Thinking Skills and Creativity 61 (2026) 102161

Contents lists available at ScienceDirect

Thinking Skills and Creativity

journal homepage: www.elsevier.com/locate/tsc

Creative potential as a bridge between mathematics and the real-life: The case of word problem-solving in primary school students

Eleonora Doz [a], Martina Taruscia [a], Sergio Agnoli [a,b], Alessandro Cuder [a], Sandra Pellizzoni [a], Maria Chiara Passolunghi [a,*]

[a] *Department of Life Sciences, University of Trieste, Trieste, Italy*
[b] *Marconi Institute for Creativity, Bologna, Italy*

ARTICLE INFO

Keywords:
Word problems
Creative potential
Mathematical creativity
General creativity
Primary school

ABSTRACT

Word problem-solving is a critical yet challenging mathematical skill for primary school children. This study examined the role of domain-general and mathematical creative potential in word problem-solving while accounting for fluid intelligence, problem representation, and computation skills. Additionally, it explored whether creative potential's influence varied across problem types. A total of 310 fourth and fifth graders were assessed on domain-general convergent creative potential, mathematical creative potential, intelligence, problem representation, and computation skills. They solved three types of problems with increasing complexity: (1) consistent problems, where relational terms align with the required operation (e.g., *less than* requiring subtraction); (2) inconsistent problems, where relational terms misalign with the operation (e.g., *less than* requiring addition); and (3) complex problems, involving intricate narratives or non-standard scenarios requiring world semantics and strong representational skills. General linear mixed models, accounting for school and classroom effects, revealed that the association between creative potential and performance varied according to the nature of creative potential (domain-general vs. mathematical) and the problem type. Neither form of creative potential predicted performance on consistent problems. Mathematical creative potential was positively associated with performance on inconsistent problems, and both domain-general convergent and mathematical creative potential showed positive associations with performance on complex problems. These findings highlight creativity's unique role in word problem-solving and suggest that fostering creative potential in education may enhance children's ability to tackle difficult problems.

1. Introduction

The development of word problem-solving skills is a central objective of mathematical education worldwide (Daroczy et al., 2015). Word problem-solving, defined as the ability to solve mathematical problems presented in verbal form (Jaffe & Bolger, 2023), enables children to learn how to apply mathematical concepts to real-life, meaningful contexts (Căprioară, 2015). As such, this skill is a strong

* Corresponding author.
E-mail address: passolu@units.it (M.C. Passolunghi).

https://doi.org/10.1016/j.tsc.2026.102161
Received 18 September 2025; Received in revised form 29 January 2026; Accepted 8 February 2026
Available online 11 February 2026
1871-1871/

predictor of educational and occupational success, as well as general well-being (Fries & Pietschnig, 2022; Gerardi et al., 2013; Pongsakdi et al., 2020; Swanson & Fung, 2016). Despite its significance, children face specific and persistent difficulties in solving word problems (De Blas et al., 2021; Powell et al., 2020). Therefore, it is essential to investigate the underlying factors that contribute to this ability in order to devise more effective interventions to promote its development.

One factor that is gaining recognition as important in mathematical learning is creativity (Bicer et al., 2021). Creativity is a multidimensional phenomenon (Sternberg & Lubart, 1996), broadly defined as the ability to produce original and effective contents in a specific context at a given time (Amabile, 2019; Barbot et al., 2015; Runco & Jaeger, 2012). Despite growing evidence linking creativity to mathematical achievement, no study to date has directly examined whether the ability to generate creative ideas plays a role in word problem-solving, nor whether different types of word problems draw on creative thinking to different extents. Thus, the present exploratory study aimed to advance previous work by investigating the specific contribution of creative potential to children's word problem-solving abilities, while controlling for key factors previously shown to influence this ability (i.e., fluid intelligence, problem representation ability, and computation skills). Furthermore, we examined whether the role of creative potential differs depending on problem type, by presenting children with three categories of problems typically found in school that vary in their level of complexity. Given the persistent challenges students face with word problem-solving, clarifying the role of creative potential in this process holds both theoretical and practical implications for educational practices.

1.1. Creativity and creative potential: definition and theoretical background

Creativity has been defined in multiple ways (Glăveanu & Beghetto, 2021; Runco & Jaeger, 2012; Simonton, 2018; Stein, 1953), reflecting its multifaceted nature. Despite this diversity, a widely accepted definition identifies creativity as requiring both originality and effectiveness (Runco & Jaeger, 2012). These two criteria capture creativity as an achievement. However, much of the creative process does not immediately satisfy these two requirements, while still constituting a meaningful part of a creative act that may eventually lead to the emergence of an original and effective idea. To account for this broader phenomenology, Corazza (2016) proposed a dynamic definition of creativity based on *potential* originality and effectiveness. By the introduction of the concept of potential, this definition involves the entire phenomenology of a creative act, including both inconclusive instances and achievements.

Within this framework, creative potential refers to the latent ability to produce original and effective work (Barbot et al., 2015; Corazza & Glaveanu, 2020; Walberg, 1988) being constituted by a multifaceted and partially domain-specific set of resources (Barbot et al., 2015). Though, the notion of creative potential is not new: already Guilford (1950) emphasized the importance of identifying individuals' inventive potentialities. This construct is particularly relevant in developmental research or in scholastic environments, where opportunities, expertise, and contextual constraints often limit the expression of fully realized creative achievements (Agnoli et al., 2018; Runco et al., 2017). For this reason, the present study focuses on creative potential rather than on creative achievement, as creative potential provides a more appropriate construct for capturing children's creative abilities (Runco, 2003).

The assessment of creative potential largely relies on tasks measuring idea generation, a core element of a creative process (Corazza & Agnoli, 2026; Reiter-Palmon et al., 2019). Idea generation is commonly conceptualized as involving two thinking modalities: divergent and convergent thinking (Brophy, 2001; Cropley, 2006; Guilford, 1967; Runco & Acar, 2012). Divergent thinking is the ability to produce many possible alternative solutions to an open-ended problem employing an exploratory modality; conversely, convergent thinking is the ability to arrive at a unique creative solution to a given problem or to integrate several elements in a unifying and synthetic new form of thought and action (Cropley, 2006; Gabora, 2018; Mumford & McIntosh, 2017).

According to the traditional models, divergent thinking can be measured mainly through four key indicators: fluency, flexibility, originality, and - even if less frequently used in research - elaboration (Guilford, 1967; Reiter-Palmon et al., 2019; Torrance, 1974). Fluency refers to the number of ideas or responses creative agents can produce during their divergent exploration. Flexibility concerns the diversity or range of categories represented within those responses or the number of changes of categories during the divergent exploration (Acar & Runco, 2017; Mastria et al., 2021). Originality indicates the infrequency or uniqueness of ideas generated using a frequentist approach (Reiter-Palmon et al., 2019), as well as represents the quality of the responses if ideas are evaluated for uncommonness, remoteness, and cleverness (Reiter-Palmon et al., 2019; Silvia, 2011). Finally, elaboration captures the degree of detail and development provided in each response. Originality, in particular, is intended as a core criterion for the measurement of individual creative potential, since originality is, as opposed to the other measurement criteria, one of the defining elements of the concept of creativity (Corazza, 2016; Rothenberg & Hausman, 1976; Runco, 1988; Runco et al., 2005; Runco & Jaeger, 2012).

Originality does not only pertain to the domain of divergent thinking, but it can emerge also through a convergent idea generation (Corazza & Agnoli, 2022, 2026; Lubart et al., 2011; Mumford & McIntosh, 2017). Measurement methods, such as the *Evaluation of Creative Potential* (EPoC; Lubart et al., 2011), explore the potential of generating original responses with convergent thinking tasks, requiring integrating and synthetizing a series of information in a new, unified, original idea. In the present study, we will specifically refer to children's potential ability as the ability to produce original responses, thus measuring in both convergent and divergent tasks the originality of the produced responses, taking into account, in the case of divergent thinking, the influencing factor of response fluency (Forthmann et al., 2020).

1.2. Domain-specific vs. domain-general creative potential

A fundamental question in creativity research is whether creativity can be expressed independently of the knowledge domain in which new ideas are generated, or whether it is inherently tied to the specific knowledge required to produce those ideas; in other words, whether creativity is domain-general or domain-specific. Some researchers argue that creativity is domain-general, suggesting that the processes involved in creative thinking are consistent across different knowledge domains (e.g., Plucker, 1999). Others contend that creativity is always linked to a particular form of knowledge, such as the mathematical or verbal domain, since expertise and knowledge in a specific field are necessary for creative expression (Bear, 2012). Empirical findings provide support for both perspectives (e.g., Huang et al., 2017; Jeon et al., 2011; Plucker, 2004), and hybrid models have emerged conceptualizing that ability to produce creative work is partly domain-general and partly domain-specific (Barbot et al., 2016; Sternberg, 1999). One influential hybrid framework is the Amusement Park Theoretical (APT) model of creativity (Baer & Kaufman, 2005), which conceptualizes creativity as a hierarchical system in which general creative prerequisites support increasingly domain-specific expressions of creativity. The model distinguishes four levels—initial requirements, general thematic areas, domains, and microdomains—with domain-specific knowledge becoming progressively more central at each level while remaining grounded in domain-general creative potential. Following the APT framework, the present study aimed to examine the combined and unique influence of domain-general and domain-specific creative potential—namely mathematical creative potential—in the context of word problem-solving.

Mathematical creative potential has been defined in various ways, and a clear consensus is still lacking (Haavold, 2018; Tubb et al., 2020). Nevertheless, a commonly accepted view conceptualizes mathematical creative potential as the divergent production of ideas within mathematical contexts and the ability to overcome fixation in mathematical problem solving (Haylock, 1987). In this sense, mathematical creative potential is the simultaneous activation of multiple ideas and sources of information in order to assemble several alternative solutions for mathematical tasks (Stolte et al., 2020). Consistent with these definitions and with previous studies in this field, the present study measures children's mathematical creative potential in terms of mathematical divergent thinking (Kattou et al., 2013; Stolte et al., 2020), which can be intended as a reliable indicator of children's mathematical creative potential (Runco & Acar, 2012).

Mathematical creative potential is believed to result from a combination of domain-specific and domain-general abilities (Baer, 1991; Baer & Kaufman, 2005). Theoretical and empirical arguments agree that domain-specific creativity would be involved in executing complex tasks where prior knowledge is crucial (Leikin & Sriraman, 2022). In mathematics, such knowledge includes an understanding of fundamental concepts, formulas, and algorithms, such as algebraic rules or geometric theorems. Evidence suggests that knowledge acts as a precondition for mathematical creativity to emerge (Kattou et al., 2013). This is different from stating that knowledge alone is responsible for creative expression; rather, its absence might pose a limiting factor (Haylock, 1987). The emphasis on knowledge implies that, in the mathematical domain, creativity should be considered as the culmination of a process requiring the acquisition of preliminary technical understanding and skills (Bahar et al., 2024; Elgrably & Leikin, 2021).

A growing body of empirical evidence has explored the role of creativity in mathematical learning (Leikin & Sriraman, 2022), revealing a positive association between mathematical performance and both domain-general and mathematical creativity (e.g., Bahar & Maker, 2011; Kattou et al., 2013; Leikin, 2009; Meier et al., 2021; Sak & Maker, 2006; Schoevers et al., 2020). Studies on gifted children have further emphasized the association between mathematical ability and creativity, showing that gifted students demonstrate higher creativity in solving mathematical problems and in generating figural patterns (Assmus & Fritzlar, 2018; 2022). Indeed, creativity in mathematics may enable individuals to combine previously acquired knowledge in original ways, discover multiple and novel solutions to mathematical problems, recognize patterns, structures, and principles underlying complex mathematical concepts, generate new ideas, and formulate relevant questions (Bicer, 2021; Herianto et al., 2024; Kandemir & Gür, 2007; Liljedahl & Sriraman, 2006; Suherman et al., 2021). Moreover, creative thinking facilitates overcoming cognitive fixation, allowing individuals to explore alternative approaches from different perspectives (Kozlowski et al., 2019; Leikin & Lev, 2007; Scheerer, 1963).

Notably, research suggests that the relationship between mathematics and creativity varies depending on the type of creativity being considered. A meta-analysis by Bicer et al. (2021), which synthesized data from 11,418 children and adolescents, found a stronger association between mathematical achievement and mathematical creativity compared to domain-general creativity. Regarding domain-general creativity, De Vink et al. (2022) confirmed that both divergent and convergent thinking contribute to solving non-verbal arithmetic problems in primary school children; yet performance relied more heavily on convergent thinking, which is crucial for effectively synthesizing new information and integrating it with prior knowledge.

However, most research exploring the relationship between creativity and math performance has focused on tasks assessing general math abilities (e.g., De Vink et al., 2022; Kattou et al., 2013; Kroesbergen & Schoevers, 2017; Vanutelli et al., 2021) or geometry (e.g., Schoevers et al., 2022). The present study aims to advance this line of research by examining whether creative potential contributes specifically to children's ability to solve word problems.

1.3. Creative potential and word problem-solving

In primary school, children are presented with several types of word problems that differ in their complexity (Verschaffel et al., 2020). According to the model proposed by Daroczy et al. (2015), three main components influence problem difficulty: (a) the linguistic complexity of the problem text itself, (b) the numerical complexity of the arithmetic problem, and (c) the interaction between the linguistic and numerical complexity of the problem. Regarding the interaction between linguistic and numerical complexity, literature highlights a lexical consistency phenomenon, which refers to the presence of linguistic cues or keywords that semantically elicit the required arithmetic operation, thus facilitating the way children solve the problem (de Koning et al., 2022; Hegarty et al., 1995; Jaffe et al., 2023). In lexically consistent problems (hereafter consistent problems) the keyword (e.g., more) is semantically coherent or consistent with the arithmetic operation required to find the solution (e.g., addition). An example of a consistent problem is: "*Emma has 12 apples. Jenny has 5 apples more than Emma. How many apples does Jenny have?*". In lexically inconsistent problems (hereafter named inconsistent problems), the keyword (e.g., more) is semantically incoherent with the arithmetic operation (i.e., subtraction). For instance: "*Emma has 12 apples. She has 5 apples more than Jenny. How many apples does Jenny have?*".

Many studies have demonstrated that performance accuracy is significantly lower on inconsistent problems compared to consistent ones (Jarosz & Jaeger, 2019; Lubin et al., 2013, 2016; Mayer & Hegarty, 1996; Pape, 2003). Importantly, the most common mistake in inconsistent problems is the reversal error, namely mistakenly applying the operation suggested by the relational term (Boote & Boote, 2018; Lewis & Mayer, 1987; Ventura-Campos et al., 2022). In consistent problems, individuals can rely on the keyword to determine the correct arithmetic operation. However, in inconsistent problems, cognitive load increases as students must override their automatic associations between linguistic cues and mathematical operations and revise their initial problem representation (Lubin et al., 2013; Passolunghi et al., 2022). Because children are explicitly and implicitly taught to associate certain words with specific operations (e.g., "more than" = addition; "less than" = subtraction; Powell et al., 2022), these habitual semantic associations can create mental fixation, which can make coming up with new ideas and more appropriate solutions difficult (Smith, 2008). In this context, creative potential may be relevant: the ability to generate original ideas through divergent or convergent thinking (which is one of the main indicators of an individual's creative potential; Agnoli et al., 2018; Barbot et al., 2015; Lubart et al., 2013) is often associated with cognitive flexibility and the ability to overcome fixation (Agnoli et al., 2023a; Haavold & Sriraman, 2022; Leikin & Lev, 2007; Scheerer, 1963). Thus, the potential to generate original ideas may help students break away from learned associations (Benedek & Neubauer, 2013), explore non-routine solution paths, and consider multiple ways to approach a problem (Haylock, 1997).

In everyday educational settings, children often encounter difficulties that go beyond simple lexical inconsistency, involving more complex problems with intricate situational narratives (Verschaffel et al., 2020). In these problems (hereafter complex problems), the required operation is not directly cued or contradicted by a relational keyword; instead, difficulty stems from an elaborate linguistic, as well as numerical complexity. Linguistic complexity may stem from long or syntactically complex sentences, the use of low-frequency or polysemous words, or the presence of irrelevant or hidden information. Numerical complexity depends on the properties of the numbers (e.g., magnitude, parity, type), the type and quantity of required operations, and the solution strategies needed (e.g., multi-step computation, memory retrieval). For example: *"Every month, Ron's mother spends 30 dollars on milk. How much does she spend in 12 months?"* is a typical problem type that children encounter daily and is relatively simple to solve, involving straightforward vocabulary and a single multiplication. By contrast, *"Every month, Ron's mother spends 30.50 dollars on milk, 60.40 dollars on bread, and 20.10 dollars on newspapers. How much does she spend each year?"* is more demanding. The latter problem requires students to manage multiple pieces of information, perform multi-step calculations with decimal numbers, and integrate contextual knowledge recognizing that the term *year* introduces hidden data, as one year consists of 12 months. Creative potential may support complex word problem-solving through several complementary mechanisms. First, as in inconsistent problems, it may facilitate *representation building*, this is generating multiple plausible ways to interpret relations among quantities and to map them onto operations, avoiding fixations (Smith, 2008). Second, it may support *integration and restructuring,* as creative thinking allows children to connect problem elements (de Vink et al., 2022; Hadamard, 1996; Mann, 2005), and restructure the problem model when the first representation does not satisfy all constraints (Knoblich et al., 1999; Patrick & Ahmed, 2014). Third, it may contribute to *adaptive search* across strategies, balancing exploration (divergent generation of approaches) with exploitation (convergent evaluation and selection), a coordination that has been argued to support mathematical problem-solving particularly when tasks are less routine or involve multiple steps and constraints (de Vink et al., 2022; Haavold & Sriraman, 2022). Indeed, research shows that when faced with complex (and unfamiliar) problems, successful problem-solving requires combining both divergent and convergent thinking (Cropley et al., 2017). Moreover, according to the APT model of creativity (Baer & Kaufman, 2005), complex specific problems should require the involvement of both very specific creative abilities and more general abilities. In the case of word problems increasing in complexity, we can expect that the creative ability to generate original ideas, being associated with cognitive flexibility and the ability to overcome fixation, can influence the ability to solve them. In very complex problems we could expect that both dimensions of creative potential could emerge to be beneficial, the most specific as well as the most general.

1.4. Other factors related to word problem-solving

When examining the relation between creative potential and word problem-solving, it is essential to account for the influence of other factors known to contribute to word problem-solving performance. In particular, fluid intelligence, computation skills, and problem representation ability, as well as age and class/school level factors, are all related to children's success in solving word problems. Fluid intelligence refers to the use of deliberate mental operations to solve novel problems tasks that cannot be performed as a function of memorization or routine (Primi et al., 2010). Extensive research has established fluid intelligence as a key predictor of word problem-solving ability in primary school children (Fung & Swanson, 2017; Passolunghi et al., 2022; Peng et al., 2019). Moreover, fluid intelligence is also consistently associated with creative thinking (Beaty et al., 2021; Benedek et al., 2014; Silvia, 2015).

Problem representation, defined as the ability to mentally construct a coherent model of the relational structure described in a word problem, has long been recognized as a central component of mathematical problem solving (Mayer & Hegarty, 1996; Reusser, 1990; Thevenot, 2010). According to Mayer and Hegarty's (1996) theoretical framework, successful solvers progress through a series of stages, these being comprehension, integration, planning, and execution, with *integration* representing the crucial phase in which linguistic and numerical information are combined into a coherent mental model that links known and unknown quantities. This representational process allows learners to reason about the underlying mathematical structure of the problem before planning the necessary operations. Several empirical studies confirmed the importance of problem representation. Yip et al. (2020) showed that children with mathematical learning difficulties exhibit poorer representation skills than typically achieving peers, even after controlling for cognitive correlates, reading achievement and arithmetic performance. In a longitudinal study, Wong and Yip (2023) further demonstrated that representation ability predicts later word problem-solving performance even after accounting for intelligence, working memory, and autoregressors.

In addition, computation ability also plays a crucial role in word problem-solving, since after representing the problem, the solver must compute the necessary arithmetic operation(s) (Fuchs et al., 2015).

Finally, age, as well as class- and school-level contextual factors, may also influence children's performance in word problem-solving and their expression of creative potential. Older children typically demonstrate more advanced problem-solving strategies and a greater familiarity with mathematical operations, as well as creative potential (Claxton et al., 2005). Additionally, school and class context plays a central role: teachers' approaches to mathematics instruction, classroom norms, and the content of the mathematical textbooks used may all shape students' experiences and skills. For example, the extent to which problem-solving is emphasized, the diversity of word problem types included, and how explicitly representation skills are taught can vary widely across classrooms and schools, potentially contributing to differences in children's performance (Powell et al., 2022; van Zanten & van den Heuvel-Panhuizen, 2018; Vicente et al., 2022).

1.5. The present study

Although a growing body of research has revealed a positive role of creativity in math achievement (see Bicer et al., 2021), literature specifically connecting creative potential to word problem-solving is still lacking. In the present exploratory study, we aimed to fill this gap with two main objectives. Firstly, we wanted to explore the unique contribution of creative potential to word problem-solving in primary school children. In doing so, we considered domain-general convergent and domain-specific (i.e., mathematical) divergent creative potential, while accounting for other relevant variables which have already been demonstrated to influence word problem-solving (i.e., age, fluid intelligence, problem representation ability, and computation skills; Fung & Swanson, 2017; Passolunghi et al., 2022; Thevenot & Barrouillet, 2015; Yip et al., 2020).

Secondly, we sought to comprehend the role of creative potential in solving word problems of different complexity. Based on the framework proposed by Daroczy et al.'s (2015), we included three types of word problems that differ in the demands they place on linguistic and numerical processing (see Table 1): (1) consistent problems, which are simple, straightforward problems in which the relational term semantically aligns with the required arithmetic operation, with low linguistic and numerical complexity; (2) inconsistent problems, which introduce greater complexity by incorporating a relational term that is semantically misaligned with the necessary arithmetic operation, while still exhibiting low linguistic and numerical complexity; and (3) complex problems, in which multiple linguistic (e.g., structural complexity, semantic complexity) and numerical (e.g., type of number used, number magnitude, type of required operation, number of required operations) sources of difficulty converge, placing greater demands on the abilities to integrate information and mentally represent the problem.

We hypothesized that creative potential would positively contribute to word problem-solving, but that its involvement would vary depending on the problem's complexity (Schoevers et al., 2022). Indeed, we expected creative potential to have a weaker association with consistent problems, as these can be solved by applying a superficial keyword-based strategy (Passolunghi et al., 2022). However, as problem complexity increased—whether due to textual ambiguity (inconsistent problems) or representational demands (complex problems)—we anticipated that creative potential would play a greater role in successful problem-solving, involving both mathematical and domain-general creative potential (Baer & Kaufman, 2005).

2. Methods

2.1. Participants

A total of 357 fourth- and fifth-grade children from 19 classrooms across seven public primary schools in north-eastern Italy were enrolled in the present study. Only typically developing children were considered for the final analysis. Consequently, 43 participants with special educational needs, intellectual disabilities, or neurological or genetic disorders were excluded. Additionally, four children were excluded due to insufficient fluency in Italian language. The final sample analyzed in this study consisted of 310 children (151 girls) with a mean age of 9.73 years ($SD = 0.65$, min = 9, max = 11). Of these, 141 were in the fourth grade and 169 in the fifth grade. The socio-economic status of the participants was mainly middle class, established on the basis of school records. All participants were either native Italian speakers or fluent in Italian language.

The study received approval by the ethical committee of the University of Trieste and was conducted in compliance with the Declaration of Helsinki, the ethical guidelines of the Italian Association of Psychology and the ethical code of the Italian Register of Professional Psychologists. Written informed parental consent was obtained prior to student assessment.

Table 1
Problem types used in the present study.

Problem type	Complexity source		
	Lexical consistency	Linguistic complexity	Numerical complexity
Consistent	Simple	Simple	Simple
Inconsistent	Complex	Simple	Simple
Complex	—	Complex	Complex

2.2. Measures

2.2.1. Consistent and inconsistent problems

An untimed task was administered to assess consistent and inconsistent problem-solving (Doz et al., 2024). The task comprised eight compare word problems, each requiring two elementary arithmetic operations—addition and subtraction—to arrive at a solution. Each problem included four short sentences: an assignment statement defining the value of a variable (e.g., “A backpack at Walmart costs 50 dollars”), a first relational statement establishing the value of a second variable in relation to the first one (e.g., “A backpack at Target costs 15 dollars more than a backpack at Walmart”), a second relational statement indicating the value of a third variable in relation to the second one (e.g., “A backpack at Target costs 10 dollars more than a travel suitcase”), and a final question asking for the value of the third variable (e.g., “How much does a travel suitcase cost?”). Each problem contained two relational statements—one consistent and one inconsistent—with their order counterbalanced across problems. Consequently, each problem involved two steps, and children were asked to perform the arithmetic operation for each step separately (e.g., $50 + 15 = 65$; $65 – 10 = 45$). Each step operation was scored independently: 1 point was awarded if the operation was correctly solved (i.e., the child identified the correct arithmetic operation and correctly performed the calculation), 0.5 points were awarded when children identified the correct operation but a calculation mistake was made, and 0 points if the operation was incorrectly identified. The score assigned to a given step did not depend on the correctness of preceding steps. This scoring approach recognizes that errors in word problems can arise from different sources, including difficulties in mentally representing the problem or calculation mistakes (Cornoldi et al., 2020a; Reusser, 1990). Final scores were calculated separately for consistent operations (sum of all consistent-step points, range 0–8) and inconsistent operations (sum of all inconsistent-step points, range 0–8). The measure demonstrated high internal consistency, with Cronbach’s alpha values of 0.81 for consistent problems and 0.87 for inconsistent problems.

2.2.2. Complex problems

The *Word problem test* derived from the Italian standardized battery *AC-MT 6–11* (Cornoldi et al., 2020a) consists of five word problems, similar to those typically encountered in Italian mathematics textbooks and aligned with the national curriculum. These problems depict real-world mathematical scenarios (e.g., calculating the total distance traveled by a cyclist, determining the arrival time of a plane) and are designed to capture both linguistic and numerical complexity, making them more demanding than simple consistent or inconsistent problems. Linguistic complexity arises from features such as the increased length of the text, the presence of hidden data (e.g., interpreting “week” as 7 days), the use of passive voice, or conceptual rewording (e.g., “double” instead of “twice as many”). Numerical complexity is introduced through the type of operation (all four arithmetic operations are required), the number of operations (one- and two-step problems), the magnitude of the numbers (up to 1200), and the use of rational numbers beyond whole numbers. Different test versions are available for each grade level (fourth and fifth), requiring age-appropriate complexity and knowledge. Among the five problems, one requires a single arithmetic operation to solve, while the four other problems require two operations. The two-step problems combine an addition/subtraction operation with either another addition/subtraction operation or a multiplication/division one. An example of a fourth grade problem is: “A cyclist rides 120 km in the morning and 30 km in the afternoon. How many kilometers does he ride in one week?”. We included an additional problem that could not be solved due to missing numerical data (adapted by Baruk, 1985). An example of this type of problem for fourth graders is “The train to Rome stops at Venice: 3 people get off and 5 get on. How many seats are now available on the train?”. Thus, the final version of the measure included five solvable and one unsolvable problem, for a total of six problems. Each operation was scored as follows: one point was awarded if the child identified the correct arithmetic operation and correctly performed the calculation, 0.5 points were awarded when children identified the correct operation but a calculation mistake was made, and 0 points were given when children identified the incorrect operation. Since the two-step problems require two operations, each two-step problem can earn a maximum of 2 points, whereas

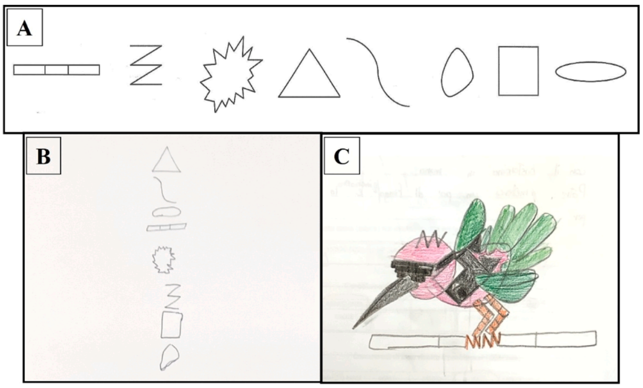

Fig. 1. Examples of low and high scores on the Convergent-Integrative Task. (A) Abstract stimuli presented to participants. (B) Example of a low originality score: the child used the stimuli by simply placing them one under the other, resulting in a mere reproduction of elements without an overall meaning. (C) Example of a high originality score: the child integrated the stimuli into a coherent drawing representing a “Gangster Hummingbird.”.

one-step problems can earn a maximum of 1 point. For the unsolvable problem, responses that explicitly acknowledged the absence of necessary data (e.g., stating that the problem is unsolvable, identifying missing data, or intentionally inventing the missing data) were considered correct and awarded 1 point. The final score ranged from 0 to 10. In the present sample, an adequate reliability of the measure was observed (α = 0.70).

2.2.3. Domain-general convergent creative potential

Domain-general creative potential was assessed using the graphical *Convergent-Integrative Task – Abstract Stimuli* from the *Evaluation of Potential Creativity* (EPoC, Lubart et al., 2011). In this study, we deliberately selected the graphical Convergent-Integrative Task, excluding the EPoC verbal subtest to minimize potential biases associated with children's verbal proficiency (Agnoli et al., 2023b). Furthermore, the Convergent-Integrative Task was chosen over the Divergent-Exploratory Task, as evidence suggests that convergent thinking in domain-general creativity is more strongly associated with children's mathematics performance than divergent thinking (De Vink et al., 2022). Following the EPoC manual, a warm-up was first administered to familiarize children with the task requirements. Subsequently, participants were presented with eight abstract shapes (Fig. 1) and instructed to create one single complete and original drawing in 10 min, using at least four of the eight shapes provided. They were explicitly encouraged to produce a drawing that differed from what other children might create. The task reflects the convergent thinking modality of creative thinking, that requires to combine, integrate or synthesize elements in a new way toward one final original product (Barbot et al., 2016; Lubart et al., 2011). The originality of each drawing was assessed by two independent raters, who were trained in the use of the EPoC scoring system. Originality was rated on a 7-point Likert scale, where 1 indicated a drawing lacking any creative elements, while 7 was assigned to a highly original drawing that integrated the given shapes in an innovative manner (see Fig. 1). Inter-rater reliability for originality scoring was assessed using a two-way mixed intraclass correlation coefficient (ICC) for absolute agreement, yielding a value of 0.93.

2.2.4. Domain-specific (Mathematical) creative potential

To assess students' domain-specific creative potential, namely mathematical creative potential, the Pyramid subtest of the *Mathematical Creativity Test* (MCT; Kattou et al., 2013) was employed. In this divergent task, participants were required to complete a numerical pyramid consisting of six cells, where the topmost cell contained the number 35. To complete the pyramid, students had to apply the same arithmetic operation (addition, subtraction, multiplication, or division) throughout, ensuring that each number in the upper row was derived from the two numbers directly below it. Participants were instructed to generate as many original solutions as possible within a 10-minute time limit. Each pyramid was then scored for originality by two independent raters using a Likert scale ranging from 1 (low originality) to 5 (high originality). To assign the originality score, raters considered three dimensions together (Silvia et al., 2008): (1) the uncommonness of the answer within the sample, (2) the remoteness (numerical and conceptual distance of the resulting values from 35), and (3) the cleverness of the result (non-obvious or surprising factors in a response). Inter-rater reliability for originality scoring was assessed using a two-way mixed ICC for absolute agreement, yielding an ICC = 0.86. To account for fluency, an overall score was then computed for each student by averaging their originality scores across all the pyramids they completed (Fig. 2).

2.3. Control variables

2.3.1. Fluid intelligence

Fluid intelligence was assessed using the short form of the *Raven's Standard Progressive Matrices* for children and adolescents (Langener et al., 2022). This measure consists of 15 items that progressively increase in difficulty. For each item, participants are presented with a geometric pattern that lacks a piece, and they are instructed to complete the pattern by identifying the correct missing piece from a provided list of options. The task was administered without a time limit. Prior to the test items, participants were given two practice items and received feedback to familiarize them with the task (van Hoogmoed et al., 2025). The final score was calculated by summing the number of correctly solved items, with higher scores reflecting stronger fluid intelligence. This short form has

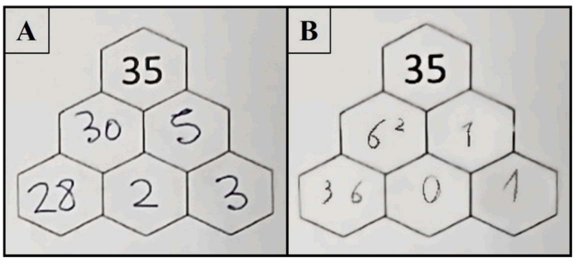

Fig. 2. Examples of low and high scores on the Mathematical Creativity Task. (A) Example of a low originality response: the child used a conventional strategy of addition based on multiples of 5, a highly activated approach, and straightforward additions. (B) Example of a high originality response: the child used a more unconventional strategy, incorporating varied numerical relationships (e.g., exponents: 6^2; use of zero) and reversing the direction of operations (e.g., 36 – 0 = 36 moving left to right; and 1 – 0 = 1, moving right to left).

demonstrated a strong correlation of 0.89 with the full *Raven's Standard Progressive Matrices* in a sample of 9- to 12-year-olds (see Langener et al., 2022). In the current study, the internal consistency of the task was good (α = 0.81).

2.3.2. Problem representation ability

An adaptation of the *Word Problem Reasoning task* (WPR; Yip et al., 2020) was employed to assess the ability to construct a coherent problem representation. This task consists of 12 additive word problems representing three problem types: combine, change, and compare. The change type is further divided into two subtypes, change-increase and change-decrease, resulting in four distinct problem subtypes. Each subtype is represented by three problems, and each problem has an unknown quantity in one of three possible positions (first position, second position, or third position). For instance, an example of a change-increase problem with the unknown in the first position is: "Lily had some candies. She received 2 more candies, and now she has 5 candies. How many candies did she have in the beginning?". An example of a problem with the unknown in the second position is: "George had 6 candies. Then he received some candies and now he has 7 candies. How many candies did he receive?". Finally, an example of a problem with the unknown in the third position is: "Mat had 8 candies, and he ate 2 candies. How many candies does he have now?". Next to the 12 word problems, children are presented with four abstract pictorial diagrams, each representing one of the four problem subtypes. The experimenter provided explanations of the diagrams to ensure clarity and instructed participants to perform two essential actions. First, children were asked to match each word problem to the schematic diagram that best represented it. After selecting the correct schematic picture, participants then identified the position of the unknown by selecting the correct position (A, B, or C). Importantly, children were not required to solve the problems; their task was limited to matching the problems with their abstract representations. To allow assessment of participants' intuitive understanding of the mathematical structure of the problems, no practice item was offered. One point was awarded when children correctly identified both the appropriate diagram and the correct position of the unknown, while zero points were given if one or both were incorrect. The final score ranged from 0 to 12, with higher scores indicating stronger problem representation ability. In the present study, the measure demonstrated good reliability (α = 0.73).

2.3.3. Computation

Computation was measured with the *Math Fluency* subtest drawn from the standardized battery *AC-MT-3*(Cornoldi et al., 2020b). This is a paper-and-pencil task in which children are asked to solve as many simple arithmetic operations as possible within one minute. The subtest includes 15 multi-digit operations (e.g., 63+79) of appropriate difficulty for each grade level. The total score corresponds to the number of correctly solved operations, with higher scores indicating better calculation ability. In the present study, the task showed good internal consistency (α = 0.77).

2.4. Procedure

Participants were tested in four collective sessions administered at school. Depending on school schedule and children's availability, the sessions were separated by 7 to 14 days. In the first session, participants were tested on consistent and inconsistent word problems and domain-general convergent creative potential. In the second session, participants were tested on complex word problems and mathematical creative potential. In the third session, children were assessed on problem representation ability and in the final session they were assessed on fluid intelligence and computation. Each session lasted approximately 40 to 50 min. Data were collected by two trained researchers.

Table 2
Descriptive statistics and bivariate correlations between all variables.

	M	SD	1.	2.	3.	4.	5.	6.	7.	8.
1. Fluid Intelligence	9.94	3.44	1							
			(310)							
2. Problem representation	3.66	2.61	.42**	1						
			(310)	(310)						
3. Computation	6.02	2.36	.24**	.12*	1					
			(310)	(310)	(310)					
4. Domain-general convergent creative potential	4.82	1.25	.21**	.08	.06	1				
			(310)	(310)	(310)	(310)				
5. Mathematical creative potential	2.02	0.59	.29**	.23**	.05	.22**	1			
			(303)	(303)	(303)	(303)	(303)			
6. Consistent problems	6.33	2.13	.26**	.25**	.15**	.10	.12*	1		
			(309)	(309)	(309)	(309)	(302)	(309)		
7. Inconsistent problems	2.89	2.74	.39**	.33**	.28**	.14*	.27**	.37**	1	
			(309)	(309)	(309)	(309)	(302)	(309)	(309)	
8. Complex problems	5.00	2.36	.38**	.26**	.46**	.14*	.19*	.23**	.40**	1
			(304)	(304)	(304)	(304)	(297)	(303)	(303)	(304)

Note. * $p < .05$, ** $p < .01$. Values in brackets indicate the number of participants included in each correlation analysis.

2.5. Statistical analysis

Data analyses were conducted using IBM SPSS 24. Given the study's objectives and the multilevel nature of the data (participants were nested within classrooms and schools), the approach of Generalized Linear Mixed Models (GLMM) was employed (Agnoli et al., 2023a). In order to explore the role of general convergent and mathematical creative potential in children's word problem-solving abilities across different problem types (consistent, inconsistent, and complex problems), accounting for control variables such as age, fluid intelligence, problem representation ability, and computation, three GLMM models were conducted (one for each problem type), including school and classroom as random nested effects. For each model, the conditional R^2 (Nakagawa & Schielzeth, 2013) were estimated to quantify the proportion of variance explained by both fixed and random effects.

3. Results

Descriptive statistics and bivariate correlations for each variable of interest are provided in Table 2. Due to the presence of missing data in some measures, listwise deletion was employed, ensuring that only participants with complete data on the variables of interest were included in the analysis. Correlational analysis revealed that mathematical creative potential was significantly and positively correlated with fluid intelligence, problem representation ability, and all types of word problems (consistent, inconsistent, and complex). No significant correlation was observed between mathematical creative potential and computation skills. Domain-general convergent creative potential was positively and significantly correlated with fluid intelligence, inconsistent problems, and complex problems. Interestingly, no significant correlation emerged between domain-general convergent creative potential and either consistent problems or computation skills. Additionally, consistent, inconsistent, and complex problems were positively correlated with fluid intelligence, problem representation ability, and computation skills. Since these correlations aligned with the initial hypotheses, further analyses were conducted using the GLMM approach.

The first GLMM examined the association of fluid intelligence, problem representation ability, computation, general convergent creative potential, and mathematical creative potential with consistent word problems (Table 3). Overall, the GLMM explained 21% of the variance (conditional R^2) in performance on consistent word problems. The results indicated a significant positive effect of computation ($b = 0.16, p = .004$) on consistent problems; whereas the effect of age ($b = 0.02, p = .499$), fluid intelligence ($b = 0.08, p = .062$), and problem representation ($b = 0.08, p = .156$) did not reach the conventional level for statistical significance. Neither general creative potential ($b = 0.07$, $p = .450$) nor mathematical creative potential ($b = -0.02$, $p = .928$) showed statistically significant effects. Regarding random effects, a significant effect emerged at school level (estimate = 0.55, SE = 0.25, $Z = 2.17, p = .030$), whereas the random effect at the classroom level did not reach significance (estimate = 0.47, SE = 0.33, $Z = 1.439$, $p = .150$).

The second GLMM investigated the effect of the same variables on inconsistent problems (Table 4). This GLMM explained 23.5% of the variance (conditional R^2) in inconsistent word problem performance. Fluid intelligence ($b = 0.16, p = .001$), representation ability ($b = 0.22, p = .001$), and computation ($b = 0.18, p = .008$) were positive predictors of children's performance. Age was not statistically significantly associated with performance ($b = 0.04, p = .065$). Regarding creative potential, only mathematical creative potential was significantly and positively related to inconsistent problems ($b = 0.51, p = .049$), while the general convergent creative potential did not reach significance ($b = 0.09, p = .462$). Thus, after taking into account the control variables, mathematical creative potential still contributed uniquely to performance on inconsistent problems. Regarding random effects, a significant effect emerged at school level (estimate = 0.26, SE = 0.01, $Z = 2.63, p < .001$), whereas the random effect at the classroom level did not reach significance (estimate = 0.03, SE = 0.19, $Z = 0.202$, $p = .841$).

Finally, the third GLMM focused on complex problems as the outcome variable (Table 5). Overall, the GLMM explained 62.9% of the variance (conditional R^2) in complex word problems. Results showed that fluid intelligence ($b = 0.16$, $p < .001$), problem representation ability ($b = 0.18, p < .001$), and computation skills ($b = 0.23, p < .001$) were positive predictors of performance in complex problems. Age was not statistically significantly associated with performance ($b = 0.05$, $p = .076$). Additionally, both general convergent creative potential ($b = 0.17, p = .046$) and mathematical creative potential ($b = 0.50, p = .005$) were significant predictors, indicating that both domain-general convergent and mathematical creative processes play a role in solving complex problems. Regarding random effects, significant variability was found at the school (estimate = 0.26, SE = 0.13, $Z = 1.965$, $p = .049$) and at the

Table 3
Results of the General Linear Mixed Model with consistent problems as outcome variable.

	b	*SE*	*t*	*p*	95% CI	
					lower limit	upper limit
Fixed effects						
Intercept	6.30	0.28	22.218	<0.001	5.738	6.854
Age	0.02	0.02	0.678	.499	−0.033	0.068
Fluid intelligence	0.08	0.04	1.873	.062	−0.004	0.158
Problem representation	0.08	0.05	1.424	.156	−0.029	0.176
Computation	0.16	0.06	2.913	.004	0.053	0.272
Domain-general convergent creative potential	0.07	0.09	0.757	.450	−0.117	0.263
Mathematical creative potential	−0.02	0.21	−0.091	.928	−0.426	0.389

$N = 302$.
Note. SE = Standard Error; CI = Confidence Interval.

Table 4
Results of the General Linear Mixed Model with inconsistent problems as outcome variable.

	b	*SE*	*t*	*p*	95% CI	
					lower limit	upper limit
Intercept	2.81	0.14	19.549	<0.001	2.526	3.092
Age	0.04	0.02	1.852	.065	−0.003	0.084
Fluid intelligence	0.16	0.05	3.322	.001	0.067	0.262
Problem representation	0.22	0.07	3.316	.001	0.087	0.342
Computation	0.18	0.07	2.693	.008	0.048	0.311
Domain-general creativity	0.09	0.12	0.737	.462	−0.147	0.324
Mathematical creativity	0.51	0.26	1.973	.049	0.001	1.014

N = 302.
Note. SE = Standard Error; CI = Confidence Interval.

Table 5
Results of the General Linear Mixed Model with complex problems as outcome variable.

	b	*SE*	*t*	*p*	95% CI	
					lower limit	upper limit
Fixed effects						
Intercept	5.16	0.51	10.058	<0.001	4.150	6.170
Age	0.05	0.03	1.781	.076	−0.05	0.098
Fluid intelligence	0.16	0.04	4.438	<0.001	0.087	0.225
Problem representation	0.18	0.05	3.977	<0.001	0.090	0.266
Computation	0.23	0.05	4.752	<0.001	0.132	0.319
Domain-general convergent creative potential	0.17	0.08	1.998	.046	0.003	0.327
Mathematical creative potential	0.50	0.18	2.810	.005	0.149	0.844

N = 297.
Note. SE = Standard Error; CI = Confidence Interval.

classroom level (estimate = 0.39, SE = 0.19, $Z = 2.016$, $p = .044$).

4. Discussion

To date, research has examined the role of both general and mathematical creativity in students' mathematical performance (for a review, see Bicer et al., 2021). However, these studies have largely overlooked the contribution of creativity to specific mathematical abilities such as word problem-solving, representing a central, yet particularly challenging educational goal (De Blas et al., 2021; Powell et al., 2020). The present study aimed to address this gap by (1) investigating the unique contribution of general and mathematical creative potential to word problem-solving in primary school children and (2) assessing whether the role of creative potential varies among different word problem types, hypothesizing that creative potential would be most relevant in problems with higher representational demands, such as those involving inconsistent relational keywords or complex linguistic, numerical, and real-world interactions.

Overall, the findings demonstrated that creative potential is a significant and positive predictor of children's word problem-solving performance. This result contrast the naïve belief that mathematics does not require creativity (Newton et al., 2022) and aligns with previous research linking creativity to mathematical achievement in children (De Vink et al., 2022; Kroesbergen & Schoevers, 2017; Schoevers et al., 2018, 2022; Vanutelli et al., 2021). Moreover, the study also revealed that the association with creative potential depended both on its nature (general vs. mathematical) and on the problem type (consistent, inconsistent, and complex problems).

For consistent problems, neither general nor mathematical creative potential emerged as significant predictors after accounting for participants age, fluid intelligence, problem representation ability, and computation. This may be because consistent problems are relatively straightforward, allowing children to rely on the relational keyword (e.g., *more*) in the problem statement to directly apply the corresponding arithmetic operation (de Koning et al., 2022; Passolunghi et al., 2022). According to Hegarty et al. (1995), solvers may adopt a *direct translation strategy*, relying on surface-level linguistic cues to derive their solution—a strategy that, despite its simplicity, leads to correct answers in the case of consistent problems. Therefore, no additional cognitive processes or efforts are necessary for successful problem-solving.

On the other hand, the study demonstrated that for inconsistent problems mathematical creative potential emerged as a significant predictor of children's performance, beyond the effects of age, fluid intelligence, problem representation ability and computation skills. In this problem type, the relational keyword triggers an incorrect arithmetic operation and in order to arrive at the correct solution, children must overcome cognitive fixation associated with the semantic meaning of the keyword (Lubin et al., 2013, 2016). Cognitive fixation is the notion of people struggling to come up with solutions because they fixate, or fail to abandon non-productive strategies (Haavold & Sriraman, 2022). Mathematical creative potential, and in particular the flexibility to switch between alternative mathematical concepts, might facilitate this process by allowing individuals to overcome cognitive fixation and to recognize that the relational term can be interpreted in a non-typical mathematical way (Haavold & Sriraman, 2022; Haylock, 1987; van Hooijdonk et al., 2022), thus allowing the generation of alternative representations and the shift from a superficial direct translation strategy to a deeper, more adaptive problem-solving approach (Hegarty et al., 1995). Since the relational term (e.g., *more, less*) is indeed inherently mathematical—reflecting a comparison of quantities and being directly linked to a mathematical operation—it is mathematical creative potential, rather than domain-general convergent creative potential, that plays a crucial role in dealing with its inconsistency. To sum up, this result suggests that lexical inconsistency is an important feature that requires mathematical creative potential to resolve conflicting information and navigate higher cognitive demands (Leikin, 2009; Mann, 2006).

Finally, our findings indicate that both domain-general convergent creative potential and mathematical creative potential were positively related to performance in complex problems, even after accounting for the control variables. This suggests that solving complex problems, which involve intricate narratives of substantial linguistic and numerical complexity, requires both the general ability to integrate and synthesize information from multiple sources (i.e., domain-general convergent creative potential) and the specific capacity to generate novel mathematical solutions (i.e., mathematical creative potential). A particularly interesting insight emerges from the observed role of domain-general convergent creative potential. It appears that domain-general convergent thinking may help students organize and integrate various information sources and knowledge (linguistic, numerical, and real-life knowledge) into a coherent mental model, allowing them to derive an effective solution strategy. This aligns with previous research showing that domain-general convergent thinking fosters success in complex mathematical problem-solving (Assmus & Fritzlar, 2018; De Vink et al., 2022; Tan & Sriraman, 2017). Specifically, convergent thinking processes, such as recognizing familiar patterns and efficiently applying known techniques, facilitate the retrieval and application of mathematical knowledge (Cropley, 2006; Tabach & Levenson, 2018). Interestingly, this effect was not observed in consistent or inconsistent problems, suggesting that domain-general convergent creative potential is particularly relevant for problems where the solution is not explicitly cued (e.g., by a keyword) and multiple solution paths are possible (e.g., addition, subtraction, multiplication, or division). In such cases, students must evaluate different strategies and determine the most appropriate approach rather than relying on automatic associations. Thus, while mathematical creative potential may be essential for applying mathematical knowledge in a flexible way, avoiding cognitive fixation and generating multiple solution paths, domain-general convergent creative potential appears to support the integration of diverse forms of information, including real-life knowledge (world semantics), into a meaningful problem representation.

Taken together, these results offer valuable implications for mathematics education and the promotion of creative thinking in children. For example, the study suggests that creativity could be more deliberately integrated into the teaching and learning of mathematics. To foster creative potential, educators should consider moving beyond traditional instruction, maily focused on closed-ended problems and computational procedures, and instead adopt instructional strategies that encourage creative engagement within the framework of mathematical reasoning (Mann, 2006; Bicer, 2021). Such approaches may include problem-posing activities, open-ended questions, tasks allowing for multiple solutions, and the integration of technology (Bicer, 2021). Moreover, the current results suggest that word problems characterized by lexical inconsistency and complex narrative situations may stimulate students' creative thinking, revealing them as a potential useful tool in the shift towards an instructional focus on creativity in mathematics.

4.1. Limitations and future directions

The results of the present study should be interpreted in light of some limitations. Firstly, the correlational and cross-sectional design of this study prevents directional or causal interpretations of the included associations. Future research should examine how general and mathematical creative potential influence word problem-solving over time, exploring potential bidirectional relationships (Kattou et al., 2013). Such studies employing a longitudinal approach would also be more sensitive to age-related differences and developmental changes in creative potential (Alfonso-Benlliure & Santos, 2016). Future longitudinal studies could also expand the present findings testing for potential mechanisms underlying this relationship, such as the mediating roles of problem representation or other mathematical processing skills. Secondly, the present study sought to disentangle the associations of general and mathematical creative potential with word problem-solving, using a convergent thinking task to assess domain-general creative potential and a divergent thinking task for mathematical creative potential. This methodological choice was guided by prior research indicating that, in the context of general creativity, children's mathematical performance is primarily supported by convergent thinking (De Vink et al., 2022). In contrast, both theoretical frameworks and empirical evidence suggest that mathematical creativity is more closely aligned with divergent thinking (Haylock, 1987; Kattou et al., 2013; Shaw et al., 2022). Nevertheless, future research could adopt a more refined approach by incorporating both divergent and convergent thinking tasks for both domain-general and mathematical creative potential. Finally, although we controlled for key variables in word problem-solving, such as fluid intelligence, problem representation, and computation skills, future studies should aim to replicate this work while controlling for additional factors, such as working memory and executive functions, linked to both word problem-solving (Passolunghi et al., 2022) and creativity (Stolte et al., 2020). Moreover, future studies should also include broader measures of mathematical ability, beyond computational skill, to disentangle the unique and shared contributions of general mathematical creative potential, mathematical ability, and word problem-solving performance.

5. Conclusion

Both mathematical and general convergent creative potential emerged as significant predictors of primary school children's word problem-solving abilities, even after accounting for well-known predictors like age, fluid intelligence, problem representation skills, and computation skills. Notably, such the role of creative potential became more pronounced as problem complexity increased, suggesting that creative potential becomes crucial when tackling more demanding and cognitively challenging word problems. Overall, our findings challenge the traditional emphasis on rote learning and routine word problem-solving in mathematics education, highlighting the value of nurturing creative potential as a core skill. By fostering both domain-specific and general creative potential, teachers can empower students to become more effective problem solvers, better equipped for the real-life demands of an increasingly complex world.

Data statement

All data and research material are available by emailing the corresponding author.

Funding information

Authors state no fundings involved.

CRediT authorship contribution statement

Eleonora Doz: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Martina Taruscia:** Writing – review & editing, Resources, Investigation. **Sergio Agnoli:** Writing – review & editing, Software, Conceptualization. **Alessandro Cuder:** Writing – review & editing, Software, Formal analysis. **Sandra Pellizzoni:** Writing – review & editing, Validation, Supervision. **Maria Chiara Passolunghi:** Writing – review & editing, Supervision, Project administration, Methodology, Conceptualization.

Declaration of competing interest

Authors state no conflict of interest.

Data availability

Data will be made available on request.

References

Agnoli, S., Mastria, S., Mancini, G., Corazza, G. E., Franchin, L., & Pozzoli, T. (2023b). The dynamic interplay of affective, cognitive and contextual resources on children's creative potential: The modulatory role of trait emotional intelligence. *Journal of Intelligence, 11*(1), 11. https://doi.org/10.3390/jintelligence11010011

Agnoli, S., Mastria, S., Zanon, M., & Corazza, G. E. (2023a). Dopamine supports idea originality: The role of spontaneous eye blink rate on divergent thinking. *Psychological Research, 87*, 17–27. https://doi.org/10.1007/s00426-022-01658-y

Agnoli, S., Runco, M. A., Kirsch, C., & Corazza, G. E. (2018). The role of motivation in the prediction of creative achievement inside and outside of school environment. *Thinking Skills and Creativity, 28*, 167–176. https://doi.org/10.1016/j.tsc.2018.05.00

Alfonso-Benlliure, V., & Santos, M. R. (2016). Creativity development trajectories in elementary education: Differences in divergent and evaluative skills. *Thinking Skills and Creativity, 19*, 160–174.

Amabile, T. M. (2019). *Creativity in context: Update to the social psychology of creativity* (2nd ed.). Routledge. https://doi.org/10.4324/9780429501234

Assmus, D., & Fritzlar, T. (2018). Mathematical giftedness and creativity in primary grades. In F. Singer (Ed.), *Mathematical creativity and mathematical giftedness* (pp. 51–65). Springer. https://doi.org/10.1007/978-3-319-73156-8_3.

Assmus, D., & Fritzlar, T. (2022). Mathematical creativity and mathematical giftedness in the primary school age range: An interview study on creating figural patterns. *ZDM Mathematics Education, 54*(1), 113–131. https://doi.org/10.1007/s11858-022-01328-8

Baer, J. (1991). Generality of creativity across performance domains. *Creativity Research Journal, 4*(1), 23–39. https://doi.org/10.1080/10400419109534371

Baer, J. (2012). Domain specificity and the limits of creativity theory. *Journal of Creative Behavior, 46*(1), 16–29. https://doi.org/10.1002/jocb.002

Baer, J., & Kaufman, J. C. (2005). Bridging generality and specificity: The amusement park theoretical (APT) model of creativity. *Roeper Review, 27*(3), 158–163. https://doi.org/10.1080/02783190509554310

Bahar, A. K., & Maker, C. J. (2011). Exploring the relationship between mathematical creativity and mathematical achievement. *Asia-Pacific Journal of Gifted and Talented Education, 3*(1), 33–48.

Bahar, A. K., Can, I., & Maker, C. J. (2024). What does it take to be original? An exploration of mathematical problem solving. *Thinking Skills and Creativity, 53*, Article 101592. https://doi.org/10.1016/j.tsc.2024.101592

Barbot, B., Besançon, M., & Lubart, T. (2015). Creative potential in educational settings: Its nature, measure, and nurture. *Education 3-13, 43*(4), 371–381. https://doi.org/10.1080/03004279.2015.1020643

Barbot, B., Besançon, M., & Lubart, T. (2016). The generality-specificity of creativity: Exploring the structure of creative potential with EPoC. *Learning and Individual Differences, 52*, 178–187. https://doi.org/10.1016/j.lindif.2016.06.005

Baruk, S. (1985). L'âge du capitaine. De l'erreur en mathématiques. Seuil.

Beaty, R. E., Zeitlen, D. C., Baker, B. S., & Kenett, Y. N. (2021). Forward flow and creative thought: Assessing associative cognition and its role in divergent thinking. *Thinking Skills and Creativity, 41*, Article 100859. https://doi.org/10.1016/j.tsc.2021.100859

Benedek, M., Jauk, E., Sommer, M., Arendasy, M., & Neubauer, A. C. (2014). Intelligence, creativity, and cognitive control: The common and differential involvement of executive functions in intelligence and creativity. *Intelligence, 46*, 73–83. https://doi.org/10.1016/j.intell.2014.05.007

Benedek, M., & Neubauer, A. C. (2013). Revisiting Mednick's model on creativity-related differences in associative hierarchies. Evidence for a common path to uncommon thought. *The Journal of creative behavior, 47*(4), 273–289. https://doi.org/10.1002/jocb.35

Bicer, A. (2021). A systematic literature review: Discipline-specific and general instructional practices fostering the mathematical creativity of students. *International Journal of Education in Mathematics, Science and Technology, 9*(2), 252–281. https://doi.org/10.46328/ijemst.1254

Bicer, A., Chamberlin, S., & Perihan, C. (2021). A meta-analysis of the relationship between mathematics achievement and creativity. *Journal of Creative Behavior, 55*(2), 569–590. https://doi.org/10.1002/jocb.474

Boote, S. K., & Boote, D. N. (2018). ABC problem in elementary mathematics education: Arithmetic before comprehension. *Journal of Mathematics Teacher Education, 21*(1), 99–122. https://doi.org/10.1007/s10857-016-9350-2

Brophy, D. R. (2001). Comparing the attributes, activities, and performance of divergent, convergent, and combination thinkers. *Creativity Research Journal, 13*(3–4), 439–455. https://doi.org/10.1207/S15326934CRJ1334_20

Căprioară, D. (2015). Problem solving–Purpose and means of learning mathematics in school. *Procedia - Social and Behavioral Sciences, 191*, 1859–1864. https://doi.org/10.1016/j.sbspro.2015.04.332

Claxton, A. F., Pannells, T. C., & Rhoads, P. A. (2005). Developmental trends in the creativity of school-age children. *Creativity Research Journal, 17*(4), 327–335. https://doi.org/10.1207/s15326934crj1704_4

Corazza, G. E. (2016). Potential originality and effectiveness: The dynamic definition of creativity. *Creativity Research Journal, 28*(3), 258–267. https://doi.org/10.1080/10400419.2016.1195627

Corazza, G. E., & Agnoli, S. (2022). The DA VINCI model for the creative thinking process. In T. Lubart, M. Botella, S. Bourgeois -Bougrine, X. Caroff, J. Guegan, C. Mouchiroud, J. Nelson, & F. Zenasni (Eds.), *Homo creativus: The 7 C's of human creativity* (pp. 49–67). Springer International Publishing. https://doi.org/10.1007/978-3-030-99674-1_4.

Corazza, G. E., & Agnoli, S. (2026). When DA VINCI Met Wallas: Extended modeling of the creative process. *The Journal of Creative Behavior, 60*, Article e70098. https://doi.org/10.1002/jocb.70098

Corazza, G. E., & Glăveanu, V. P. (2020). Potential in creativity: Individual, social, material perspectives, and a dynamic integrative framework. *Creativity Research Journal, 32*(1), 81–91. https://doi.org/10.1080/10400419.2020.1712161

Cornoldi, C., Lucangeli, D., & Perini, N. (2020a). AC-MT 6–11 anni. Prove per la classe. Edizioni Erickson.

Cornoldi, C., Mammarella, I.C., & Caviola, S. (2020b). AC-MT-3. Test di valutazione delle abilità di calcolo e del ragionamento. Edizioni Erickson.

Cropley, A. J. (2006). In praise of convergent thinking. *Creativity Research Journal, 18*(3), 391–404. https://doi.org/10.1207/s15326934crj1803_13

Cropley, D. H., Westwell, M., & Gabriel, F. (2017). Psychological and neuroscientific perspectives on mathematical creativity and giftedness. In R. Leikin, & B. Sriraman (Eds.), *Creativity and giftedness. Advances in mathematics education*. Cham: Springer. https://doi.org/10.1007/978-3-319-38840-3_12.

Daroczy, G., Wolska, M., Meurers, W. D., & Nuerk, H. C. (2015). Word problems: A review of linguistic and numerical factors contributing to their difficulty. *Frontiers in Psychology, 6*, 348. https://doi.org/10.3389/fpsyg.2015.00348

De Blas, G. D., Gómez-Veiga, I., & García-Madruga, J. A. (2021). Arithmetic word problems revisited: Cognitive processes and academic performance in secondary school. *Education Sciences, 11*(4), 155. https://doi.org/10.3390/educsci11040155

de Koning, B. B., Boonen, A. J., Jongerling, J., van Wesel, F., & van der Schoot, M. (2022). Model method drawing acts as a double-edged sword for solving inconsistent word problems. *Educational Studies in Mathematics, 111*(1), 29–45. https://doi.org/10.1007/s10649-022-10150-8

De Vink, I. C., Willemsen, R. H., Lazonder, A. W., & Kroesbergen, E. H. (2022). Creativity in mathematics performance: The role of divergent and convergent thinking. *British Journal of Educational Psychology, 92*(2), 484–501. https://doi.org/10.1111/bjep.12459

Doz, E., Cuder, A., Pellizzoni, S., Granello, F., & Passolunghi, M. C. (2024). The interplay between ego-resiliency, math anxiety and working memory in math achievement. *Psychological Research, 88*, 2401–2415. https://doi.org/10.1007/s00426-024-01995-0

Elgrably, H., & Leikin, R. (2021). Creativity as a function of problem-solving expertise: Posing new problems through investigations. *ZDM–Mathematics Education, 53*, 891–904. https://doi.org/10.1007/s11858-021-01228-3

Forthmann, B., Szardenings, C., & Holling, H. (2020). Understanding the confounding effect of fluency in divergent thinking scores: Revisiting average scores to quantify artifactual correlation. *Psychology of Aesthetics, Creativity, and the Arts, 14*(1), 94.

Fries, J., & Pietschnig, J. (2022). An intelligent mind in a healthy body? Predicting health by cognitive ability in a large European sample. *Intelligence, 93*, Article 101666. https://doi.org/10.1016/j.intell.2022.101666

Fuchs, L. S., Fuchs, D., Compton, D. L., Hamlett, C. L., & Wang, A. Y. (2015). Is word-problem solving a form of text comprehension? *Scientific Studies of Reading, 19*(3), 204–223. https://doi.org/10.1080/10888438.2015.1005745

Fung, W., & Swanson, H. L. (2017). Working memory components that predict word problem solving: Is it merely a function of reading, calculation, and fluid intelligence? *Memory & Cognition, 45*(5), 804–823. https://doi.org/10.3758/s13421-017-0697-0

Gabora, L. (2018). The neural basis and evolution of divergent and convergent thought. *The Cambridge handbook of the neuroscience of creativity* (pp. 58–70). Cambridge University Press.

Gerardi, K., Goette, L., & Meier, S. (2013). Numerical ability predicts mortgage default. *Proceedings of the National Academy of Sciences, 110*(28), 11267–11271. https://doi.org/10.1073/pnas.1220568110

Glăveanu, V. P., & Beghetto, R. A. (2021). Creative experience: A non-standard definition of creativity. *Creativity Research Journal, 33*(2), 75–80. https://doi.org/10.1080/10400419.2020.1827606

Guilford, J. P. (1950). Creativity. *American Psychologist, 5*(9), 444–454. https://doi.org/10.1037/h0063487

Guilford, J. P. (1967). *The nature of human intelligence*. McGraw-Hill. https://doi.org/10.3102/00028312005002249

Haavold, P.Ø. (2018). An empirical investigation of a theoretical model for mathematical creativity. *The Journal of Creative Behavior, 52*(3), 226–239. https://doi.org/10.1002/jocb.145

Haavold, P.Ø., & Sriraman, B. (2022). Creativity in problem solving: Integrating two different views of insight. *ZDM Mathematics Education, 54*, 83–96. https://doi.org/10.1007/s11858-021-01304-8

Hadamard, J. (1996). *The mathematician's mind: The psychology of invention in the mathematical field*. Princeton University Press.

Haylock, D. W. (1987). Mathematical creativity in schoolchildren. *Journal of Creative Behavior, 21*(1), 48–59. https://doi.org/10.1002/j.2162-6057.1987.tb00452.x

Haylock, D. (1997). Recognising mathematical creativity in schoolchildren. *ZDM, 29*(3), 68–74. https://doi.org/10.1007/s11858-997-0002-y

Hegarty, M., Mayer, R. E., & Monk, C. A. (1995). Comprehension of arithmetic word problems: A comparison of successful and unsuccessful problem solvers. *Journal of Educational Psychology, 87*(1), 18–32. https://doi.org/10.1037/0022-0663.87.1.18

Herianto, H., et al. (2024). Quantifying the relationship between self-efficacy and mathematical creativity: A meta-analysis. *Education Sciences, 14*(11), 1251. https://doi.org/10.3390/educsci14111251

Huang, P., Pen, S., Chen, H., Tseng, L., & Hsu, L. (2017). The relative influences of domain knowledge and domain-general divergent thinking on scientific creativity and mathematical creativity. *Thinking Skills and Creativity, 25*, 1–9. https://doi.org/10.1016/j.tsc.2017.06.001

Jaffe, J. B., & Bolger, D. J. (2023). Cognitive processes, linguistic factors, and arithmetic word problem success: A review of behavioral studies. *Educational Psychology Review, 35*, 105. https://doi.org/10.1007/s10648-023-09821-6

Jaffe, J. B., Gharibani, T., & Bolger, D. J. (2023). "Acquired" equals addition? Associating verbs with arithmetic operations impacts word problem performance. *Mind, Brain, and Education, 17*(1), 93–97. https://doi.org/10.1111/mbe.12355

Jarosz, A. F., & Jaeger, A. J. (2019). Inconsistent operations: A weapon of math disruption. *Applied Cognitive Psychology, 33*(1), 124–138. https://doi.org/10.1002/acp.3471

Jeon, K. N., Moon, S. M., & French, B. (2011). Differential effects of divergent thinking, domain knowledge, and interest on creative performance in art and math. *Creativity Research Journal, 23*(1), 60–71. https://doi.org/10.1080/10400419.2011.545750

Kandemir, M. A., & Gür, H. (2007). Creativity training in problem solving: A model of creativity in mathematics teacher education. *New Horizons in Education, 55*(2), 107–122.

Kattou, M., Kontoyianni, K., Pitta-Pantazi, D., & Christou, C. (2013). Connecting mathematical creativity to mathematical ability. *ZDM–Mathematics Education, 45*, 167–181. https://doi.org/10.1007/s11858-012-0467-1

Knoblich, G., Ohlsson, S., Haider, H., & Rhenius, D. (1999). Constraint relaxation and chunk decomposition in insight problem solving. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 25*(6), 1534–1555. https://doi.org/10.1037/0278-7393.25.6.1534

Kozlowski, J. S., Chamberlin, S. A., & Mann, E. (2019). Factors that influence mathematical creativity. *Montana Mathematics Enthusiast, 16*(1–2), 505–540. https://doi.org/10.54870/1551-3440.1471

Kroesbergen, E. H., & Schoevers, E. M. (2017). Creativity as predictor of mathematical abilities in fourth graders in addition to number sense and working memory. *Journal of Numerical Cognition, 3*(2), 417–440. https://doi.org/10.5964/jnc.v3i2.63

Langener, A. M., Kramer, A. W., van den Bos, W., & Huizenga, H. M. (2022). A shortened version of Raven's standard progressive matrices for children and adolescents. *British Journal of Developmental Psychology, 40*, 35–45.

Leikin, R. (2009). Exploring mathematical creativity using multiple solution tasks. In R. Leikin (Ed.), *Creativity in mathematics and the education of gifted students* (pp. 129–145). Brill. https://doi.org/10.1163/9789087909352_010.

Leikin, R., & Lev, M. (2007). Multiple solution tasks as a magnifying glass for observation of mathematical creativity. In *, 3. Proceedings of the 31st international conference on psychology of mathematics education* (pp. 161–168).

Leikin, R., & Sriraman, B. (2022). Empirical research on creativity in mathematics (education): From the wastelands of psychology to the current state of the art. *ZDM–Mathematics Education, 54*, 1–17. https://doi.org/10.1007/s11858-022-01340-y

Lewis, A. B., & Mayer, R. E. (1987). Students' miscomprehension of relational statements in arithmetic word problems. *Journal of Educational Psychology, 79*(4), 363–371. https://doi.org/10.1037/0022-0663.79.4.363

Liljedahl, P., & Sriraman, B. (2006). Musings on mathematical creativity. *For the Learning of Mathematics, 26*(1), 17–19.

Lubart, T., Besançon, M., & Barbot, B. (2011). *EPOC: évaluation du potentiel créatif*. Hogrefe.

Lubart, T., Zenasni, F., & Barbot, B. (2013). Creative potential and its measurement. *International Journal for Talent Development and Creativity, 1*(2), 41–51.

Lubin, A., et al. (2013). Inhibitory control is needed for the resolution of arithmetic word problems: A developmental negative priming study. *Journal of Educational Psychology, 105*(3), 701–708. https://doi.org/10.1037/a0032625

Lubin, A., et al. (2016). Expertise, inhibitory control and arithmetic word problems: A negative priming study in mathematics experts. *Learning and Instruction, 45*, 40–48. https://doi.org/10.1016/j.learninstruc.2016.06.004

Mann, E. L. (2006). Creativity: The essence of mathematics. *Journal of Education of the Gifted, 30*, 236–260.

Mann, E.L. (2005). Mathematical creativity and school mathematics: Indicators of mathematical creativity in middle school students (Doctoral dissertation). University of Connecticut. http://www.gifted.uconn.edu/siegle/Dissertations/Eric%20Mann.pdf.

Mastria, S., Agnoli, S., Zanon, M., Acar, S., Runco, M. A., & Corazza, G. E. (2021). Clustering and switching in divergent thinking: Neurophysiological correlates underlying flexibility during idea generation. *Neuropsychologia, 158*, Article 107890. https://doi.org/10.1016/j.neuropsychologia.2021.107890

Mayer, R. E., & Hegarty, M. (1996). The process of understanding mathematical problems. In R. J. Sternberg, & T. Ben-Zeev (Eds.), *The nature of mathematical thinking* (pp. 29–53). Lawrence Erlbaum Associates. https://doi.org/10.4324/9780203053270.

Meier, M. A., Burgstaller, J. A., Benedek, M., Vogel, S. E., & Grabner, R. H. (2021). Mathematical creativity in adults: Its measurement and its relation to intelligence, mathematical competence and general creativity. *Journal of Intelligence, 9*(1), 10. https://doi.org/10.3390/jintelligence9010010

Mumford, M. D., & McIntosh, T. (2017). Creative thinking processes: The past and the future. *The Journal of Creative Behavior, 51*(4), 317–322. https://doi.org/10.1002/jocb.197

Nakagawa, S., & Schielzeth, H. (2013). A general and simple method for obtaining R2 from generalized linear mixed-effects models. *Methods in Ecology and Evolution, 4*(2), 133–142. https://doi.org/10.1111/j.2041-210x.2012.00261.x

Newton, D., Wang, Y., & Newton, L. (2022). 'Allowing them to dream': Fostering creativity in mathematics undergraduates. *Journal of Further and Higher Education, 46*, 1334–1346. https://doi.org/10.1080/0309877X.2022.2075719

Pape, S. J. (2003). Compare word problems: Consistency hypothesis revisited. *Contemporary Educational Psychology, 28*(3), 396–421. https://doi.org/10.1016/S0361-476X(02)00046-2

Passolunghi, M. C., Doz, E., Cuder, A., Pellizzoni, S., & Carretti, B. (2022). The role of working memory updating, inhibition, fluid intelligence, and reading comprehension in explaining differences between consistent and inconsistent arithmetic word-problem-solving performance. *Journal of Experimental Child Psychology, 224*, Article 105512. https://doi.org/10.1016/j.jecp.2022.105512

Patrick, J., & Ahmed, A. (2014). Facilitating representation change in insight problems through training. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 40*(2), 532.

Peng, P., Wang, T., Wang, C., & Lin, X. (2019). A meta-analysis on the relation between fluid intelligence and reading/mathematics: Effects of tasks, age, and social economics status. *Psychological Bulletin, 145*(2), 189–236. https://doi.org/10.1037/bul0000182

Plucker, J. (1999). Reanalyses of student responses to creativity checklists: Evidence of content generality. *Journal of Creative Behavior, 33*(2), 126–137. https://doi.org/10.1002/j.2162-6057.1999.tb01042.x

Plucker, J. (2004). Generalization of creativity across domains: Examination of the method effect hypothesis. *Journal of Creative Behavior, 38*(1), 7–12. https://doi.org/10.1002/j.2162-6057.2004.tb01228.x

Pongsakdi, N., Kajamies, A., Veermans, K., Lertola, K., Vauras, M., & Lehtinen, E. (2020). What makes mathematical word problem solving challenging? Exploring the roles of word problem characteristics, text comprehension, and arithmetic skills. *ZDM, 52*, 33–44. https://doi.org/10.1007/s11858-019-01118-9

Powell, S. R., Berry, K. A., & Barnes, M. A. (2020). The role of pre-algebraic reasoning within a word-problem intervention for third-grade students with mathematics difficulty. *ZDM – Mathematics Education, 52*, 151–163. https://doi.org/10.1007/s11858-019-01093-1

Powell, S. R., Namkung, J. M., & Lin, X. (2022). An investigation of using keywords to solve word problems. *The Elementary School Journal, 122*(3), 452–473.

Primi, R., Ferrão, M. E., & Almeida, L. S. (2010). Fluid intelligence as a predictor of learning: A longitudinal multilevel approach applied to math. *Learning and Individual Differences, 20*(5), 446–451. https://doi.org/10.1016/j.lindif.2010.05.001

Reiter-Palmon, R., Forthmann, B., & Barbot, B. (2019). Scoring divergent thinking tests: A review and systematic framework. *Psychology of Aesthetics, Creativity, and the Arts, 13*(2), 144.

Reusser, K. (1990). *Understanding word arithmetic problems. Linguistic and situational factors*. American Educational Research Association.

Rothenberg, A., & Hausman, C. R. (1976). *The creativity question*. Duke University Press.

Runco, M. A. (1988). Creativity research: Originality, utility, and integration. *Creativity Research Journal, 1*, 1–7.

Runco, M. A. (2003). Education for creative potential. *Scandinavian Journal of Educational Research, 47*(3), 317–324. https://doi.org/10.1080/00313830308598

Runco, M. A., & Acar, S. (2012). Divergent thinking as an indicator of creative potential. *Creativity Research Journal, 24*(1), 66–75. https://doi.org/10.1080/10400419.2012.652929

Runco, M. A., Acar, S., & Cayirdag, N. (2017). A closer look at the creativity gap and why students are less creative at school than outside of school. *Thinking Skills and Creativity, 24*, 242–249. https://doi.org/10.1016/j.tsc.2017.04.003

Runco, M. A., Illies, J. J., & Eisenman, R. (2005). Creativity, originality, and appropriateness: What do explicit instructions tell us about their relationships? *The Journal of Creative Behavior, 39*(2), 137–148. https://doi.org/10.1002/j.2162-6057.2005.tb01255.x

Runco, M. A., & Jaeger, G. J. (2012). The standard definition of creativity. *Creativity Research Journal, 24*(1), 92–96. https://doi.org/10.1080/10400419.2012.650092

Sak, U., & Maker, C. J. (2006). Developmental variation in children's creative mathematical thinking as a function of schooling, age, and knowledge. *Creativity Research Journal, 18*(3), 279–291. https://doi.org/10.1207/s15326934crj1803

Scheerer, M. (1963). Problem-solving. *Scientific American, 208*(4), 118–131.

Schoevers, E. M., Kroesbergen, E. H., & Kattou, M. (2018). Mathematical creativity: A combination of domain-general creative and domain-specific mathematical skills. *Journal of Creative Behavior, 54*(1), 242–252. https://doi.org/10.1002/jocb.361

Schoevers, E. M., Kroesbergen, E. H., Moerbeek, M., & Leseman, P. P. (2022). The relation between creativity and students' performance on different types of geometrical problems in elementary education. *ZDM Mathematics Education, 54*(1), 133–147. https://doi.org/10.1007/s11858-021-01315-5

Shaw, S. T., et al. (2022). Mathematical creativity in elementary school children: General patterns and effects of an incubation break. *Frontiers in Education, 7*, Article 835911.

Silvia, P. J., et al. (2008). Assessing creativity with divergent thinking tasks: Exploring the reliability and validity of new subjective scoring methods. *Psychology of Aesthetics, Creativity, and the Arts, 2*(2), 68–85.

Silvia, P. J. (2011). Subjective scoring of divergent thinking: Examining the reliability of unusual uses, instances, and consequences tasks. *Thinking Skills and Creativity, 6*(1), 24–30.

Silvia, P. J. (2015). Intelligence and creativity are pretty similar after all. *Educational Psychology Review, 27*(4), 599–606. https://doi.org/10.1007/s10648-015-9299-1

Simonton, D. K. (2018). Defining creativity: Don't we also need to define what is not creative? *The Journal of Creative Behavior, 52*(1), 80–90. https://doi.org/10.1002/jocb.137

Smith, S. M. (2008). Invisible assumptions and the unintentional use of knowledge and experiences in creative cognition. *Lewis & Clark Law Review, 12*, 509–525.

Stein, M. I. (1953). Creativity and culture. *The Journal of Psychology, 36*(2), 311–322. https://doi.org/10.1080/00223980.1953.9712897

Sternberg, R. J. (1999). *Handbook of creativity*. Cambridge University Press.

Sternberg, R. J., & Lubart, T. I. (1996). Investing in creativity. *American Psychologist, 51*(7), 677–688. https://doi.org/10.1037/0003-066X.51.7.677

Stolte, M., García, T., Van Luit, J. E. H., Oranje, B., & Kroesbergen, E. H. (2020). The contribution of executive functions in predicting mathematical creativity in typical elementary school classes: A twofold role for updating. *Journal of Intelligence, 8*(2), 26. https://doi.org/10.3390/jintelligence8020026

Suherman, S., Setiawan, R. H., Herdian, H., & Anggoro, B. S. (2021). 21st century STEM education: An increase in mathematical critical thinking skills and gender through technological integration. *Journal of Advanced Sciences and Mathematics Education, 1*(1), 33–40.

Swanson, H. L., & Fung, W. (2016). Working memory components and problem-solving accuracy: Are there multiple pathways? *Journal of Educational Psychology, 108*(8), 1153–1177. https://doi.org/10.1037/edu0000116

Tabach, M., & Levenson, E. (2018). Solving a task with infinitely many solutions: Convergent and divergent thinking in mathematical creativity. In N. Amado, S. Carreira, & K. Jones (Eds.), *Broadening the scope of research on mathematical problem solving* (pp. 153–168). Springer. https://doi.org/10.1007/978-3-319-99861-9_10.

Tan, A. G., & Sriraman, B. (2017). Convergence in creativity development for mathematical capacity. In R. Leikin, & B. Sriraman (Eds.), *Creativity and giftedness* (pp. 123–137). Springer. https://doi.org/10.1007/978-3-319-38840-3_8.

Thevenot, C. (2010). Arithmetic word problem solving: Evidence for the construction of a mental model. *Acta Psychologica, 133*(1), 90–95. https://doi.org/10.1016/j.actpsy.2009.10.004

Thevenot, C., & Barrouillet, P. (2015). Arithmetic word problem solving and mental representations. In R. Cohen Kadosh, & A. Dowker (Eds.), *The Oxford handbook of numerical cognition* (pp. 158–179). Oxford University Press.

Torrance, E. P. (1974). *Norms technical manual: Torrance tests of creative thinking*. Lextington: Ginn & Co.

Tubb, A. L., Cropley, D. H., Marrone, R. L., Patston, T., & Kaufman, J. C. (2020). The development of mathematical creativity across high school: Increasing, decreasing, or both? *Thinking Skills and Creativity, 35*, Article 100634. https://doi.org/10.1016/j.tsc.2020.100634

van Hoogmoed, A., Adriaanse, P., Vermeiden, M., & Weggemans, R. (2025). Combining cognitive and affective factors related to mathematical achievement in 4th graders: A network analysis study. *SSRN*. https://doi.org/10.2139/ssrn.4883634

van Hooijdonk, M., Ritter, S. M., Linka, M., & Kroesbergen, E. (2022). Creativity and change of context: The influence of object-context (in)congruency on cognitive flexibility. *Thinking Skills and Creativity, 45*, Article 101044.

van Zanten, M., & van den Heuvel-Panhuizen, M. (2018). Opportunity to learn problem solving in Dutch primary school mathematics textbooks. *ZDM, 50*(5), 827–838. https://doi.org/10.1007/s11858-018-0973-x

Vanutelli, M. E., Pirovano, G., Esposto, C., & Lucchiari, C. (2021). Let's do the math… about creativity and mathematical reasoning: A correlational study in primary school children. *Education Quarterly Reviews, 4*(4), 445–454. https://doi.org/10.31014/aior.1993.04.04.406

Ventura-Campos, N., Ferrando-Esteve, L., & Epifanio, I. (2022). The underlying neural bases of the reversal error while solving algebraic word problems. *Scientific Reports, 12*, Article 21654. https://doi.org/10.1038/s41598-022-25442-5

Verschaffel, L., Schukajlow, S., Star, J., & Van Dooren, W. (2020). Word problems in mathematics education: A survey. *ZDM, 52*, 1–16. https://doi.org/10.1007/s11858-020-01130-4

Vicente, S., Verschaffel, L., Sánchez, R., & Múñez, D. (2022). Arithmetic word problem solving. Analysis of Singaporean and Spanish textbooks. *Educational Studies in Mathematics, 111*(3), 375–397. https://doi.org/10.1007/s10649-022-10169-x

Walberg, H. J. (1988). Creativity and talent as learning. In R. Sternberg (Ed.), *The nature of creativity* (pp. 340–361). Cambridge University Press.

Wong, T. T. Y., & Yip, E. S. K. (2023). What is the unknown? The ability to identify the semantic role of the unknown from word problems longitudinally predicts mathematical problem solving performance. *Contemporary Educational Psychology, 73*, Article 102183. https://doi.org/10.1016/j.cedpsych.2023.102183

Yip, E. S. K., Wong, T. T. Y., Cheung, S. H., & Chan, K. K. W. (2020). Do children with mathematics learning disability in Hong Kong perceive word problems differently? *Learning and Instruction, 68*, Article 101352. https://doi.org/10.1016/j.learninstruc.2020.101352