Fronteiras: Journal of Social, Technological, and Environmental Science
http://periodicos.unievangelica.edu.br/fronteiras/
ISSN 2238-8869

Changes in Motivation Among Students Graduatein Mathematics Education During an Experience OnlineUsing the Mastery Learning Methodology

Emilio J. Castro-Navarro[1], Danilo Díaz-Levicoy[2], Jarnishs Beltrán[3]

[1] Ph.D. in Science with a specialization in Mathematics Education. Metropolitan Technological University. ORCID: 0000-0003-4931-6180. Email: ecastron@utem.cl
[2] Ph.D. in Education. Catholic University of Maule. ORCID: 0000-0001-8371-7899. Email: dddiaz01@hotmail.com
[3] Ph.D. in Science with a concentration in Mathematics. University of Santiago. ORCID: 0000-0001-6867-5950. Email: Jarnishs.beltranm@usach.cl

ABSTRACT
This article analyzes the perceived evolution of motivation among graduate students in Mathematics Education who took an online course organized using the Mastery Learning methodology. Through thematic analysis of a focus group conducted at the end of the semester, the study retrospectively perceived motivational changes, as well as examines periods of high and low motivation, from the perspective of self-determination theory, which conceives of motivation as a continuum ranging from demotivation to extrinsic and intrinsic forms. The students' accounts suggest perceived shifts from more controlled forms of motivation toward more autonomous regulation, associated with the instructional conditions characteristic of Mastery Learning such as initial assessment, modular progression, and peer interaction . Likewise, participants associated the course structure and the teacher's role as a facilitator with experiences of collaboration, perceived competence , and autonomy . It is concluded that, from the students' retrospective perspective, the instructional structure of Mastery Learning, together with an emotionally safe and cooperative environment, was associated with the fulfillment of the basic psychological needs for competence, relatedness, and autonomy, and with more self-determined forms of motivation in virtual contexts of advanced education.
Keywords: student motivation; Mastery Learning; online mathematics education ; higher education.

RESUMEN
Este artículo analiza la evolución percibida de la motivación en estudiantes de posgrado en Educación Matemática que cursaron una asignatura en línea organizada bajo la metodología Mastery Learning. A través del análisis temático de un grupo focal realizado al finalizar el semestre, se examinan retrospectivamente los cambios motivacionales percibidos, así como los momentos de alta y baja motivación, estudiados desde la teoría de la autodeterminación, la cual concibe la motivación como un continuo que transita desde la desmotivación hacia formas extrínsecas e intrínsecas. Los relatos de los estudiantes sugieren cambios percibidos desde formas más controladas de motivación hacia regulaciones más autónomas, asociados a las condiciones didácticas propias del Mastery Learning como el diagnóstico inicial, la progresión modular y la interacción entre pares. Asimismo, los participantes asociaron la estructura del curso y el rol del profesor como facilitador con experiencias de colaboración, competencia percibida y la autonomía. Se concluye que, desde la percepción retrospectiva de los estudiantes, la estructura instruccional del Mastery Learning, junto con un ambiente emocionalmente seguro y cooperativo, se asoció con la satisfacción de las necesidades psicológicas básicas de competencia, relación y autonomía, y con formas más autodeterminadas de motivación en contextos virtuales de formación avanzada.
Palabras clave: motivación estudiantil; Mastery Learning; educación matemática en línea; educación superior.

Introduction

The study of motivation in higher education settings has gained increasing importance over the past decade, especially in contexts mediated by digital technology (Urdabayev et al. 2024). In mathematics courses, where levels of anxiety and perceived difficulty are often high, understanding the factors that influence motivation is key to improving instructional design (Hanafi et al. 2025; Rodríguez et al. 2022; Wu & Dong 2024). Within this framework, methodological approaches that promote active student engagement —such as

Submission: 02/12/2025 Accepted: 10/09/2026 Publication: 14/11/2026

Vol. 15, No. 3, 2026 • pp. 1–12. • DOI http://dx.doi.org/10.21664/2238-8869.2026v15i3.8403

© 2021 by the authors. This journal offers immediate open access to its content, following the principle that making scientific knowledge freely available to the public promotes greater global democratization of knowledge. This manuscript is distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (https://creativecommons.org/licenses/by-nc/4.0/legalcode), which allows the reproduction and sharing of the licensed material, in whole or in part, solely for noncommercial purposes; and the creation, reproduction, and sharing of adapted material solely for noncommercial purposes.

Mastery Learning—are emerging as promising strategies in online settings (Collie & Martin 2019; Winget & Persky 2022).

Mastery Learning posits that every student can achieve mastery of the content if provided with adequate time, feedback, and support. This approach has shown positive effects on variables such as academic performance, self-regulation, and motivation in virtual contexts (Castro-Navarro et al. 2020; Tan 2018; Zakariya 2022; Hammond & Barber 2024). By dividing learning into progressive units, offering diagnostic assessments, and promoting peer collaboration, opportunities are created for students to regulate their own pace of progress and tackle challenges appropriate to their level of readiness.

The theoretical framework underpinning this study is self-determination theory, which posits that motivation is enhanced when three basic psychological needs are met: autonomy, competence, and relatedness (Ryan & Deci 2020; Huyghebaert-Zouaghi et al. 2021). In virtual environments, these needs can be threatened by a lack of interaction, disorganization, or isolation; therefore, a purposeful instructional design becomes essential (Miao & Ma 2023; Heo et al. 2021). Various studies have shown that fostering autonomy and providing clear task structures have a direct effect on student engagement and persistence (Bai & Gu 2022; Niemiec & Ryan 2009 ; Huyghebaert-Zouaghi et al. 2021).

In the field of mathematics education, it has been documented that teachers' recognition of students' achievements, the opportunity to interact with peers, and the sense of competence derived from solving complex problems are central factors that influence sustained motivation (Biese et al. 2024; Castro & Miranda 2019; Panaoura et al. 2024; Tambunan et al. 2021). These conditions become even more relevant when courses are conducted online, given that physical distance can hinder the development of strong pedagogical bonds (Dwijuliani et al. 2021).

The purpose of this article is to analyze the perceived evolution of motivation among graduate students in Mathematics Education who took an course onlineimplemented using the Mastery Learning methodology. In this study, the evolution of motivation is understood as the students' retrospective reconstruction of the motivational changes they experienced during the course. To this end, the transcript of a was used as the empirical sourcefocus group conducted at the end of the semester ; therefore, the study does not constitute a longitudinal tracking of motivation but rather an analysis of the participants' retrospective perceptions of their motivational changes throughout the educational experience. Based on these accounts, thematic analysis allows us to identify perceived shifts between different forms of motivation, as well as periods of greater or lesser engagement associated with the course's progression.The study aims to provide recent empirical evidence on the conditions that foster self-determined motivation in virtual contexts of advanced training. In particular, it seeks to answer the following question: How do students retrospectively reconstruct the perceived changes in their motivation during an online learning experience based on the Mastery Learning approach?

Theoretical Framework

Understanding the motivational mechanisms involved in learning mathematics in digital contexts requires a conceptual framework that acknowledges the complexity of the phenomenon from educational, psychological, and contextual perspectives (Liu 2021). This research adopts Self-Determination Theory (SDT) as its primary approach, complemented by recent studies on motivation in mathematics courses and the impact of Mastery Learning in virtual environments (Chiu 2022 ; Rahma & Pujiastuti 2021).

SDT posits that the quality of student motivation is distributed along a continuum ranging from demotivation to intrinsic motivation, passing through various types of extrinsic regulation (Howard et al. 2021; Ryan & Deci 2020). This model maintains that the fulfillment of three basic psychological needs—autonomy, competence, and relatedness—is essential for well-being, engagement, and deep learning. In higher education, and particularly in online settings , these needs are influenced by the design of activities, social interaction, and students' perceived efficacy (Heo et al. 2021; Miao & Ma 2023).

Recent studies have confirmed that environments offering opportunities for decision-making, feedback, and peer collaboration increase self-determined motivation among college students (Datu 2018 ; Bai & Gu 2022; Panadero 2023). In particular, when students perceive control over their progress and feel that their effort contributes to a real improvement in their skills, their intrinsic motivation is enhanced . This type of motivation has been shown to be more resilient to academic frustration and to be associated with higher performance and persistence (Froiland et al. 2016).

On the other hand, the Mastery Learning instructional model has been updated and reevaluated in recent studies for its ability to promote meaningful learning and sustained motivation, especially in distance learning settings (Herdian & Subekti 2022; Liu et al. 2023; Winget & Persky 2022). Research such as that by Collie and

Martin (2019) highlights that its implementation in online courses creates structured, achievement-oriented learning environments focused on formative feedback. These environments are particularly effective for students who need to strengthen their sense of competence without losing autonomy (Ng 2018).

In the field of mathematics education, evidence shows that motivation improves when students actively participate in problem-solving, receive clear feedback, and collaborate with peers (Bieg et al. 2017; Panaoura et al. 2024). Likewise, it has been emphasized that the type of relationship students establish with the teacher and the opportunity to play an active role in the classroom directly influence their attitude toward learning mathematics (Biese et al. 2024; Fokkens-Bruinsma et al. 2021).

The studies by Castro and Miranda (2019) and by Castro-Navarro et al. (2020) provide empirical evidence from the Latin American context on the ways in which students experience motivation in university programs. Both studies have identified thematic categories such as the teacher's role, performance, and collaborative learning, which illustrate how instructional design and teaching practices mediate the motivational experience in mathematics courses.

In summary, this theoretical framework allows us to understand motivation as a dynamic process influenced by individual and contextual factors, which can be enhanced through pedagogical strategies such as Mastery Learning. The integration of SDT and mathematics education provides a solid framework for interpreting the student narratives emerging from the qualitative analysis presented below.

Methodology

This study adopts an interpretive qualitative approach, aimed at understanding how students retrospectively reconstruct the perceived changes in their motivation during an online course structured according to the Mastery Learning methodology. Within this framework, the evolution of motivation is approached as a retrospective reconstruction based on the meanings participants attribute to different moments of the learning experience, rather than as a trajectory observed through longitudinal measurements. Consequently, the findings are interpreted as situated perceptions of motivational variations rather than as evidence of directly measured temporal changes. The choice of a qualitative design stems from an interest in exploring complex phenomena through the voices of the participants themselves, taking into account their meanings, experiences, and social contexts (Levitt et al. 2018).

The primary data collection technique used was a focus group, which allows for the exploration of collective constructions of meaning and fosters interaction and the comparison of perceptions among participants (Krueger & Casey 2014; Tracy 2024). The focus group was conducted at the end of the semester and included nine students from the Master's program in Mathematics Education. The course consisted of nine students, all of whom voluntarily agreed to participate in the focus group; thus, the participating group represented the entire course cohort. The inclusion criteria were that participants belong to the cohort under study, have taken the course during the semester in which the Mastery Learning experience was implemented, and voluntarily agree to participate in the focus group once the educational experience had concluded. Participation was not contingent on academic performance or on the students' opinions regarding the implemented methodology. All of them took the course "Statistics and Probability for Teaching," which was offered entirely online at .

The call for participants was issued by the course instructor, who also moderated the discussion in a synchronous virtual environment. Given the instructor's dual role as both course leader and focus group moderator, we carefully considered the potential influence of this pedagogical relationship on the participants' narratives, particularly in terms of power asymmetry and social desirability—aspects recognized in qualitative research conducted with the researcher's own students (Ferguson et al. 2004; Olmos-Vega et al. 2023). The focus group was held after the course had ended and the participants' grades had been finalized, so the opinions expressed could not affect their academic performance. Furthermore, the script included questions designed to elicit both highly motivating and less motivating experiences, as well as positive and critical assessments of the methodology, with the aim of encouraging the expression of diverse perspectives. During the moderation, efforts were made to facilitate participation and exchange among the participants without imposing interpretations on their responses, in accordance with recommendations for conducting focus groups in teaching and learning research (Winlow et al. 2013). The session lasted approximately 90 minutes. Participation was voluntary, and before the focus group began, participants were informed about the research objectives, the academic use of the information, and the recording of the session, and their informed consent was obtained. Given the ethical considerations specific to research using focus groups, confidentiality was safeguarded in the handling and dissemination of information, while acknowledging that the group nature of this technique does

not allow for the same level of confidentiality among participants as an individual interview (Sim & Waterfield 2019). To reduce the risk of identification when reporting the results, identities were replaced with identifiers, and the inclusion of directly identifiable personal information in the quotations and results presented was avoided (Kaiser 2009). The session was recorded and then transcribed in its entirety for analysis.

The choice of the focus group as a data-generation strategy is based on its potential to investigate shared perceptions, identify tensions , and explore educational phenomena from a dialogic perspective, which is particularly useful in studies addressing constructs such as motivation (Barbour 2018; Winlow et al. 2013).

For data analysis, the reflective thematic analysis technique was used, following the methodological guidelines of Braun & Clarke (2021). This approach allows for the identification of patterns of meaning in the narratives, while simultaneously acknowledging the researcher's agency in the construction of knowledge. The process began with familiarization with the data, which consisted of reading and rereading the complete focus group transcript, accompanied by initial analytical notes on experiences of higher and lower motivation and on the pedagogical conditions that participants associated with those experiences. Subsequently, initial codes were generated based on units of meaning relevant to the research question, striving to remain faithful to the meaning participants attributed to their experiences. The codes were then grouped into broader patterns of meaning and used to construct provisional themes. These themes were reviewed recursively, comparing them both with the coded excerpts and with the full transcript, which allowed for the redefinition, integration, or differentiation of themes when necessary. Once the interpretive core of each theme was delineated, their scope and names were defined, and the textual excerpts that best documented them were selected. Finally, the constructed themes were interpreted in light of self-determination theory, particularly in relation to forms of motivational regulation and the basic psychological needs of autonomy, competence, and relatedness . These stages were not conceived as linear but rather as an iterative and reflective process, consistent with an interpretive epistemology (Braun & Clarke 2021).

The coding and categorization were performed using Atlas.ti software, which facilitated rigorous management of the textual corpus and allowed for the traceability of analytical decisions. As a complementary process to validate the thematic analysis, a subset equivalent to 10% of the corpus was selected. In the first stage, two researchers independently coded this subset. Subsequently, both codings were compared with the coding obtained previously in the main analysis, examining convergences and discrepancies in code assignment and their relationship to the constructed themes. The identified discrepancies were reviewed in light of the analytical criteria used, allowing for the reconsideration and adjustment of the main coding when appropriate. In a second stage of the same validation process, an expert review was conducted with three researchers selected for their expertise in qualitative research and thematic analysis. The experts were provided with the subset corresponding to 10% of the corpus—selected to ensure that the themes identified in the analysis were represented—along with the codes associated with those excerpts. The experts evaluated the relevance, significance, clarity, and appropriateness of the codings, as well as the consistency between the resulting categories and themes and the study's objectives. Their evaluations were taken into account in the final review of the analysis, allowing us to reexamine the correspondence between the corpus excerpts, the codes, and the constructed themes and to make the necessary analytical adjustments before establishing the final thematic structure. Taken together, these two stages made it possible to examine the interpretive consistency of the thematic analysis and strengthen the rationale for the thematic structure ultimately used (Nowell et al. 2017).

The methodology developed allowed for an in-depth understanding of the students' narratives regarding their experience with the " " course and for exploring moments of higher and lower motivation from an inductive and situated perspective. This design is particularly relevant for investigating affective dimensions of learning that elude traditional quantitative methods.

Results

The reflective thematic analysis of the focus group identified five major themes that made it possible to retrospectively reconstruct the motivational changes perceived by students during the course . In addition to identifying forms of motivation associated with different moments of the learning experience , the narratives allowed us to interpret perceived variations among different types of motivational regulation . These variations do not correspond to transitions observed longitudinally, but rather to an interpretive reconstruction based on the participants' retrospective narratives. From this perspective, the perceived changes can be understood, in light of self-determination theory, as expressions consistent with processes of motivational internalization (Burgueño et al. 2024 ; Howard et al. 2021; Ryan & Deci 2020).

The Initial Assessment as an Experience of Contrast and Activation

Students reported feelings of anxiety and insecurity regarding the diagnostic assessment, which they experienced as an exposure of their shortcomings. However, this instance also served as a trigger, prompting them to commit to the course. In their retrospective accounts, participants described a perceived shift from initial states bordering on demotivation toward forms of extrinsic motivation compatible with introjected regulation .

> "When I saw the test, I felt like I didn't know anything… but then I realized it was to figure out where to start" (Student 4).
>
> "That test put me in study mode; I realized I had a long way to go" (Student 1).

Collaborative Learning and a Sense of Belonging to the Group

The experience of group work was highly valued. Students highlighted how interacting with others allowed them to clarify concepts, maintain emotional balance, and move forward with greater confidence. Some participants reported in retrospect that these experiences came to be valued beyond their academic utility; these accounts were interpreted as consistent with a perceived shift from forms of identified regulation toward expressions of intrinsic motivation .

> "My classmates helped me a lot. It was key to hear how they understood the concepts" (Student 7).
>
> "I felt like I was part of something, like we were moving forward together" (Student 2).

Peer Teaching as a Source of Competence

The practice of explaining content to others was described as a highlight of the learning experience. Students valued the opportunity to demonstrate their mastery and to contribute to collective learning. The accounts related to this topic reveal expressions consistent with intrinsic motivation, along with elements that can be interpreted as integrated regulation .

> "When I was able to explain it on the board and my classmates understood, I felt that I had truly mastered the topic" (Student 5).
>
> "It was interesting to see that I, too, could help others; that motivated me even more" (Student 3).

The Teacher's Role as a Facilitator of the Learning Process

The accounts reflected a positive perception of the teacher's role, characterized as a facilitator rather than a transmitter of knowledge. This supportive style enabled decision-making, strengthening autonomy and commitment. The retrospective accounts associated with this theme were interpreted as consistent with a perceived shift from more controlled forms of regulation toward expressions of integrated regulation .

> "The teacher gave us the space to learn with others, without pressuring us" (Student 5).
>
> "I felt that the teacher supported us, but didn't give us everything laid out for us. That was good" (Student 3).

Recognition of Progress and Ownership of Learning

Toward the end of the course, students expressed pride and satisfaction with what they had learned. Beyond the grade, what mattered most was the sense of accomplishment and the ability to teach what they had learned. In some accounts, these experiences were interpreted as expressions consistent with intrinsic motivation and as motivational changes perceived in retrospect compared to earlier stages of the learning experience.

> "Now I really feel capable of teaching this material, not just solving the problems myself" (Student 6).
> "I studied with enthusiasm, not for the grade, but because I wanted to do well" (Student 9).

Taken together, the five themes made it possible to retrospectively reconstruct the motivational shifts perceived by the participants, from experiences associated with more controlled forms of regulation toward others compatible with more autonomous forms of motivation. In their accounts, the students associated these changes with various aspects of the educational experience,

including the course structure, opportunities for collaboration, and the teacher's facilitating role. These associations are interpreted as part of how participants retrospectively made sense of their motivational experience, rather than as trajectories of self-determination observed longitudinally.

Table 1 summarizes the correspondence between the five identified themes, the forms of motivational regulation interpreted in the narratives, and the associated basic psychological needs. Taken together, the narratives allow for a retrospective reconstruction of perceived motivational shifts from experiences linked to more controlled forms of regulation toward others compatible with more autonomous forms of motivation. In the narratives referring to the initial diagnosis, expressions consistent with introjected regulation were identified, associated with initial insecurity and the need to demonstrate competence. In contrast, in the narratives concerning the conclusion of the process and the internalization of learning, expressions consistent with intrinsic motivation were identified, linked to an interest in learning and a sense of personal achievement. These differences are interpreted as motivational changes perceived by the participants and not as a directly measured longitudinal progression.

Table 1. Relationship between the themes, the forms of regulation interpreted in the narratives, and the associated basic psychological needs

Theme	***Form of regulation interpreted in the narratives***	***Associated basic psychological need***	***Narrative indicators***
Initial diagnosis	Extrinsic, introjected regulation	Competence	Initial insecurity, perception of shortcomings, and need to demonstrate competence
Collaborative learning	Identified Extrinsic Regulation	Relationship	Peer support, shared understanding, and a sense of belonging to the group
Peer teaching	Intrinsic	Competence	Satisfaction from explaining, perception of mastery, and contribution to others' learning
Role of the teacher	Integrated Regulation (Extrinsic)	Autonomy / Competence	Perception of the teacher as a facilitator, ability to make decisions, and greater autonomy
Ownership of learning	Intrinsic	Autonomy	Pride in what has been learned, interest beyond grades, and a sense of personal achievement

Source: Author's own work

The information summarized in Table Table 1 shows that basic psychological needs were associated in the narratives with different moments and conditions of the learning experience. Competence appeared to be linked primarily to peer assessment and teaching experiences, in which students described situations related to their perception of mastery of the content. The need for relatedness was associated with experiences of collaborative work and the sense of belonging developed through interaction with peers. Autonomy, meanwhile, was linked in the accounts to the teacher's role as a facilitator and to greater opportunities for decision-making and self-directed learning. Taken together, these associations form a retrospectively reconstructed pattern of perceived motivational changes, which participants related to the course structure and opportunities for interaction, though this does not imply a motivational trajectory observed longitudinally.

Discussion

The results of this study provide insight into how the Mastery Learning approach, implemented in an online graduate-level course in Mathematics Education , was associated by participants with different forms of motivation and with perceived motivational changes—shifting from experiences linked to more controlled regulations toward others compatible with more self-determined and even intrinsic forms of motivation . This finding adds an important nuance to the recent literature, as it is not merely a matter of classifying students' motivation at a given moment, but rather of analyzing how participants retrospectively reconstruct variations

in their motivation and relate them to specific pedagogical conditions of the educational experience, without this implying a temporal trajectory observed longitudinally (Burgueño et al. 2024 ; Howard et al. 2021; Ryan & Deci 2020).

The experience of the initial diagnosis showed that a potentially threatening event can become a motivational trigger when contextualized within a course structure that promotes feedback, emotional support, and a sense of progress. In this sense, the transitionreconstructed retrospectively from the participants' accounts —( )—from demotivation toward introjected regulation suggests that the function of the diagnosis can be pedagogically reframed: not as a judgment of deficit, but as a starting point for the development of perceived competence. This pattern aligns with what was observed in similar contexts by Castro-Navarro et al. (2020) and with the models of academic self-regulation proposed by Bakhtiar and Hadwin (2022).

During the intermediate stages of the course, collaborative work emerged as a central factor in the consolidation of autonomous motivation. Students who initially participated to "go along with the group" retrospectively described greater involvement in the interaction, interpreted as consistent with perceived shifts toward forms of identified regulation and even with expressions of intrinsic motivation . This finding aligns with the results of Yong and Thi (2022), who highlight that collaboration and a sense of belonging strengthen the fulfillment of the need for relatedness and act as mediators between controlled and self-determined motivation in digital environments.

Peer teaching emerged as an experience of high affective and cognitive value. Students reported that explaining content to others allowed them to confirm their conceptual mastery and strengthen their self-confidence, thereby triggering the need for competence. This finding aligns with the arguments of Rodríguez et al. (2022), who describe how the practice of sharing knowledge promotes individual and situational interest, and complements the results obtained in previous studies on motivation in mathematics education (Castro & Miranda 2019; Leenknecht et al. 2019).

Regarding the teacher's role, participants associated the perception of a teacher acting as a facilitator with a motivational climate conducive to autonomy and integrated regulation. Participants valued the opportunity to make decisions and reflect on their own learning, which is consistent with the literature linking climates that support autonomy to the development of more self-determined forms of motivation (Howard et al. 2021; Huyghebaert-Zouaghi et al. 2021). Furthermore, this finding is particularly relevant in virtual contexts, where the sense of teacher presence depends on communication and support strategies that balance guidance and freedom.

Finally, ownership of learning and recognition of individual progress were interpreted, in the retrospective accounts referring to the final stage of the course, as expressions consistent with intrinsic motivation . These motivational expressions, , are not limited to the enjoyment of learning but extend to perceptions of self-efficacy and the construction of a professional teaching identity oriented toward continuous learning. This identity component, which has been less explored in the literature on Mastery Learning, represents a future line of inquiry that could link self-determination with the development of teacher identity (Ma 2022).

Overall, the results show that it is possible to design online instructional programs that not only convey content but areassociated, from the participants' retrospective perspective, with motivational changes also significant . The motivational changes reconstructed retrospectively allow for an expansion of an analysis focused solely on specific motivational states, showing how the participants link pedagogical conditions (assessment, collaboration, facilitative teaching, and recognition of progress) with more autonomous forms of academic engagement.

Among the study's limitations, it should first be noted that the results are based on a single focus group consisting of nine participants; therefore, the interpretations obtained correspond to the experiences and meanings constructed by this group and are not intended to be generalized to other contexts. Furthermore, since the focus group was conducted at the end of the semester, changes in motivation were reconstructed retrospectively based on the students' accounts rather than through measurements taken at different points during the course. For this reason, the results do not allow for the establishment of longitudinal trajectories or the determination of the temporal stability of the identified forms of motivation. Another limitation stems from the instructor's dual role as both the course instructor and the focus group moderator, a situation that may have influenced how participants expressed their experiences, even though the activity took place after the course had ended and grades had been finalized. Consequently, the findings must be interpreted in light of the situated, retrospective, and interpretive nature of the design and the absence of longitudinal measurements that would allow for a direct comparison of the perceived motivational changes throughout the educational process.

From the perspective of mathematics , these findings provide criteria for designing teaching experiences that integrate mathematical learning with the motivational conditions in which it takes place. In particular, the

participants' accounts suggest the importance of using the initial assessment as an opportunity to identify prior knowledge and guide learning, rather than having it perceived solely as a punitive evaluation. Likewise, solving and explaining mathematical problems with peers educationcan offer opportunities to articulate reasoning, compare strategies, and assess one's own mastery of the content, while collaborative work fosters experiences related to social connection and a sense of belonging. Added to this is the importance of feedback that acknowledges progress and of a teacher's facilitative role that combines structure, support, and opportunities for decision-making. Taken together, participants associated these conditions with experiences related to the needs for competence, autonomy, and connection—dimensions that are particularly relevant for the design of mathematics instruction in virtual environments for advanced training (Castro & Miranda 2019; Castro-Navarro et al. 2020; Panaoura et al. 2024). These associations should be understood as interpretations derived from the participants' retrospective accounts and not as evidence of causal effects of these pedagogical strategies.

Conclusions

This study has provided insight into how graduate students in Mathematics Education retrospectively reconstruct perceived changes in their motivation, during an online course structured according to the Mastery Learning approach. Through thematic analysis of a focus group , five central themes were identified that not only allowed for the classification of types of motivation but also enabled the retrospective reconstruction of perceived motivational changes—from experiences associated with demotivation or more controlled forms of regulation toward others compatible with more autonomous and intrinsic forms of motivation .

The accounts analyzed suggest that certain pedagogical practices—such as initial assessment, collaborative work, peer teaching, and a teacher's role as a facilitator—were associated in the accounts with experiences consistent with processes of internalization of motivation , as posited by SDT. Particularly valuable is the finding that several participants retrospectively described changes consistent with a transition from forms of introjected regulation toward expressions of intrinsic motivation , a phenomenon that has been little documented empirically in the Latin American context and in studies focused on graduate education.

These results reinforce the importance of designing instructional experiences that promote the fulfillment of basic psychological needs (autonomy, competence, and relatedness), especially in virtual environments where these needs are often threatened. It is noteworthy that the Mastery Learning approach, combined with collaborative strategies and constant feedback, was associated by participants with favorable motivational climates and with experiences consistent with more autonomous forms of motivation .

From a practical perspective, this study recommends that teachers and designers of graduate programs consider not only the content and teaching modality but also the relational and emotional conditions that enable students to take ownership of the learning process. Furthermore, it proposes systematically integrating tools to monitor student motivation and perceptions throughout the course. This recommendation is particularly relevant given that the present study retrospectively reconstructs perceived motivational changes based on a single focus group conducted at the end of the educational experience. In this regard, future research should incorporate longitudinal measurements at different points during the course to allow for a comparison of these retrospective reconstructions with motivational variations recorded as the experience unfolded.

Future research could explore how perceived motivational changes are linked to subsequent professional performance, and whether the motivational changes retrospectively reconstructed by participants are maintained, modified, or take on new meanings in later stages of their professional careers . Likewise, it is suggested to investigate in greater depth the tensions that may arise during moments of motivational transition, and the role of the instructor as a mediator of these complex dynamics. Furthermore, it is suggested that further research be conducted on how perceived motivational changes are linked to other factors such as performance, self-regulation, self-efficacy, and a sense of belonging.

References

Bai X, Gu X 2022. Effect of teacher autonomy support on the online self-regulated learning of students during COVID-19 in China: The chain mediating effect of parental autonomy support and students' self-efficacy. *Journal of Computer Assisted Learning* 38(4):1173-1184. https://doi.org/10.1111/jcal.12676

Bakhtiar A, Hadwin AF 2022. Motivation from a self-regulated learning perspective: Application to school psychology. *Canadian Journal of School Psychology* 37(1):93-116. https://doi.org/10.1177/08295735211054699

Barbour R 2018. *Doing Focus Groups*. 2nd ed., SAGE Publications Ltd, London, 224 pp.

Bieg M, Goetz T, Sticca F, Brunner E, Becker E, Morger V, Hubbard K 2017. Teaching methods and their impact on students' emotions in mathematics: An experience-sampling approach. *ZDM Mathematics Education* 49(3):411-422. https://doi.org/10.1007/s11858-017-0840-1

Biese M, Sydänmaanlakka AS, Holm ME, Häsä J, Hannula MS 2024. Differences in mathematics-related achievement emotions between in-person and distance learning arrangements during the COVID-19 pandemic. *Educational Psychology* 44(1):96-116. https://doi.org/10.1080/01443410.2024.2306277

Braun V, Clarke V 2021. One size fits all? What counts as quality practice in (reflexive) thematic analysis? *Qualitative Research in Psychology* 18(3):328-352. https://doi.org/10.1080/14780887.2020.1769238

Burgueño R, García-González L, Abós Á, Sevil-Serrano J 2024. Students' motivational experiences across profiles of perceived need-supportive and need-thwarting teaching behaviors in physical education. *Physical Education and Sport Pedagogy* 29(1):82-96. https://doi.org/10.1080/17408989.2022.2028757

Castro EJ, Miranda I 2019. Demotivational and motivational experiences of male engineering students regarding the study of mathematics. The case of Andrés Bello University in Santiago, Chile. *Formación Universitaria* 12(6):83-92. https://doi.org/10.4067/S0718-50062019000600083

Castro-Navarro E, Urbina M, Toledo M 2020. Motivations and demotivations of graduate students in mathematics education based on the mastery learning methodology. *Paulo Freire. Revista de Pedagogía Crítica* 23:135-157. https://doi.org/10.25074/pfr.v0i23.1654

Chiu TKF 2022. Applying self-determination theory (SDT) to explain student engagement in online learning during the COVID-19 pandemic. *Journal of Research on Technology in Education* 54(sup1):S14-S30. https://doi.org/10.1080/15391523.2021.1891998

Collie RJ, Martin AJ 2019. Motivation and engagement in learning. In K Hytten (ed.). *Oxford Research Encyclopedia of Education*. Oxford University Press, Oxford. https://doi.org/10.1093/acrefore/9780190264093.013.891

Datu JAD 2018. Flourishing is associated with higher academic achievement and engagement in Filipino undergraduate and high school students. *Journal of Happiness Studies* 19(1):27-39. https://doi.org/10.1007/s10902-016-9805-2

Dwijuliani R, Rijanto T, Munoto, Nurlaela L, Basuki I, Maspiyah 2021. Increasing student achievement motivation during online learning activities. *Journal of Physics: Conference Series* 1810(1):012072. https://doi.org/10.1088/1742-6596/1810/1/012072

Ferguson LM, Yonge O, Myrick F 2004. Students' involvement in faculty research: Ethical and methodological issues. *International Journal of Qualitative Methods* 3(4):56-68. https://doi.org/10.1177/160940690400300405

Fokkens-Bruinsma M, Vermue C, Deinum JF, van Rooij E 2021. First-year academic achievement: The role of academic self-efficacy, self-regulated learning, and engagement beyond the classroom. *Assessment & Evaluation in Higher Education* 46(7):1115-1126. https://doi.org/10.1080/02602938.2020.1845606

Froiland JM, Worrell FC 2016. Intrinsic motivation, learning goals, engagement, and achievement in a diverse high school. *Psychology in the Schools* 53(3):321-336. https://doi.org/10.1002/pits.21901

Hammond K, Barber C 2024. The limits of mastery learning. *Phi Delta Kappan* 106(2):14-18. https://doi.org/10.1177/00317217241287979

Hanafi NH, Zakaria MI, Ismail N, Hanid MFA, Suhaimee NRA 2025. Insights into M-learning in Mathematics Education: A bibliometric study from 2007 to 2024. *International Journal of Instruction* 18(3):637-658. https://doi.org/10.29333/iji.2025.18333a

Heo H, Bonk CJ, Doo MY 2021. Enhancing learning engagement during the COVID-19 pandemic: Self-efficacy in time management, technology use, and online learning environments. *Journal of Computer-Assisted Learning* 37(6):1640-1652. https://doi.org/10.1111/jcal.12603

Herdian, Subekti RL 2022. Achievement goal orientation in online learning: Is the performance goal more important than the mastery goal for pharmacy students? *International Journal of Scientific Research and Management* 10(4):1052-1056. https://doi.org/10.18535/ijsrm/v10i4.sh02

Howard JL, Bureau J, Guay F, Chong JXY, Ryan RM 2021. Student motivation and associated outcomes: A meta-analysis from self-determination theory. *Perspectives on Psychological Science* 16(6):1300-1323. https://doi.org/10.1177/1745691620966789

Huyghebaert-Zouaghi T, Ntoumanis N, Berjot S, Gillet N 2021. Advancing the conceptualization and measurement of psychological need states: A 3 × 3 model based on Self-Determination Theory. *Journal of Career Assessment* 29(3):396-421. https://doi.org/10.1177/1069072720978792

Kaiser K 2009. Protecting respondent confidentiality in qualitative research. *Qualitative Health Research* 19(11):1632-1641. https://doi.org/10.1177/1049732309350879

Krueger RA, Casey MA 2014. *Focus Groups: A Practical Guide for Applied Research*. 5th ed., SAGE Publications, Thousand Oaks, 280 pp.

Leenknecht M, Hompus P, van der Schaaf M 2019. Feedback-seeking behavior in higher education: The association with students' goal orientation and deep learning approach. *Assessment & Evaluation in Higher Education* 44(7):1069-1078. https://doi.org/10.1080/02602938.2019.1571161

Levitt HM, Bamberg M, Creswell JW, Frost DM, Josselson R, Suárez-Orozco C 2018. Journal article reporting standards for qualitative primary, qualitative meta-analytic, and mixed methods research in psychology: The APA Publications and Communications Board task force report. *American Psychologist* 73(1):26-46. https://doi.org/10.1037/amp0000151

Liu WC 2021. Implicit theories of intelligence and achievement goals: A look at students' intrinsic motivation and achievement in mathematics. *Frontiers in Psychology* 12:593715. https://doi.org/10.3389/fpsyg.2021.593715

Liu Y, Huang Z, Wang G 2023. Student learning performance prediction based on online behavior: An empirical study during the COVID-19 pandemic. *PeerJ Computer Science* 9:e1699. https://doi.org/10.7717/peerj-cs.1699

Ma D 2022. The role of motivation and commitment in teachers' professional identity. *Frontiers in Psychology* 13:910747. https://doi.org/10.3389/fpsyg.2022.910747

Miao J, Ma L 2023. The influence of teacher autonomy support on online learning engagement: The mediating roles of self-efficacy and self-regulated learning. *SAGE Open* 13(4):1-13. https://doi.org/10.1177/21582440231217737

Ng B 2018. The neuroscience of growth mindset and intrinsic motivation. *Brain Sciences* 8(2):20. https://doi.org/10.3390/brainsci8020020

Niemiec CP, Ryan RM 2009. Autonomy, competence, and relatedness in the classroom: Applying self-determination theory to educational practice. *Theory and Research in Education* 7(2):133-144. https://doi.org/10.1177/1477878509104318

Nowell LS, Norris JM, White DE, Moules NJ 2017. Thematic analysis: Striving to meet the trustworthiness criteria. *International Journal of Qualitative Methods* 16(1):1-13. https://doi.org/10.1177/1609406917733847

Olmos-Vega FM, Stalmeijer RE, Varpio L, Kahlke R 2023. A practical guide to reflexivity in qualitative research: AMEE Guide No. 149. *Medical Teacher* 45(3):241-251. https://doi.org/10.1080/0142159X.2022.2057287

Panadero E 2023. Toward a paradigm shift in feedback research: Five further steps influenced by self-regulated learning theory. *Educational Psychologist* 58(3):193-204. https://doi.org/10.1080/00461520.2023.2223642

Panaoura A, Charalambides M, Tsolaki E, Pericleous S 2024. First-year engineering students' affective behavior toward mathematics in relation to their performance. *European Journal of Science and Mathematics Education* 12(1):128-138. https://doi.org/10.30935/scimath/13884

Rahma NA, Pujiastuti H 2021. The effectiveness of online mathematics instruction during the COVID-19 pandemic in the city of Cilegon. *Journal of Holistic Mathematics Education* 5(1):1-12. https://doi.org/10.19166/johme.v5i1.3811

Rodríguez S, González-Suárez R, Vieites T, Piñeiro I, Díaz-Freire FM 2022. Self-regulation and student well-being: A systematic review 2010–2020. *Sustainability* 14(4):2346. https://doi.org/10.3390/su14042346

Ryan RM, Deci EL 2020. Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary Educational Psychology* 61:101860. https://doi.org/10.1016/j.cedpsych.2020.101860

Sim J, Waterfield J 2019. Focus group methodology: Some ethical challenges. *Quality & Quantity* 53(6):3003-3022. https://doi.org/10.1007/s11135-019-00914-5

Tambunan H, Sinaga B, Widada W 2021. Analysis of teacher performance to build student interest and motivation toward mathematics achievement. *International Journal of Evaluation and Research in Education* 10(1):42-47. https://doi.org/10.11591/ijere.v10i1.20711

Tan SH 2018. Mastery learning. In BB Frey (ed.). *The SAGE Encyclopedia of Educational Research, Measurement, and Evaluation*. SAGE Publications, Thousand Oaks, p. 1024. https://doi.org/10.4135/9781506326139.n413

Tracy SJ 2024. Qualitative Research Methods: Collecting Evidence, Crafting Analysis, Communicating Impact. 3rd ed., Wiley-Blackwell, Hoboken, 480 pp.

Urdabayev M, Ainakul N, Sabdenaliyev B 2024. Modernization of the Motivation Systems in Higher Education: Challenges and Digital Solutions. *Eurasian Journal of Economic and Business Studies* 68(3):111-126. https://doi.org/10.47703/ejebs.v68i3.431

Winget M, Persky AM 2022. A practical review of mastery learning. *American Journal of Pharmaceutical Education* 86(10):8906. https://doi.org/10.5688/ajpe8906

Winlow H, Simm D, Marvell A, Schaaf R 2013. Using focus group research to support teaching and learning. *Journal of Geography in Higher Education* 37(2):292-303. https://doi.org/10.1080/03098265.2012.696595

Wu D, Dong X 2024. Autonomy support, peer relations, and teacher-student interactions: Implications for psychological well-being in language learning. *Frontiers in Psychology* 15:1358776. https://doi.org/10.3389/fpsyg.2024.1358776

Yong SM, Thi LS 2022. Online learning motivation during the COVID-19 pandemic. *Malaysian Journal of Learning and Instruction* 19(2):213-249. https://doi.org/10.32890/mjli2022.19.2.8

Zakariya YF 2022. Improving students' mathematics self-efficacy: A systematic review of intervention studies. *Frontiers in Psychology* 13:986622. https://doi.org/10.3389/fpsyg.2022.986622