Mathematical Creativity in Model-Eliciting Activities: Adapting and Refining an Analytical Framework

Duygu Arabacı[1]; Adnan Baki[2]

1 Düzce University, Türkiye
2 Trabzon University, Türkiye

Abstract: Existing approaches to mathematical creativity often focus on the evaluation of students' final products, offering a more limited view of how creative reasoning emerges during modelling processes. Addressing this gap, this study adapts Amaral and Carreira's (2012) analytical framework to the context of model-eliciting activities (MEAs). In this study, MEAs are understood as open-ended modelling tasks that require students to construct, test, and justify mathematical models in meaningful problem situations. The study examined the applicability of this framework in the MEA context and identified the additional resources needed for its refinement. Data were collected from the written work and clinical interviews of 12 Turkish middle school students in Grades 7 and 8, including six gifted and six non-gifted students, and analysed through deductive–inductive content analysis. The results indicated that the original indicators of originality, flexibility, and fluency remained relevant in the MEA context; however, three additional resources were needed to capture data-based mathematical inference, the prioritisation of alternative variables or criteria, and adaptive strategic reorganisation. These results suggest that the adapted framework offers a more process-sensitive analytic lens for examining mathematical creativity in MEAs and may support future research on modelling, assessment, and task design.

Keywords: mathematical creativity, model-eliciting activities, framework adaptation, middle school students.

Contact: duyguarabaci@duzce.edu.tr

1 Introduction

Creativity is widely recognised as a key competency for future learning and as a central aim of mathematics education (OECD, 2018). As a multidimensional construct encompassing cognitive styles, performance categories, and outcomes (Haylock, 1997), creativity enriches learners' ability to connect ideas, think flexibly, and make sense of mathematical experiences. Embedding creative thinking into mathematical activity supports deep understanding and enables students to view mathematics as a tool for exploration and problem solving (Chamberlin & Moon, 2005; Shriki, 2010). In mathematics education, creativity has long been discussed through the dimensions of fluency, flexibility, and originality. These perspectives have made an important contribution to recognising creative performance in students' mathematical work. At the same time, recent scholarship suggests that mathematical creativity cannot be understood solely through the quality of final products, since it also becomes visible in how ideas are generated, transformed, justified, and refined throughout mathematical activity (Lu et al., 2025; Lu & Kaiser, 2022a).

Within mathematics education, model-eliciting activities (MEAs) provide authentic opportunities to observe creativity in action. Model-eliciting activities are a distinctive class of modelling tasks designed to elicit students' construction, testing, and communication of mathematical models in meaningful problem situations (Johnson & Lesh, 2003; English, 2006). Unlike routine school problems, MEAs do not direct students toward a predetermined procedure or a single fixed answer; rather, they require students to interpret and reorganise contextual information, formulate assumptions, coordinate representations, and generate a solution that is mathematically defensible and reusable beyond the immediate case (Johnson & Lesh, 2003; English, 2006). This distinction is illustrated in English's (2006) study, in which students were asked to develop a consumer guide for determining the "best" snack chip. Rather than applying a given algorithm, they had to establish criteria, structure and compare data, weigh competing attributes, and refine a model capable of supporting a justified recommendation. Through the three creative processes of abstraction, association, and investigation identified by Brunkalla (2009), students iteratively construct, test, and refine models, thereby revealing creative behaviours that might remain invisible in routine problem solving (Haavold, 2013). In this sense, MEAs provide a context in which mathematical activity extends beyond answer production to include interpretation, model construction, revision, and justification, thereby offering a particularly suitable setting for examining how creative mathematical thinking becomes visible in the course of modelling. Although research on mathematical creativity has a long history, many existing approaches have been operationalised primarily through students' products. Torrance's (1974) indicators of fluency, flexibility, originality, and elaboration have long been recognised as fundamental components of creativity research. These indicators were later adapted to mathematics by Balka (1974), who introduced them into the field in a discipline-specific manner. Subsequently, Silver (1997) and Leikin (2009) reinterpreted these indicators to assess mathematical creativity, particularly in problem-solving and problem-posing contexts. These studies have made a substantial contribution by clarifying how mathematical creativity may be recognised and assessed. However, when creativity is inferred mainly from final responses, less attention is given to how ideas emerge, shift, and become justified throughout complex solution processes. Pitta-Pantazi et al. (2011) proposed a broad model linking mathematical and creative abilities, yet it offers limited insight into the contextual and dynamic nature of creative reasoning based on process data. Overall, this body of work indicates that creativity is often treated more readily through its visible outcomes than through the evolving actions and representations that give rise to those outcomes.

This limitation becomes even more pronounced in the context of MEAs. MEAs are inherently iterative, multimodal, and decision-driven tasks in which students interpret data, coordinate multiple representations, test emerging ideas, and justify evolving models (English, 2006; Johnson & Lesh, 2003). Recent research on mathematical modelling has further strengthened the view that modelling is closely related to creativity, since modelling problems are open and underdetermined and allow multiple pathways of interpretation and solution development (Lu & Kaiser, 2022a, 2022b; Lu et al., 2025). Earlier research has also shown that model-eliciting activities can support and reveal students' creative mathematical activity (Chamberlin & Moon, 2005; Gilat & Amit, 2013). Taken together, these studies suggest that relatively few have examined how mathematical creativity becomes visible through students' ongoing modelling processes. Similar tendencies are observed in the Turkish literature, where creativity is often examined through outcome-based measures rather than process-oriented analyses (Akgül, 2014; Gören Summak & Aydın, 2011). Consequently, there remains a need for a systematic and process-sensitive framework capable of tracing students' creative behaviours throughout the modelling cycle.

To address this need, the present study adapts and refines the framework of Amaral and Carreira (2012) for use in MEAs. Among the available approaches, this framework is particularly relevant because it relates the major dimensions of mathematical creativity to observable features of students' solution processes, thereby providing an analytical basis for examining creativity in action rather than inferring it solely from final products. At the same time, the framework was originally formulated in relation to problem solving beyond the classroom. Its application to MEAs therefore requires refinement, since modelling tasks call for forms of reasoning that include reorganising contextual data, coordinating multiple representations, weighing alternative variables, and revising an emerging model under situational constraints. The present study retains the central orientation of the framework while refining it to capture these modelling-specific manifestations of mathematical creativity. Accordingly, this study adapts and refines Amaral and Carreira's framework for analysing mathematical creativity in MEAs and evaluates its applicability through students' written products and clinical interviews. In doing so, it seeks to enhance the visibility of creative reasoning processes and connects theoretical development with classroom practice. Guided by this rationale, the study addresses the following research questions:

1. How can Amaral and Carreira's (2012) framework be adapted to model-eliciting activities, and which data-driven resources emerge from this adaptation?
2. How can the adapted framework be used to characterise middle-school students' originality, flexibility, and fluency in MEAs?

1.1 Theoretical Framework

The present study is grounded in the analytical framework proposed by Amaral and Carreira (2012), originally developed to characterise students' mathematical creativity in problem-solving processes beyond the classroom. In this framework, creativity is not treated as an abstract quality inferred only from final products; rather, it is examined through observable features of students' solution processes. This orientation makes the framework particularly relevant for the present study, which seeks to analyse mathematical creativity through students' written work and clinical interviews in MEA contexts.

Amaral and Carreira's (2012) framework is organised around three interrelated components: knowledge, indicators, and descriptors/resources. Knowledge refers to the mathematical activity involved in problem solving, including mathematical content, strategies, forms of reasoning, and mathematical language and symbols. Indicators refer to the major dimensions through which creativity is interpreted—Originality (O), Flexibility (Fx), and Fluency (Fn). Descriptors/resources, in turn, provide the more specific and observable basis for analysis. In other words, the descriptor names—Novelty, Representation, and Communication—identify the analytic focus associated with each indicator, whereas the numbered resources specify the concrete forms through which that indicator may become visible in students' solutions. An overview of this theoretical framework is presented in Table 1.

Table 1. Amaral and Carreira's (2012) framework of analysis of the finalists' problem solving processes (p. 1422)

Knowledge	Indicator Code	Descriptors/Resources Codes
Problem solving	**Originality (O)**	**Novelty (ON)** 1) Creates and interprets original figures, diagrams, tables, etc. as part of the solution (ON1) 2) Uses unusual and original strategies to solve the problem (ON2)
	Flexibility (Fx)	**Representations (FxR)** 1) Uses appropriate mathematical representations (FxR1) 2) Employs different representation systems (verbal, visual, numerical, etc.) (FxR2) 3) Builds connections between data and goals through representations (FxR3)
	Fluency (Fn)	**Communication (FnC)** 1) Uses mathematical concepts and procedures (FnC1) 2) Develops and explores mathematical concepts and procedures (FnC2) 3) Clearly and consistently explains the strategies used during the problem-solving process (FnC3) 4) Communicates the organized structure of the problem-solving process (FnC4)

As shown in Table 1, the framework does more than reproduce broad creativity categories. By linking each indicator to a descriptor family and to numbered resources, it offers an analytical structure through which creativity can be examined in relation to concrete aspects of students' mathematical activity. In this respect, the framework provides a basis for moving from general theoretical constructs to observable evidence in students' solution processes.

Originality refers to producing unexpected or unconventional solutions. Leikin (2009) defines it as a unique way of thinking that yields original intellectual products, whereas Amaral and Carreira (2012) describe it as solutions that deviate from those typically expected based on students' prior mathematical experience.

Flexibility denotes the ability to shift perspectives and apply multiple strategies through various representations (Leikin, 2009). According to Amaral and Carreira (2012), flexibility involves using representational systems effectively to interpret reasoning, translate information into mathematical form, and relate givens to goals.

Fluency refers to the number and continuity of ideas or solutions, as well as transitions between strategies, logical flow, and use of prior knowledge (Leikin, 2009; Silver, 1997). Amaral and Carreira (2012) link fluency to clear and coherent communication and to the capacity to generate and evaluate multiple mathematical ideas.

The value of this framework for the present study lies in its capacity to connect the major dimensions of mathematical creativity with observable features of students' solution processes. At the same time, the framework was originally articulated in relation to problem solving beyond the classroom rather than to modelling-oriented MEAs. For this reason, its use in the present study does not involve adopting a wholly new framework but adapting an existing one to a context that places greater emphasis on interpreting contextual information, reorganising data, coordinating multiple representations, weighing alternative variables, and revising an emerging model under situational constraints. Accordingly, the present study retains the core analytical architecture of Amaral and Carreira's framework while examining how its resources operate in MEA contexts and where further refinement is required. The methodological process through which the framework was applied and refined is described in the next section, and the additional MEA-specific resources derived from the data are presented in the Results.

2 Methodology

This section presents the participants, data sources, and analytic procedure through which Amaral and Carreira's (2012) framework was adapted to the present MEA context.

2.1 Participants

The participants comprised twelve Turkish students in Grades 7–8 (aged 12–14), including six identified as gifted and six as non-gifted. Given the mixed findings on the relationship between giftedness and creativity and the evidence of a positive association (Hershkovitz et al., 2008; Leikin & Lev, 2013; Leikin & Pitta-Pantazi, 2013), the inclusion of gifted students was methodologically warranted to support the development of a framework for assessing mathematical creativity in MEAs. Gifted students were those enrolled in Turkey's Science and Art Centers (SACs), following the Ministry of National Education's multi-stage national identification process (teacher nomination via standardized forms, group screening using cognitive tests such as TKT 7–11, and individual assessment using instruments such as the WISC-R). Non-gifted peers attended public schools and demonstrated at least average mathematics achievement based on teacher judgments and school grades. This criterion was applied to ensure that participants possessed sufficient conceptual understanding and experience to meaningfully express mathematical creativity (Haylock, 1997; Haavold, 2013). Purposive sampling was employed to deliberately select participants representing distinct ability groups (gifted and non-gifted) and to ensure balanced distribution across grade levels, which is appropriate for qualitative studies seeking in-depth comparison rather than statistical generalization (Patton, 2015). Within each subgroup, codes 1–3 denote Grade 7 (typically ages 12–13) and 4–6 denote Grade 8 (13–14). Participation was voluntary; reporting codes are G1–G6 (gifted) and NG1–NG6 (non-gifted).

2.2 Data Collection Tools

Data were collected through students' written work on a single model-eliciting activity and through individual clinical interviews. Because the present paper focuses on the adaptation of a creativity framework to an MEA context, only the task retained for the main study is reported here.2.2.1 Mathematical Model-Eliciting Activity: "Summer Jobs" and Students' Written Work

In this study, a model-eliciting activity originally developed by Johnson and Lesh (2003, pp. 270–271) and adapted into Turkish by the researcher was used to explore students' mathematical creativity. The translated version was reviewed by three mathematics teachers and four academic experts, including one language specialist. The mathematics education experts were experienced in mathematical modelling, problem solving, and problem posing. Based on their feedback, linguistic adjustments and minor contextual revisions were made before finalizing the task.

The "Summer Jobs" task presents a realistic employment decision scenario. Students are given tabulated data on nine park workers from the previous summer, including their working times, workload intensities, and earnings, and are asked to determine which six workers should be rehired for the following year—three full-time and three part-time—and to justify their decisions. The task was selected because it requires students to compare alternatives, interpret multiple variables, reorganise contextual data, and construct a mathematically justified decision model. In this respect, it creates opportunities for data organisation, proportional reasoning, ranking, selection, and weighted evaluation (Mousoulides et al., 2007, 2008). The full task statement is available in Johnson and Lesh (2003), the source from which the activity was adapted. Students were given two weeks to work on the task. During this period, they produced written solutions and participated in two individual clinical interviews conducted once per week. This design made it possible to examine not only the final written products but also the development of students' modelling decisions over time.

2.2.2 Clinical Interviews

Clinical interviews were conducted individually to elicit process-level evidence of students' mathematical creativity while working on the MEA. Following an in-depth, task-based interview approach (Legard et al., 2003), the interviews focused on how students interpreted the data, selected variables, constructed and coordinated representations, and justified or revised their decisions. Each student participated in two interviews over a two-week period, with each session lasting approximately 15–30 minutes. Interviews were conducted in quiet school settings and video-recorded with consent.

2.3 Framework Adaptation and Analytic Procedure

The present study adapted Amaral and Carreira's (2012) framework to an MEA context through an iterative analytic procedure consisting of preparation, pilot application, main analysis, and evaluation.

In the preparation phase, the literature on creativity, mathematical creativity, and its assessment was reviewed in detail. Particular attention was given to how fluency, flexibility, and originality have been conceptualised in the literature, together with the structure and resources of Amaral and Carreira's (2012) analytical framework. This review informed the analytical orientation of the study and supported the identification of candidate MEAs capable of eliciting mathematical creativity in modelling contexts. At this stage, two tasks were considered, one adapted from the literature and one developed by the researcher. The adapted task was translated into Turkish and revised in line with language and field-expert feedback.The pilot study was conducted to examine task clarity, cognitive demand, and the potential of the candidate tasks to elicit mathematical creativity. During this phase, students' written work and interview data were analysed in accordance with Amaral and Carreira's (2012) framework. The pilot analyses showed that many segments of the data could be interpreted through the original indicators and existing resources. At the same time, some forms of mathematical thinking that emerged in the data were not sufficiently captured by the available resources. These instances were therefore considered as possible indicators of mathematical creativity and provisionally coded. The pilot results also indicated that one of the candidate tasks did not generate sufficiently rich evidence of mathematical creativity, whereas the adapted Summer Jobs task elicited diverse strategies, multiple representations, and substantial opportunities for justification and revision. For this reason, only Summer Jobs was retained for the main study.

The main study followed the same analytic orientation. Students' written work and interview transcripts were analysed in sections in which they expressed a distinct idea, justification, decision, use of representation, or step in the solution process. These sections were then examined in relation to the original framework, that is, in terms of the three indicators of originality, flexibility, and fluency and their existing resources (ON, FxR, and FnC). Sections that were adequately represented by the original resources were coded accordingly. Forms of mathematical thinking that could not be fully explained by the existing resources were marked with provisional codes. As similar behaviours reappeared across participants' written work and interviews, these provisional codes were compared, reviewed, and consolidated. In addition, cases that appeared in only one student's solution were also retained when they were considered meaningful as potential indicators of mathematical creativity. In this way, the analysis preserved the structure of the original framework while allowing additional MEA-sensitive resources to emerge from the data.

The analytic procedure combined deductive and inductive content analysis. The deductive dimension involved examining the data through the indicators and existing resources of Amaral and Carreira's (2012) framework, whereas the inductive dimension involved identifying patterns not fully captured by the original structure through open coding, comparison, categorisation, and abstraction (Elo & Kyngäs, 2008; Hsieh & Shannon, 2005; Mayring, 2014; Thomas, 2006). Thus, the adaptation of the framework emerged through the interaction between the existing analytical structure and the demands of the modelling context.

In the evaluation phase, the initial coding of students' MEA solutions was carried out by the first author and then reviewed by the second author with attention to conceptual alignment and consistency of application. Coding differences were discussed until agreement was reached. The newly proposed resources were then submitted to two additional mathematics education experts for external review with regard to clarity, relevance, and coverage. Feedback from these reviews was incorporated into the final version of the framework. The credibility and consistency of the study were further supported through the combined use of students' written work and interview data, the consistent application of coding rules, and iterative comparison across cases (Lincoln & Guba, 1985). Finally, the adapted framework was applied across the dataset in order to examine its descriptive adequacy and functionality in capturing mathematical creativity in the MEA context, particularly with respect to originality, flexibility, and fluency as these became visible throughout students' modelling processes.

3 Results

This section presents the three additional resources identified in the analysis, as these constituted the main refinement of the framework in the MEA context. Each resource is introduced with its operational focus, an illustrative example from the data, and a brief analytic interpretation.

In the present dataset, the main refinement concerned originality and flexibility. While the original fluency-related resources (FnC1–FnC4) remained sufficient to describe communication-related aspects of students' modelling processes, the analysis revealed three additional resources that were needed to capture modelling-specific forms of inference, variable selection, and adaptive strategy revision.

Table 2. New resources added to the framework

Indicators	Descriptors/Resources Codes
Originality (O)	Draws original mathematical inferences from existing or self-generated data (ON3)
Flexibility (Fx)	Considers alternative variables, conditions, or criteria in solving the problem (FxR4)
	Adapts and reorganises a strategy for use under new conditions (FxR5)

As shown in Table 2, three new resources were identified in the analysis of students' written work and clinical interview data. These resources did not replace the original framework; rather, they extended it in order to capture forms of reasoning that became visible in the MEA context. The following subsections show how each resource contributed to the descriptive adequacy of the adapted framework.

3.1 ON3: Draws original mathematical inferences from existing or self-generated data

ON3 was introduced to capture a form of originality that was not fully represented by ON1 or ON2. In some sections of the data, students did not simply produce an original representation or use an unusual strategy; rather, they generated mathematically meaningful inferences from contextual or self-generated data and used these inferences to make sense of the modelling situation. ON3 was therefore used when a student drew a non-obvious mathematical inference from available data and treated it as relevant for interpreting the problem context.

An illustrative example comes from G1, who interpreted park density not as a fixed feature of the setting, but as a condition-dependent phenomenon shaped by weather, time of day, and weekly routines:

> In a low environment, it is either very rainy or very sunny. When it is very sunny, people don’t come here much … It can be a little early in the morning, or very late. Late hours are a bit busier again … it might be on weekends… (G1, Grade 7)

Rather than merely commenting on the context, the student constructed a conditional interpretation of park use by coordinating several contextual factors. This reasoning suggested that visitor flow would vary across changing conditions such as weather, time of day, and weekly routines. The analytic focus here is not on selecting a variable for decision making, but on generating a mathematically meaningful inference from contextual information that was not explicitly stated in the task data. ON3 was therefore necessary to represent originality expressed through data-based mathematical inference within the modelling process.

3.2 FxR4: Considers alternative variables, conditions, or criteria in solving the problem

FxR4 was introduced because the original flexibility resources mainly captured the use of representations and the connections established between givens and goals through representations. In the MEA context, however, some students demonstrated flexibility not by generating a new contextual inference, but by deciding which variable or criterion should organise the model. FxR4 was therefore used when a student explicitly considered, prioritised, or replaced a variable, condition, or criterion in order to construct or justify a modelling decision.

This form of reasoning is illustrated by G6, who chose not to base worker selection on density and instead relied on average earnings across the summer:

> R: So density is not important for you in determining the workers.
> G6: Yes. Because density can change every day. What was important for me was an average amount at an average density [...] I thought about how much it would be at average intensity, because that could change. At the average intensity, Buket was the highest. Mustafa and Zeynep followed her [...] I did the same for them, and this time Tuğba, Arzu and Emre came out. (G6, Grade 7)

Here, the student treated density as an unstable variable and prioritised average earnings as a more suitable basis for comparison. The analytic focus here is not on generating a new contextual inference, but on determining which variable should serve as the most meaningful basis for model construction and decision making. In this sense, FxR4 captures flexibility expressed through the selection and prioritisation of alternative variables or criteria.

3.3 FxR5: Adapts and reorganises a strategy for use under new conditions

FxR5 was introduced to capture a form of flexibility that was not fully represented by the existing FxR resources. In some sections of the data, students did not simply select a different variable or criterion; rather, they revised an already established strategy by reorganising its internal logic in response to a new condition that became relevant during the modelling process. FxR5 was therefore used when a student modified a previously adopted strategy by adding, reshaping, or reweighting decision criteria under changing conditions.

An illustrative example is provided by NG4. This student initially relied on average earnings across intensity levels when assigning full- and part-time roles, but later refined this strategy by introducing consistency across conditions as an additional criterion:

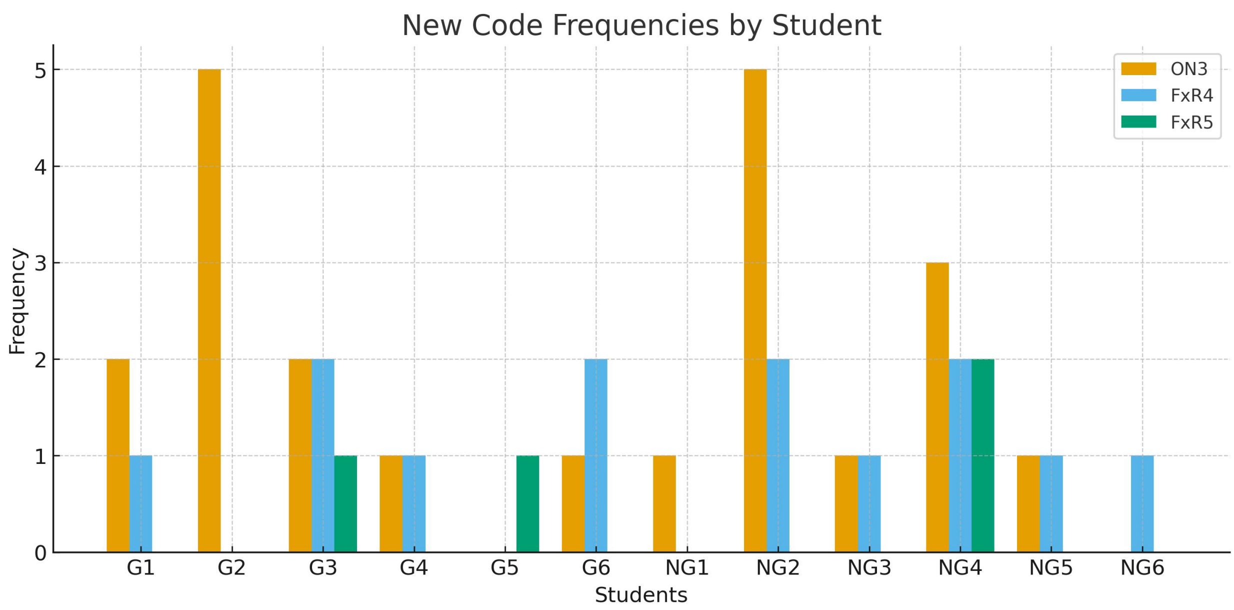
> R: For example, why did you choose Tuğba but not Zeynep and Sinan?
> NG4: Because Tuğba's low and medium days are always close to each other [...] Sinan's 87 and 19, the difference between them is very big [...] I chose Tuğba because Tuğba is much more consistent than the others. I also chose Zeynep because her prices are high and her consistency is good. (NG4, Grade 8)

Rather than abandoning the original strategy, the student reorganised it by incorporating stability across conditions into the decision process. The analytic focus here is not on generating a new contextual inference, as in ON3, or on selecting the most appropriate variable or criterion, as in FxR4, but on restructuring an existing strategy to make it more robust under new evaluative conditions. FxR5 was therefore necessary to represent flexibility expressed through adaptive strategic reorganisation within the modelling process.

3.4 Distribution and analytic contribution of the new resources

The distribution of the newly introduced resources across students is presented in Figure 1.

Figure 1. New Resources Frequencies by Student



As shown in Figure 1, ON3 occurred 22 times and was identified in 10 of the 12 students, while FxR4 occurred 13 times across 9 students and FxR5 occurred 4 times in 3 students. Within the present dataset, ON3 and FxR4 were distributed across a broader range of students than FxR5. This distribution indicates that data-based mathematical inference and the prioritisation of alternative variables or criteria were more recurrent features of students' modelling processes, whereas adaptive strategic reorganisation was observed less often. However, recurrence was not treated as the sole basis for retaining a resource. FxR5 was also retained because it captured a qualitatively distinct form of flexibility that extended the descriptive adequacy of the original framework in the MEA context.

Taken together, these results show that the refinement of the framework was not based solely on isolated illustrative excerpts. Rather, the additional resources emerged from the analysis of students' written and verbal reasoning in cases where the original framework did not provide sufficient analytic resolution. More specifically, ON3 made visible students' originality in generating mathematically meaningful inferences from contextual or self-generated data, FxR4 captured flexibility in selecting or prioritising alternative variables or criteria, and FxR5 captured flexibility in reorganising an existing strategy under new conditions. No additional resource was retained under fluency, suggesting that the original communication-related resources remained sufficient for describing that dimension in the present dataset.

4 Conclusions and Discussions

This study adapted Amaral and Carreira's (2012) analytical framework to the context of model-eliciting activities (MEAs) and identified three additional resources within the present dataset that extended the framework's descriptive adequacy: ON3, FxR4, and FxR5. Taken together, the results indicate that the original framework remained useful for examining students' mathematical creativity in MEAs, while requiring refinement to account for forms of reasoning that became visible during modelling processes. More specifically, the adapted framework made it possible not only to describe originality, flexibility, and fluency at a general level, but also to characterise how these dimensions were expressed through students' interpretation of contextual information, prioritisation of decision criteria, and revision of emerging strategies.

The three additional resources contributed to the framework in analytically distinct ways. ON3 made visible a form of originality expressed through mathematically meaningful inferences drawn from contextual or self-generated data. Rather than reducing originality to unusual products or strategies alone, this resource captured cases in which students inferred relationships or conditions that were not explicitly stated in the task but became relevant for interpreting the modelling situation. FxR4 extended the flexibility dimension by capturing how students considered and prioritised alternative variables, conditions, or criteria during model construction. In this respect, flexibility was expressed not only through the use of representations, but also through decisions about which aspects of the data should be treated as analytically central. FxR5 further extended flexibility by identifying cases in which students reorganised an existing strategy in response to new evaluative conditions. Taken together, these resources indicate that, in MEAs, creative mathematical thinking may become visible not only in what students produce, but also in how they interpret, select, and reorganise throughout the modelling process.

These results extend discussion in the mathematical creativity literature by bringing a process-sensitive perspective to work grounded in the dimensions of originality, flexibility, and fluency. Previous studies have made important contributions by conceptualising creativity through these dimensions and by identifying creative features in students' responses to mathematical tasks (Silver, 1997; Leikin, 2009). At the same time, recent research has increasingly emphasised that, in modelling contexts, mathematical creativity also becomes visible through the emergence, transformation, and justification of ideas during the solution process (Lu & Kaiser, 2022a; Lu et al., 2025). From this perspective, the present study suggests that MEAs provide a particularly suitable context for examining process-level creativity, as such activities require students to interpret contextual data, weigh alternative criteria, and reconsider provisional decisions while constructing a model (English, 2006; Johnson & Lesh, 2003). The adapted framework therefore offers an analytic perspective that is more sensitive to these modelling-specific aspects of creative reasoning while remaining grounded in the original indicator structure proposed by Amaral and Carreira (2012).

The study has two main implications. Theoretically, the results suggest that adapting a creativity framework to the MEA context does not require replacing its central indicators; rather, refinement may occur through the identification of additional resources that better account for context-specific forms of reasoning. In the present study, this refinement was concentrated in the dimensions of originality and flexibility, whereas the original fluency-related resources remained sufficient for describing the communication-related aspects of students' work. Practically, the adapted framework may support researchers and teacher educators in examining how mathematical creativity becomes visible in students' written work and interview data in modelling contexts. It may also inform the design and interpretation of MEAs by drawing attention to forms of reasoning that might otherwise remain less visible, such as contextual inference, variable prioritisation, and adaptive strategic reorganisation.

These implications should, however, be interpreted in light of the study's limitations. The analysis was based on a single main MEA and a small purposive sample comprising gifted and non-gifted Grade 7 and Grade 8 students. Written work and clinical interviews provided important access to students' modelling processes; however, they did not allow every moment of strategy development to be traced in real time. For this reason, the adapted framework should be regarded not as a final or comprehensive model for all MEA contexts, but as an analytically promising tool within the present dataset.

Future research may examine the applicability of the framework across different types of model-eliciting activities, broader student populations, and classroom-based implementations. Studies using richer process data, such as video recordings, screen capture, or time-stamped written records, may help trace finer-grained shifts in students' reasoning and provide further opportunities to test the boundaries of the new resources identified here. Overall, the present study suggests that mathematical creativity in MEA contexts can be examined more closely not only through final solutions, but also through how students draw inferences from data, prioritise variables, and reorganise their strategies while modelling.

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