and provide valuable information for designing future interventions aimed at modifying teachers' use of engaging messages. Previous studies have concluded that teachers should focus on using more *gain-framed identified* and *intrinsic* messages to improve students' motivation to learn, vitality and performance (Santana-Monagas et al., 2023; Santana-Monagas, Putwain et al., 2022). For this reason, designing interventions aimed at teachers to this purpose could be worthwhile. Interventions directed at teachers rather than students have already proven to be efficient, as a single teacher may teach hundreds of students annually (Allen et al., 2011; Gregory et al., 2017). It has been found that an effective way to change teachers' behaviour is through interventions aimed at self-awareness of their practices (Abbate et al., 2006). This can be achieved by providing feedback, although previous studies have found that it is challenging to deliver teachers with frequent high-quality feedback (Kraft & Christian, 2022). However, by the methodology of this study, it would be easier to provide them with information on their actual use of engaging messages. This may be a satisfactory solution, as it is objective and simple for teachers to understand.

5. Conclusions

The present study was focused on examining the relations between students' performance, and teachers' enthusiasm for teaching, with their use of engaging messages. We measured the engaging messages by class recordings, which until now had only been measured through student reports. Using a two-part model, we were able to separately test whether these variables were related with the likelihood of using engaging messages, and the number of messages used. Our findings suggest that both factors, students' performance, and teachers' enthusiasm, are related with the use of engaging messages. We could observe that teachers with high-performing students were less likely to use almost every type of engaging messages, except for the ones that appealed to *extrinsic* motivations. In addition, when teachers did use engaging messages, the higher their students' performance, and their enthusiasm, the higher their use of messages in general. These findings offer an important contribution to the research as they allow to better understand the role of teachers' professional and personal dimensions on their use of engaging messages. In addition, they show the usefulness of the data collection method based on transcription and filtering in the assessment of these messages, and the utility of two-part models in the analysis of this type of data.

Credit roles

Samuel Falcon: Formal analysis, Investigation, Writing - Original Draft, Writing - Review & Editing
Jaime Leon: Conceptualization, Methodology, Resources, Writing - Review & Editing, Supervision, Funding acquisition
Wilfried Admiraal: Writing - Review & Editing, Supervision

Declaration of interest

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Chapter 4. Teachers' engaging messages, students' motivation to learn and academic performance: The moderating role of emotional intensity in speech.

*"Porque mientras con mayor profundidad veas el mundo, vas a poder entender las cosas de otra manera. Y no solo las cosas de las asignaturas, **las cosas de la vida, las cosas de la calle y las cosas de cualquier sitio"***

*"Because the more deeply you see the world, the more you will be able to understand things in a different way. And not just things in subjects, but **things in life, things in the street and things everywhere"***

Engaging message number 743

4.1. Study 3.

Research paper

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

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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 (Urdan, 2004), and that students' evaluations of

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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

Gain-framed

Gain-framed extrinsic-normal	*Gain-framed identified-normal*
Gain-framed extrinsic-achievement	*Gain-framed identified-achievement*
Gain-framed introjected-normal	*Gain-framed intrinsic-normal*
Gain-framed introjected-achievement	*Gain-framed intrinsic-achievement*

External forms of motivation / Internal forms of motivation

|	
Loss-framed extrinsic-normal	*Loss-framed identified-normal*
Loss-framed extrinsic-achievement	*Loss-framed identified-achievement*
Loss-framed introjected-normal	*Loss-framed intrinsic-normal*
Loss-framed introjected-achievement	*Loss-framed intrinsic-achievement*

Loss-framed

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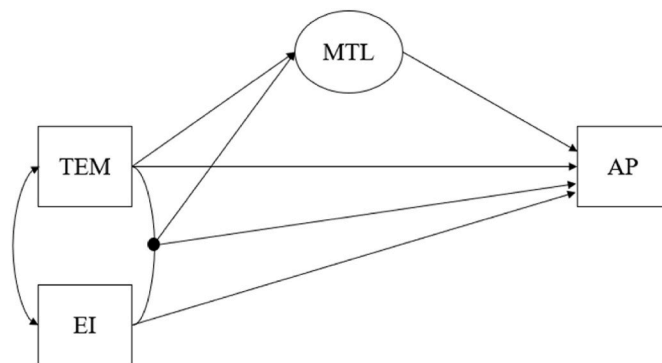
Fig. 2. Proposed model
Note. TEM = Teachers' engaging messages; EI = Emotional intensity; MTL = Motivation to learn; AP = Academic performance.

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: 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 & Vander-Weele, 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).
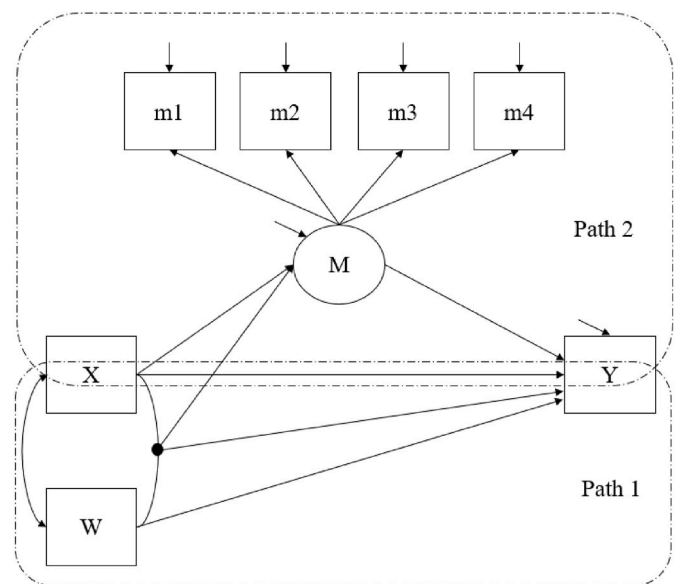

Fig. 3. Tested paths

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
Gain-framed extrinsic-normal	8.53	.99	.99	.001	.03
Gain-framed extrinsic-achievement	6.17	.99	.99	.001	.03
Gain-framed introjected-normal	20.92	.97	.94	.059	.04
Gain-framed identified-normal	27.07	.98	.96	.041	.02
Gain-framed identified-achievement	11.07	.99	.99	.001	.03
Loss-framed extrinsic-achievement	24.87	.96	.93	.058	.04
Loss-framed introjected-normal	16.02	.99	.97	.040	.04
Loss-framed identified-normal	15.60	.99	.99	.018	.03
Loss-framed identified-achievement	20.84	.95	.91	.062	.05
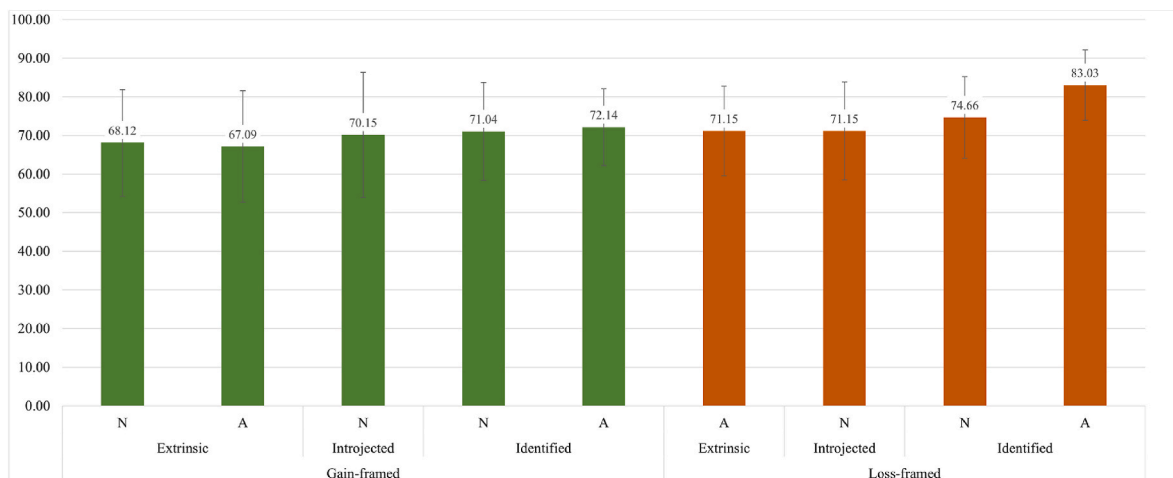
Fig. 4. Means and standard deviations of the emotional intensity for the used categories.
Note. N = Normal; A = Achievement; Green bars = Gain-framed messages; Orange bars = Loss-framed messages. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web 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
Gain-framed extrinsic-normal	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
Gain-framed extrinsic-achievement	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
Gain-framed introjected-normal	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
Gain-framed identified-normal	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
Gain-framed identified-achievement	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	−.30	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
Loss-framed extrinsic-achievement	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

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
Loss-framed introjected-normal	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
Loss-framed identified-normal	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**
Loss-framed identified-achievement	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.

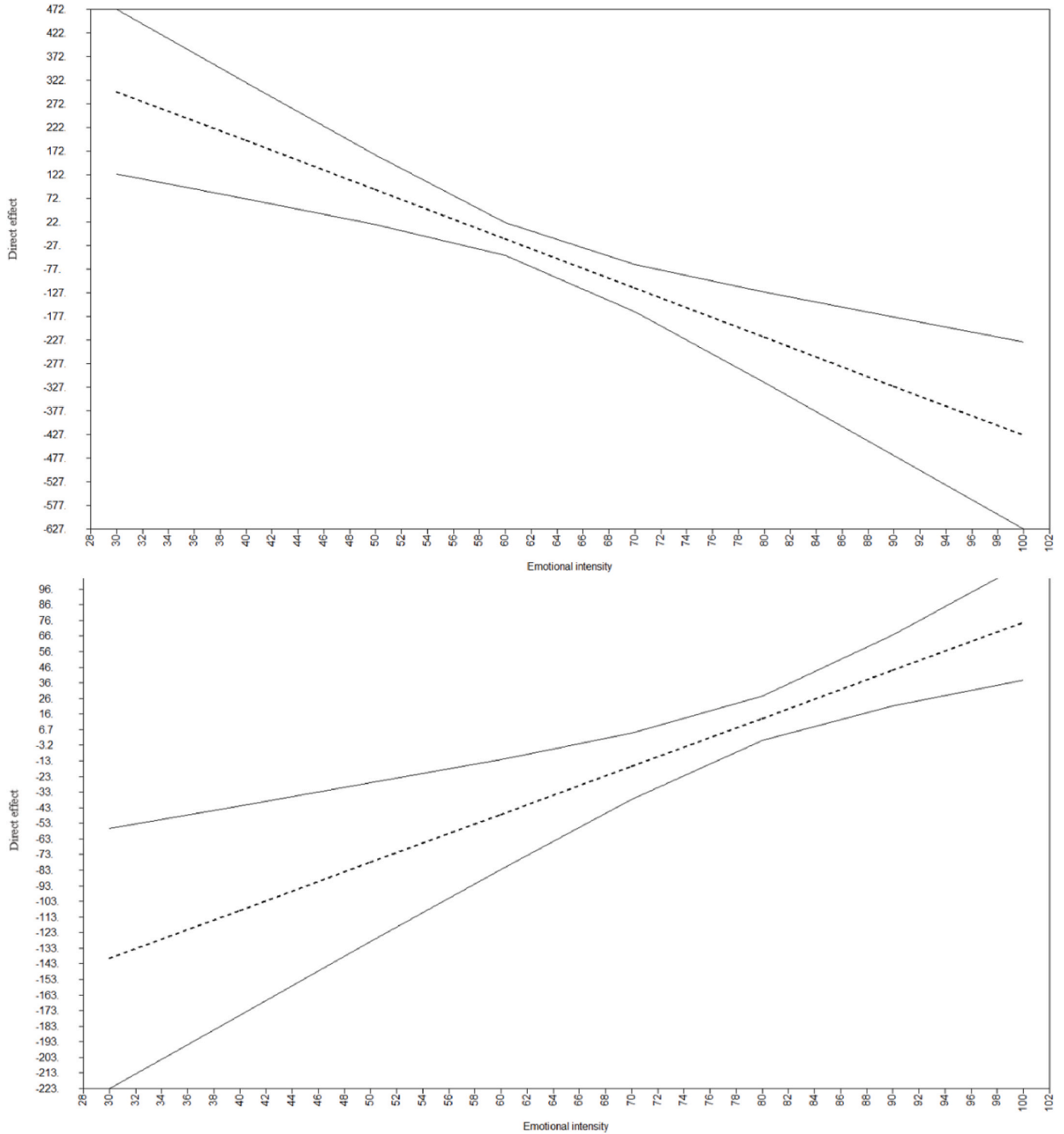The results showed that messages' emotional intensity varied

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.

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Declaration of Competing interest

None.

Data availability

Data will be made available on request.

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Chapter 5. Summary of results and discussion

*"Con lo **bueno y bonito** que es aprender estudiando"*

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*"How **good and beautiful** it is to learn by studying"*

Engaging message number 767

5.1. Summary

This thesis followed three main objectives related to the exploration of the factors influencing the use and effect of engaging messages, as well as the consequences of these messages. To achieve these aims, we collected data on teachers' use of engaging messages via open-ended methods, and we analysed it using different techniques that allowed us to manage the large volumes of information collected. Each of the three studies comprising this thesis was designed with specific goals, which are detailed below along with the results obtained.

The first study aimed to evaluate how students' perceptions of their teachers' use of engaging messages affect their sentiments towards their teachers' communication and explored the mediating role of students' sentiments in the relation between the perceived use of engaging messages and students' motivation to learn. To this end, we used sentiment analysis to automatically obtain data from students' open-ended responses regarding their sentiments on teachers' communication. The results indicated that higher levels of perceived use of engaging messages led to more positive sentiments among students towards their teachers' communication. Furthermore, the findings confirmed that sentiment does play a mediating role, partially explaining the effect of students' perception of engaging messages use on students' motivation to learn. These results reinforced the notion that the way teachers talk, particularly when they employ engaging messages, significantly impacts students' opinions and sentiments towards their communication. Moreover, the study demonstrated the utility of sentiment analysis in educational research. By analysing students' responses to open-ended questions, the tool allowed us to transform huge amounts of textual information into analysable data, quantifying how students felt about their teachers' communications and making possible to link these sentiments to their motivation to learn.

The following study aimed to explore the antecedents of the actual use of engaging messages. Specifically, we tested how teachers' enthusiasm for teaching and students' prior performance affects the likelihood of using engaging messages, and how these predictors influenced the number of engaging messages used. To achieve this, we measured the actual use of engaging messages by audio-recording the lessons and processing them with automatic transcription and keyword filtering. Results showed that both teachers' enthusiasm and students' performance are related to the use of engaging messages. Better student performance increased the likelihood of teachers using messages that appeal to extrinsic motivations, regardless of the frame. However, among teachers who used messages, those with better-performing students used a greater variety of message types. On the other hand, and contrary to our initial hypothesis, greater enthusiasm was associated with a lower likelihood of using messages. Nonetheless, among teachers already using messages, those more enthusiastic tended to use a greater number of engaging messages. This research not only enhanced our understanding of the factors influencing the use of engaging messages, but also provided a methodological framework for efficiently analysing teacher discourse and obtain observations of engaging messages.

The third study sought to assess whether the levels of emotional intensity in teachers' engaging messages moderated the direct effect of these messages on students' performance, as well as their indirect effect through motivation to learn. To achieve this, we reapplied the methodology used in the second study to obtain observations of the engaging messages. Then, we obtained audio clips from each engaging message and analysed their emotional intensity. Initially, a descriptive analysis showed that messages appealing to internal motivations had higher emotional intensity compared to those appealing to external motivations. Subsequently, we observed that the actual use of

engaging messages had a direct impact on students' academic performance, although the study did not find a significant indirect effect of these messages through motivation to learn. Finally, we confirmed that the direct effect of engaging messages on academic performance was moderated by emotional intensity, with the relations weakening as emotional intensity increased for almost all types of messages. This suggests that while engaging messages can be effective, the emotional intensity of their delivery should be carefully managed to avoid diminishing returns or negative effects, as too little or too much intensity might not yield the desired educational outcomes. The study ends by highlighting the relevance of acoustic features in teacher communication, suggesting that how something is said can be as important as what is said in influencing student outcomes.

5.2. Implications

The implications derived from this thesis can be divided into theoretical and methodological contributions. Theoretically, the thesis continues to emphasise the role of engaging messages as a crucial factor of teachers' discourse for improving student performance (Santana-Monagas et al., 2023; Santana-Monagas, Núñez, et al., 2022; Santana-Monagas, Putwain, et al., 2022). Methodologically, the results highlight the utility of open-ended information for studying teachers' discourse. However, the real implication lies in the ability to gather huge amounts of data from open-ended questions and audio-recorded lessons, and to process this information using sentiment analysis, automatic transcriptions, and keyword-based filtering. This approach made it possible to transform the information into data appropriate for advanced statistical analysis, while also allowing for the extraction of additional features such as the emotional intensity of the audio. The following paragraphs will delve into both the theoretical and practical implications of this thesis.

From a theoretical perspective, starting with students' sentiments about their teachers' communication, the results highlight the impact of using engaging messages to improve students' perceptions of their teacher's communication and how this sentiment influences motivation to learn. This indicates that training teachers to use more engaging messages could be a valuable investment in improving students' motivation, which in turn could boost students' academic performance (Núñez et al., 2005).

Regarding the actual use of engaging messages by teachers, we first confirmed the importance of the students' prior performance and the teachers' enthusiasm for teaching as predictors. This result supported the notion that teachers adapt their practices to the characteristics of their students (Parsons et al., 2018), as we observed how the students' prior performance influenced both the likelihood and the number of messages used. Similarly, we saw how enthusiasm for teaching, an internal characteristic of the teachers, could affect the likelihood of using messages and the number used as well. These theoretical results have clear implications in the creation of interventions aimed at improving teachers' use of engaging messages, both in their training and for teachers who are already in service.

In terms of these interventions, previous research has highlighted the benefits of teaching teachers to use more gain-framed messages, both identified and intrinsic (Santana-Monagas, Núñez, et al., 2022; Santana-Monagas, Putwain, et al., 2022; Santana-Monagas & Núñez, 2022). However, the insights gained from the second study of this thesis can improve the approach to teacher education programmes. In addition to instructing teachers on the types of messages to use, we now also have information on the optimal timing for their application. For example, now that we know that teachers tend to use more extrinsic messages with students who are performing well, we can tailor interventions to encourage the use of intrinsic and identified gain-framed messages for

all students, especially for those with high performance. Additionally, it could be beneficial to encourage the use of engaging messages even when teachers themselves feel enthusiastic. Such an approach would not only maintain but potentially increase the use of engaging messages by those teachers who are already using them.

Finally, the analysis of the emotional intensity of the messages also underscored the importance of conveying engaging messages with moderate emotional intensity - neither too low nor too high- to ensure their effective impact on student performance. This knowledge could also be incorporated into the above-mentioned interventions to inform teachers that it is not only what is said that matters, but how it is said. All these insights have significant implications for improving teachers' use of engaging messages, enhancing in turn students' performance.

Regarding methodological implications, the use of sentiment analysis allowed us to rapidly process hundreds of responses to open-ended questions to quantify how students felt about their teachers' communications and to examine the relations between this variable, engaging messages, and motivation to learn. The utility of the data obtained through this tool opens the door for future research using this technique to analyse the relations between students' sentiments towards their teachers' communication and other types of messages, such as praise or reprimands (Caldarella et al., 2023; Jenkins et al., 2015), or with other educational outcomes. Similarly, the tool could be used to analyse responses to open-ended questions about aspects other than teacher communication. This could ultimately enhance decision-making processes within educational institutions by analysing students' sentiments and improving teaching quality (Sultana et al., 2018). Moreover, by analysing sentiments, it might be possible to identify students' emotional responses to the curriculum and learning environment, enabling the development of personalised interventions to enhance learning outcomes (Dolianiti et al., 2019).

Similarly, we have managed to transform hundreds of hours of audio into text and have developed a methodology to optimise the coding of transcripts and identification of engaging messages. Thanks to this methodology, we now have the opportunity to obtain data on teachers' actual use of other types of messages such as achievement goals (Boden et al., 2020), efficacy and fear appeals (Wilkinson, 2023), motivational messages (Putwain et al., 2021), and praise and reprimands (Caldarella et al., 2023), among many others. This advancement could significantly progress the theory in two ways. Firstly, it would be much more feasible and accessible for many more researchers to verify the existence and real use of these messages and other types of teachers talk factors. Secondly, it would also be more affordable to analyse the relations between the actual use of these messages and other important educational outcomes.

Lastly, thanks to the methodology used for collecting the messages, it was possible to obtain the emotional intensity of the messages and examine what role this acoustic feature played. This new methodology enables researchers to study this acoustic feature in naturalistic settings, something that was unthinkable a few years ago. In addition to continuing to explore the role of this variable, the use of audio opens the possibility to explore other types of acoustic features that can be extracted from the audios, such as the emotions expressed by the teachers in the messages using speech emotion recognition techniques (Chintalapudi et al., 2023; Hume AI, 2023; Seknedy & Fawzi, 2021).

5.3. Limitations and future perspectives

This section presents an overview of the thesis's limitations as well as some recommendations that future studies might consider overcoming them, alongside future perspectives.

A primary general limitation across the three studies is the absence of causal evidence regarding the effect of one variable on another. Although the studies followed a temporal sequence where variables are measured at time 1 and others at time 2, we did not gather repeated measures of the same variables to observe changes and trends. To establish causal relations, longitudinal studies with multiple measurements of all variables would be preferable. Another option to establish causality could be to conduct randomized controlled interventions involving training in the use of engaging messages and testing the differential effect of different treatments on students' performance (Rubin, 2005). These methods could significantly enhance the robustness of the findings by addressing the temporal precedence and excluding alternative explanations, thereby strengthening claims of causality. Moreover, implementing these approaches would allow researchers to isolate the effects of the messages and assess their impact over time, providing a clearer understanding of the dynamics at play more effectively.

Regarding the first study, the primary limitation is that, although we measured a characteristic of the students -namely their sentiment towards their teacher's communication- these responses may be biased. Potential biases affecting student responses include social desirability (Chung & Monroe, 2003) and negativity biases (Poncheri et al., 2008), as well as effects related to the format of the question (Smyth et al., 2009). To mitigate these problems, future studies could implement social desirability scales or pay special attention to the phrasing of the open-ended questions to avoid these biases (Álvarez-Álvarez & Falcon, 2023; Hynninen et al., 2019; Nederhof, 1985).

Furthermore, it is important to acknowledge that the sentiment analysis technique only provides information about one aspect of the student's response, which is their sentiment regarding the queried factor. While this information can be useful, recent advancements in natural language processing and the development of large pre-trained

language models (LLMs) such as GPT (Brown et al., 2020) may allow a deeper study of the content of these responses (Demszky et al., 2023). For instance, recent studies have demonstrated the usefulness of these models in the automatic coding of responses to open-ended questions into theory-based categories (Álvarez-Álvarez & Falcon, 2023). This opens the possibility to analyse the dataset used in the first study from another perspective, categorising student responses according to the types of communication they refer to and combining this information with that obtained from sentiment analysis. Moreover, it also enables the formulation of different open-ended questions querying about other aspects in future studies. Then, the answers could be automatically coded with LLMs, maintaining the idea of optimising the analysis of open-ended information while allowing for the extraction of a greater amount of information.

Moving on to subsequent studies where we collected data on the actual use of messages, a limitation is that we only used message observations, without considering alternative data sources. This is relevant because the methodology for obtaining these message observations, although optimised for an easy coding of information, may present some problems. For example, potential biases such as coder fatigue (Vohs et al., 2005) or a lack of context that may have led to overlooking some engaging messages. A possible solution to these limitations is for future studies to triangulate the information with direct classroom observations. While this form of data collection can be quite demanding, a study where the data is triangulated could help to confirm the reliability and validity of the method used in this thesis (Demszky & Hill, 2022).

Finally, the previously mentioned idea of using LLMs to process textual information can be recovered for the analysis of transcripts. This technology has rapidly positioned itself as one of the most promising for text analysis in general, and for class transcript analysis in particular (Demszky et al., 2023). For example, the analysis of

transcripts could be further optimised by using these LLMs to automatically code the transcripts and quickly and reliably identify the messages used by teachers. This approach could also contribute to developing interventions that provide automatic feedback on the messages teachers use. These are interesting future perspectives for this line of research, given that instant feedback our actions has been shown to improve them, as is the case with pedometer apps that count daily steps and increase physical activity (Laranjo et al., 2021). Thus, providing instant feedback on teachers' use of messages could lead to an improvement in their use, both in terms of frequency and type of message.

5.4. Conclusions

Based on the findings from the three studies that compose this thesis and the objectives they aimed to fulfil, the following conclusions can be drawn:

1. Sentiment analysis is a valuable tool in educational research for transforming huge amounts of textual information into analysable data.

2. Higher levels of perceived use of engaging messages led to more positive sentiments among students towards their teachers' communication.

3. Students' sentiments towards their teachers' communication partially mediate the effect of students' perception of engaging messages use on their motivation to learn.

4. The combination of automatic transcription of audio-recorded lessons with keyword-based filtering is a useful methodology for efficiently analysing teachers' discourse and extract relevant information on engaging messages.

5. Greater enthusiasm for teaching is associated with a lower likelihood of using messages.

6. Among teachers already using messages, those more enthusiastic tend to use a greater number of engaging messages of almost all types.

7. Better students' prior performance increases the likelihood of teachers using messages that appeal to extrinsic motivations.

8. Among teachers who use messages, better student performance increases the number of messages used of almost all types.

9. Teachers' engaging messages direct impact on students' academic performance is moderated by emotional intensity, with the relation weakening as emotional intensity increased.

In summary, this thesis has made both theoretical and methodological contributions to the field of teachers' discourse in general, and engaging messages in particular. Results showed how the increased perceived use of engaging messages fosters positive sentiments in students' opinions of teacher communication, which in turn enhances motivation to learn. We also found that both prior student performance and enthusiasm for teaching can act as predictor in the likelihood of using messages and the quantity used. Finally, we observed that not only the content of the message matters but also the way it is delivered. Sending messages using moderate emotional intensities could be beneficial for better transmission of the messages' effects on performance. All this knowledge contributes to the scientific corpus on engaging messages and prepares the groundwork for creating an intervention to improve teachers' use of these messages. If effective, this intervention could impact hundreds of students each year, ultimately helping to address the problem of underperformance and its associated consequences.

Methodologically, by utilising techniques such as sentiment analysis, transcriptions, and keyword-based filtering, it was possible to obtain and analyse large quantities of data from sources including open-ended questions and audio-recordings of lessons. This allowed us to overcome some of the limitations associated with more traditional methods of data collection. The results obtained after using these

methodologies calls for future studies in the field of teachers' discourse, as well as other fields of educational research, to adopt similar approaches for data gathering and analysis. By doing so, researchers could be able to uncover deeper insights and develop more effective strategies for improving educational practices.

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