THE INTERPLAY OF EMOTION AND DECISION: AN INSTRUMENT FOR MATH TEACHER ERROR RESPONSE

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This study presents the development and pilot testing of a vignette-based research instrument designed to capture the interplay between mathematics teachers' emotions and decision-making. Focusing on situations involving students' mathematical errors, the instrument elicits teachers' emotional responses, teaching actions, and the typical and emotional resources underlying their decisions. Data from a pilot sample of secondary mathematics teachers illustrate the instrument's capacity to capture emotion intensity, action selection, and justificatory reasoning. The findings demonstrate the analytical potential of the instrument and inform its further refinement, contributing a scalable tool for systematic quantitative investigation of emotion–decision-making processes in mathematics teaching.

INTRODUCTION

Emotions are integral to everyday experience and, interacting with cognition and action, shape decision-making. Despite their importance, the relationship between mathematics teachers' emotions and decision-making remains underexplored, particularly in secondary education (Martinez-Sierra et al., 2022). Student errors constitute a salient context in which teachers' emotions and decisions interplay. Teachers' reactions to student errors are complex and multifaceted; however, existing instruments tend to examine emotions and actions in isolation, limiting the ability to capture their dynamic interplay. Addressing this gap, Kourti and Potari (2024), through an in-depth qualitative study of four secondary mathematics teachers, introduced a methodological and analytical tool for investigating teachers' emotions and decision-making interplay during pivotal teaching moments. Building on this work, the present study aims to develop and pilot a research instrument that extends this approach to a broader sample and supports quantitative exploration. While qualitative studies are essential for revealing the situated complexity of teachers' emotions and decision-making, a quantitative approach is needed to examine recurring patterns across larger samples and instructional contexts. The present study addresses this need by piloting a research instrument designed to enable systematic and scalable investigation of the interplay between teachers' emotions and instructional decision-making. Specifically, the instrument captures teachers' emotional responses, teaching actions, and the typical and emotional resources underlying their emotions and decisions when managing students' mathematical errors, with the study focusing on illustrating the analytical possibilities the instrument affords.

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THEORETICAL BACKGROUND

According to activity theory, emotions reflect the relationship between an individual's motives and their expectations regarding the success of their actions (Roth & Radford, 2011). To study emotions, Schuman and Scherer (2014) conceptualized them as episodic phenomena composed of multiple components: (1) the subjective feeling component, in which individuals experience and recognize what is felt at a given moment; (2) the motor component, referring to how emotions are expressed (e.g., facial expressions, gestures); (3) the physiological component, involving bodily reactions (e.g., blood flow); (4) the action tendency component, whereby after recognizing an emotion the body is oriented toward action; and (5) the appraisal component, through which individuals identify situations that elicit emotions and evaluate their impact on well-being. Plutchik (2001) proposed the wheel of emotions, consisting of eight basic emotions organized into four pairs of opposites (e.g., joy–sadness), with four positive (anticipation, joy, trust, surprise) and four negative (anger, fear, disgust, sadness). The wheel also represents gradations of intensity: emotional intensity increases toward the center and decreases toward the outer layers (e.g., terror–fear–apprehension).

Within activity theory, decision-making is shaped both by the subject's (e.g., teacher's) goals and by social interaction and needs arising within the activity. Decisions are manifested through the subject's actions, which are inherently mediated by emotional appraisals: *"Emotion and volition are inseparable and mutually constitutive moments of the same unit"* (Roth & Radford, 2011, p. 22). In a previous study, Kourti (2023) distinguishes exploratory, guiding, and emotional teaching actions. Exploratory actions engage students' reasoning, guiding action's structure activity with limited exploration, and emotional actions capture teachers' verbal expressions of appraisal and emotion. Subcategories include eliciting, responding, facilitating, and extending student reasoning (Ellis et al., 2019, as cited in Kourti, 2023).

To examine why teachers tend to act in particular ways, Kourti and Potari (2024) employed a synthesis of Engeström's (2001) four-dimensional resource framework and that of Herbst and Chazan (2012), identifying five resource dimensions: (1) the social-spatial (SS-D) found in the communities influencing the decisions (e.g., who else should be included?), (2) the anticipatory-temporal (AT-D), found in the temporally distributed steps of decisions (e.g., what previous and next steps should be considered?), (3) the moral-ideological (MI-D), grounded on issues of power and teacher's responsibility about students' well-being (e.g., who is responsible and who decides?), (4) systemic–developmental (SD-D), involving decisions aimed at changing the way the activity is enacted, (5) teacher's responsibility about mathematics (RM-D) corresponds to disciplinary obligation (Herbst & Chazan, 2012). It refers to obligations grounded in the scientific discipline of mathematics. Teachers are expected to present mathematical knowledge that accurately represents the discipline's knowledge, practices, and applications. A previous study by Kourti and Potari (2024) employed these categories of actions and resources, highlighting the connection between

resources and the appraisal component of teachers' emotions and proposing their integration as an analytical framework for the dialectical investigation of the activity of teaching. Building on this framework, the present study introduces and pilot-tests a vignette-based research instrument designed to examine the interplay between mathematics teachers' emotions and instructional decision-making. The pilot implementation aims to demonstrate the instrument's analytical potential and to inform its subsequent use in larger-scale quantitative research, thereby strengthening empirical investigation of the emotion–decision-making interplay in mathematics teaching. The following research questions guide the investigation: (RQ1) What emotional responses and teaching actions do teachers report when managing students' mathematical-errors? (RQ2) Which typical and emotional resources are activated by teachers while managing students' mathematical-errors? (RQ3) What indicative patterns emerge among teachers' emotional responses, activated resources, and teaching actions?

METHODOLOGY

Participants and Materials

The pilot study involved 11 secondary mathematics teachers (6 female). Most participants held a master's degree (10) and had up to 10 years of teaching experience (8). The study employed a pilot, vignette-based instrument development design, combining descriptive quantitative analyses with theory-driven qualitative coding. For this purpose, an online questionnaire was developed, presenting teachers with three scenarios depicting everyday classroom situations involving the management of students' mathematical errors. The scenarios were presented in the form of vignettes, designed in line with the framework proposed by Skilling and Stylianides (2020). As short descriptive episodes simulating authentic classroom situations, vignettes constitute a flexible research tool well suited to educational research. Accordingly, the three vignettes were constructed to represent teaching moments in which teachers are called upon to handle students' mathematical errors (conceptual, procedural, and proof-related). This design enables the examination of teachers' emotional responses, activated resources, and teaching actions across contexts. Vignette 1 depicts a secondary lesson on quadratic equations near the end of class, where students misinterpret the discriminant and rely on procedural approaches rather than Vieta's formulas. Vignette 2 presents a geometry lesson toward the end of the school day marked by conceptual and proof-related errors, including misused definitions and circular reasoning. Vignette 3 describes a lesson on polynomial factorization, during which some students are absent and those present display limited engagement, leading to confusions between factors and roots and reliance on procedurally driven strategies.

After reading each vignette, participants responded to a series of questions. Question 1 (Q1) asked teachers to rate the intensity (0–5) of eight basic emotions from Plutchik's (2001) model elicited by the vignette. Q2 invited teachers, through an open-ended response, to explain why they experienced these emotions. Q3 asked teachers to select the teaching action they would be most likely to adopt from a predefined list of guiding

and exploratory actions and empirically grounded subcategories (Kourti, 2023), with the option to choose "Other" and describe their action in their own words if the provided options did not apply. Q4 required teachers to identify the resources influencing their decision by selecting one or more predefined resource categories (social–spatial, anticipatory–temporal, moral–ideological, and disciplinary responsibility). Q5 asked teachers to justify their selected action in an open-ended response, describing what they aimed to achieve. Four of the five resource dimensions proposed in the framework of Kourti and Potari (2024) were used to examine the resources contributing to the interaction between teachers' emotions and decision-making (Q2, Q4, and Q5). All resources presented above were included except the systemic-developmental dimension, as capturing changes in the enactment of the activity requires data on how the activity was performed at a prior time. Finally, Q6 invited open-ended feedback on the clarity, realism, and design of the questionnaire.

Analysis

For the questions following each vignette, the coded data were analyzed using descriptive statistical methods. Responses to closed-ended questions were analyzed by calculating means and sample standard deviations for emotion intensity ratings, and frequencies for selected teaching actions and resource dimensions, per vignette. Responses to the open-ended Q2 and Q5 were analyzed using a deductive, theory-driven coding approach, aligned with principles of qualitative content analysis. This approach was guided by the resource framework proposed by Kourti and Potari (2024) and was used to code the resources contributing to teachers' emotional experiences (emotional resources) and to their teaching actions (typical resources), respectively [indicative response to Q5: "*I would like the discussion to be completed within the lesson time and for students to become enthusiastic (code given: MI-D) about the usefulness of the formulas. I trust that this will happen. However, I anticipate that it will not happen during this lesson (code given: AT-D)*"]. Responses to Q6 were analyzed using open and axial coding, yielding feedback on vignette realism, response options, and completion time.

RESULTS

Tables 1 and 2 present descriptive patterns of teachers' emotional responses and teaching actions across the three vignettes, which are examined in relation to RQ1. Table 1 presents the intensity of teachers' emotional responses across the three mathematical-error vignettes. Across the vignettes, positive emotions, particularly anticipation and trust, dominate teachers' emotional responses, while negative emotions remain consistently low. Standard deviations indicate moderate variability in teachers' emotions, suggesting both common and differentiated emotional patterns across scenarios. Table 1's purpose is not to compare emotions per se, but to demonstrate that the instrument can capture the selection of emotions and the intensity with which these emotions are experienced in response to different teaching situations.

Table 1: Mean (and Standard Deviation) of Teachers' Emotional Intensity Ratings

Subjective feeling	Anticipation	Trust	Surprise	Sadness	Joy	Fear	Anger	Disgust
Vignette 1	3,45 (0.82)	2,45 (1.13)	1,82 (1.17)	1,82 (1.08)	1,27 (1.10)	0,9 (0.83)	1 (0.89)	0,55 (0.69)
Vignette 2	3,18 (1.17)	1,82 (1.25)	1,27 (1.19)	1,55 (1.37)	1,18 (1.40)	1 (1.18)	0,73 (1.01)	0,64 (0.81)
Vignette 3	3,00 (1.10)	2,36 (1.36)	2,00 (1.26)	1,18 (1.25)	1,45 (1.44)	0,73 (0.90)	0,64 (0.92)	0,55 (0.69)
Average	3,21	2,21	1,7	1,52	1,3	0,88	0,79	0,58

Table 2 presents the frequency of teaching actions and sub-actions adopted by teachers in each vignette. Across Vignettes 1 and 2, guiding actions slightly predominate, with facilitation emerging as the most frequent sub-action, particularly in Vignette 2.

Table 2: Teaching Actions and Sub-actions frequencies by Vignette

	Guiding actions			Exploratory actions		
Vignette	1st	2nd	3rd	1st	2nd	3rd
Eliciting actions	2	0	0	4	1	4
Responding actions	1	0	3	0	2	1
Facilitating actions	3	6	2	0	1	0
Extending student reasoning	0	0	0	1	1	1
Total	6	6	5	5	5	6

In contrast, Vignette 3 shows a shift toward exploratory actions, mainly through eliciting student thinking. The variation in both action types and sub-actions across vignettes highlights the instrument's ability to capture fine-grained differences in teachers' instructional responses to different mathematical-error situations. This table also demonstrates the instrument's ability to document not only broad instructional orientations (i.e., guiding versus exploratory actions) but also fine-grained pedagogical moves within these categories, such as eliciting, facilitating, responding, or extending).

In relation to RQ2, Table 3 summarizes the frequency of activated resource dimensions across vignettes, distinguishing between emotional (Emo) and typical (Typ) resources. Across all three vignettes, moral-ideological (MI-D) and anticipatory-temporal (AT-D) resources are activated most frequently, both at the emotional and typical level,

indicating their central role in teachers' reasoning. Social-spatial resources (SS-D), appear consistently but less prominently, while responsibility about mathematics (RM-D) is activated only marginally across vignettes. These recurring patterns also shows the instrument's capacity for consistent capture of teachers' resource activation.

Table 3: Resource Activation Frequencies by Dimension and Vignette

SS-D						MI-D						AT-D						RM-D					
Vignette			*Vignette*			*Vignette*			*Vignette*			*Vignette*			*Vignette*			*Vignette*			*Vignette*		
1	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*
Emo			Typ			Emo			Typ			Emo			Typ			Emo			Typ		
3	2	2	7	7	6	5	7	6	10	11	8	7	8	4	9	7	10	2	0	1	1	1	1
7			20			18			29			19			26			3			3		

The results indicate relationships between teachers' emotional responses, activated resources, and teaching actions (RQ3). Table 4 synthesizes the dominant emotions, resources, and teaching actions per vignette by aggregating the highest-intensity emotions, the most frequently activated resource dimensions, and the prevailing action types. In Table 4, parentheses denote mean intensity scores for emotions and frequencies for resources and teaching actions.

Table 4: Indicative Emotion–Resource–Action Patterns by Vignette

	Emotions (Mean)	Emotional Resources (Fr)	Typical Resources (Fr)	Action type (Fr)
Vignette 1	Anticipation (3.45) Trust (2.45) Surprise (1.82)	AT-D (7) MI-D (5) SS-D (3)	MI-D (10) AT-D (9) SS-D (7)	Guiding (6) Facilitating (3) Eliciting (6)
Vignette 2	Anticipation (3.18) Trust (1.82) Joy (1.18)	MI-D (7) AT-D (8) SS-D (2)	MI-D (11) AT-D (7) SS-D (7)	Guiding (6) Facilitating (7) Responding (2)
Vignette 3	Anticipation (3.00) Surprise (2.00) Joy (1.45)	AT-D (4) MI-D (6) SS-D (2)	AT-D (10) MI-D (8)	Exploratory (6) Eliciting (4) Responding (4)

Across all three vignettes, anticipation emerges as the dominant emotional response, accompanied by moderate levels of trust and, in some cases, surprise or joy, indicating a shared emotional orientation toward students' mathematical errors. Regarding resources, the anticipatory–temporal and moral–ideological dimensions are activated most frequently across all vignettes, both in emotional and typical resources. This consistent pattern suggests that teachers' emotional experiences and instructional decisions are commonly grounded in temporal considerations and moral–ideological commitments. In terms of teaching actions, guiding actions predominate in two of the three vignettes, while exploratory actions slightly prevail in the third. Additionally, this pattern points to a largely stable instructional orientation, with limited variation across vignettes. The similar response patterns emerged across all three episodes strengthens the instrument's ability to capture coherent and interpretable responses, providing indications of its validity.

DISCUSSION

Addressing the research questions, the findings show that teachers' emotional responses to students' mathematical errors are mainly characterized by anticipation and trust and are associated with systematic patterns of teaching actions and resource activation. Despite low levels of negative emotions, guiding actions predominated in the first two vignettes, while exploratory actions prevailed in the third. Within this overall pattern, the slightly higher prevalence of exploratory actions in Vignette 3 may be related to the teaching context, as this vignette unfolds near the beginning of the lesson. In contrast to Vignettes 1 and 2, which occur toward lesson closure, reduced time pressure may allow greater flexibility to engage with students' reasoning, in line with research showing that temporal constraints tend to favor more structured, teacher-centered actions (Herbst & Chazan, 2012).

The predominance of moral–ideological and anticipatory–temporal resources across all three vignettes suggests that teachers' reasoning in error-related situations is consistently shaped by concerns about responsibility toward students and anticipation of instructional consequences. The recurrence of these resource dimensions at both the emotional and typical level points to their centrality in how teachers interpret situations and justify their teaching decisions, regardless of vignette-specific features. These findings resonate with prior work emphasizing the role of responsibility and temporal anticipation in teachers' in-the-moment decision-making (Herbst & Chazan, 2012; Kourti & Potari, 2024).

The findings do not support causal claims about the role of emotions in shaping teaching actions. Instead, the synthesis of results shows that similar patterns of emotional responses, resource activation, and teaching actions recur across all three vignettes, indicating that these dimensions systematically co-occur in teachers' in-the-moment reasoning (Roth & Radford, 2011). These convergent patterns suggest a stable configuration in how teachers respond to error-related situations and, in turn,

demonstrate that the instrument is capable of coherently and meaningfully documenting the relationships among emotions, resources, and teaching actions.

Importantly, this capacity is illustrated within the underexplored context of secondary mathematics teaching, contributing empirical insight into teachers' in-the-moment decision-making (Martinez-Sierra et al., 2022).

Based on the pilot analysis, the revised instrument may capture nuanced relations between emotions, resources, and teaching actions, informing its further refinement and evaluation through larger-scale data collection. With improvements to the emotion scale, item formats, and vignette selection guided by error frameworks, the instrument is positioned to support more systematic quantitative analyses and investigation of the emotion–decision-making interplay in mathematics teaching.

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