REVIEW ARTICLE

Linking Disparate Strands: A Critical Review of the Relationship Between Creativity and Education

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Abstract

Whether schools help or hinder creativity is a topic of vibrant, international debate. Some contend that the focus on structure, rote learning and standardised assessments associated with formal education stifles children's creativity. Others argue that creativity, much like numeracy or literacy, is a skill that can be taught, and educational settings provide optimal contexts for children to learn creative skills. With creativity increasingly recognised as a critical skill of the twenty-first century and formal education reaching more children across the globe, understanding the impact of schools on its development is critical. We suggest that much of the discourse on this topic has a narrow focus, precluding a global perspective. Here, we take a step back to integrate important but disparately presented research strands on education and creativity, to inform this debate. We first synthesize what we know about creativity and education, before presenting work on different areas—either directly or indirectly assessing creativity in educational contexts—including the relationship between creativity and academic achievement, classroom infrastructure and experiences, developmental slumps, teachers' perspectives on creative children and research on culturally and educationally diverse populations. Reviewing research from these approaches shows that the relationship is nuanced and requires careful interpretation—while some research showcases the positive impact schooling can have on children's creative development, other work, including from culturally and educationally diverse populations, shows how school experiences could be detrimental in this regard. We finish by summarising and integrating these research strands before making suggestions for future research.

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Introduction

In 2006, the British author Sir Ken Robinson delivered a TED Talk in which he passionately argued that formal education, with its focus on rote learning, standardized assessment, general curricula and lack of individual-based learning, 'kills' children's creativity. This evocative talk stimulated a wave of heated debates across academia, public culture, politics and media, and with over 77 million views at the time of writing, remains the most-watched TED talk of all time (Robinson, 2006). Numerous studies, books, special issues and conferences have been devoted to the question of whether schooling is beneficial or detrimental to children's creativity. Researchers meticulously and strongly advocate for both sides of the argument, including debates on whether, and how, the changing landscape of schools over recent decades impacts creativity (for discussions, see Barbot & Said-Metwaly, 2021; Kim, 2011). The scrutiny on understanding creativity and the factors associated with its development has further increased because of the growing economic and social value of creativity. The 2020 and 2023 World Economic Future of Jobs Reports identified creativity as the first and third most important emerging skills for future employees across the world, respectively (Battista et al., 2023; Schwab & Zahidi, 2020). As a result, there has also been a particular recent growth in focus on the role of education on children's creativity in recent years. For example, in 2021, OECD's Programme for International Students (PISA) introduced a framework for developing and assessing creative thinking in children, considering it a key academic competency for assessment. Various national institutions and governments have also targeted commissions, reports or initiatives to document whether schools are sufficiently supporting children's creativity, and, if not, what can be done (Brown et al., 2024; Gallup, 2019; Patston et al., 2021; Serota et al., 2021; Smith, 2018). Given that formal education is becoming ever more accessible globally—UNICEF has targeted providing all children (~ 3.5 billion individuals) with access to digitised educational resources by 2030—there is a time-sensitive opportunity to examine and understand whether, and how, schools and educational contexts promote or inhibit creativity over development across the world.

Although, as noted, many review and opinion articles exist on the topic of education and creativity, we suggest that their focus is often narrow, typically on one strand of the discussion, and several key and nuanced topics are omitted from them or are presented disparately. This precludes a more global theoretical understanding of this complex relationship. For example, published reviews or meta-analyses tend to focus on specific strands of the debate such as the relationship between academic achievement and creativity (Gajda et al., 2017; Karwowski, 2022) or whether developmental trajectories in children's creativity result from educational experiences (Barbot & Said-Metwaly, 2021; Kim, 2011; Said-Metwaly et al., 2020). We argue that there lacks literature presenting and linking this and broader work in unison.

In this this article, we briefly synthesize the debate on the relationship between creativity and education, before presenting work on different

areas—either directly or indirectly assessing creativity in educational contexts. Specifically, we explore the relationship between creativity, academic achievement, school and classroom experiences, teachers' perspectives on creative children at school, developmental slumps in creativity and the value of studying culturally and educationally diverse populations—particularly outside of western cultural contexts. We have chosen these specific topics because they each provide important contributions to the debate surrounding education and creativity, yet they are often treated disparately and have not been integrated to provide a holistic view of whether, and how, different types of educational experiences help or hinder creativity over childhood. In particular, they comprise core areas typically involved in the help or hinder discourse (including the relationship between creativity, academic achievement and classroom experiences, or how developmental slumps in creativity may be related to educational experiences) and those which tend not to be included in broader debates, but that we suggest can provide novel perspectives to discourse on the topic (such as research comparing different types of school and the value of studying culturally and educationally diverse populations). Thus, bringing them together here assimilates new literature and perspectives alongside more traditional ones in creativity-education debates (for an overview of key findings across the target topics, see Table 1). We then integrate these fields and provide some recommendations for future research.

Throughout the manuscript, we focus on literature to provide a comprehensive and balanced perspective from each of the topics and include studies that provide points of departure for future research. In doing so, we include key (literature directly addressing the role of education on creativity), seminal (heavily cited, influential literature on the topic), newer (2018 onwards) and wider (literature not typically included in creativity-education debates or that indirectly address the debate) literature. This allows us to introduce new perspectives alongside existing ones in the debate. To source our literature, we used a hybrid approach combining a systematic search, snowballing and using literature known to us from our backgrounds. Hybrid approaches are argued to be more effective in identifying core and wider literature compared to a single approach (Mourão et al., 2020; Wohlin et al., 2022). To start our systematic search, we entered the following terms into the Scopus digital library: 'education', 'school*', 'formal', 'class*', 'creativ*', 'divergent', 'convergent', 'thinking', along with 'develop*', 'pupil*', 'student*'. For each specific topic we discuss (i.e. the relationship between creativity and academic achievement, classroom infrastructure and experiences, developmental slumps, teachers' perspectives on creative children and research on culturally and educationally diverse populations), we tailored our search to include more specific terms (e.g. 'numeracy', 'literacy', 'test scores', 'grades', 'achievement', etc.). After identifying relevant literature, we then further identified relevant research using the reference lists and citations (snowballing) from manuscripts identified in our Scopus search (Wohlin, 2014). Finally, where necessary, we supplemented this with any research (particularly wider/indirect work) known to us before the literature search.

Table 1 Broad overview of definitions, typical measures and key findings on the relationship between divergent thinking and convergent thinking and each of the topics of this review

Construct	Brief definition	Examples of typical measurement(s)	Key links to children's educational outcomes
Divergent thinking (DT)	Producing multiple novel ideas, solutions or possibilities	Verbal: Alternate uses measures (generating novel uses for everyday objects) Figural: Drawing multiple, diverse objects from geometric shapes Self/other report	*Academic achievement, school, and classroom experiences:* The evidence is mixed, but overall DT is positively linked with academic achievement—particularly psychometric and verbal measures (Gajda et al., 2017). DT skills such as fluent, flexible, and original thinking may be beneficial for learning, and DT may help children consolidate new knowledge. Classroom activities such as peer collaboration (Segundo Marcos et al., 2020), storytelling (Ruini et al., 2022) and mind mapping (Yu-Sheng Su et al., 2022), and perspective taking (Doron, 2017), have also been shown to benefit children's DT *The teachers' perspective:* Although teachers are keen to nurture creativity in the classroom (Bereczki & Kárpáti, 2018), their understanding of creativity tends to differ from that of researchers, where they emphasise novelty over value (Mullet et al., 2016). Teachers' ratings of creative children also correlate poorly with psychometric performance and ratings (Gralewski & Karwowski, 2019; Hoff, 2011). Teachers tend to prefer appropriate answers over novel (divergent ones), rate fictitious creative children as disruptive (Scott, 1999), and studies indicate they can ignore creative questions by students—potentially suggesting that DT skills may be less valued by educators than other skills (Beghetto, 2007; AJ Cropley, 1996). Training teachers on creativity improves their perspectives and understanding of it (Urbanne & Wijnia, 2021; van de Watering & van der Rijt, 2006) *Developmental slumps:* Evidence is mixed: early work claimed evidence for slumps in DT around 9–10 years of age, with some suggesting that school transitions or social pressures to conform in educational contexts may contribute to these slumps (Kim, 2011; Torrance, 1967, 1968). However, a recent large-scale meta-analysis failed to find convincing evidence of developmental slumps in DT, and the ages at which slumps are reported (9–10 years) do not correspond with changes in educational contexts for most children (Said-Metwaly et al., 2020). It is thus unclear whether DT slumps exist and whether educational factors play any role in them *Different school types:* There is growing evidence that children who attend alternative schools (e.g. Montessori, Steiner) outperform those attending mainstream ones on figural (and to a lesser extent verbal) DT measures (Denervaud et al., 2021; Eon Duval et al., 2022). While there is no concrete consensus explaining why yet, it has been proposed that the lower focus on rigorous structure, generalised curricula and standard assessment tools, and comparatively greater focus on independence, hands-on, play-based and self-directed learning, peer-tutoring found in alternative schools, and that they typically avoid standardised assessments, may facilitate children's divergent thinking and creative expression (Denervaud et al., 2021; Eon Duval et al., 2022) *Culturally and educationally diverse populations:* There has been much focus on comparing Western vs. Eastern populations on DT measures, where the former have traditionally been suggested to outperform the latter because Western populations place greater emphasis on novelty, uniqueness, and divergence from convention (Cheung et al., 2016; McCarthy, 2019). However, recent work suggests that the different focuses of Eastern and Western schools lend themselves to different facets of creative thinking, with Eastern children outperforming Western ones one DT measures in domains such as mathematics (Shi et al., 1995; Zha, 1986, 1998). Other work shows that children with very limited integration into formal schooling show impressive DT, potentially because early adversity can lead to enhanced cognitive skills such as creativity—not captured in typical academic contexts (Frankenhuis et al., 2020)(Frankenhuis et al., 2018, 2020)

Table 1 (continued)

Construct	Brief definition	Examples of typical measurement(s)	Key links to children's educational outcomes
Convergent thinking (CT)	Homing in on single, correct solutions from a range of options	Verbal: Remote Associations Test (finding a word that can be associated with a set of target stimuli words) Figural: Generating pictures with a set number of geometric shapes Self/other report	*Academic achievement, school, and classroom experiences:* Verbal CT is linked with mathematical ability in older children (de Vink et al., 2022), and some evidence that self-report CT is associated with school exam performance in Chinese adolescents (Yang & Zhao, 2021). Ostensibly, CT is beneficial for school tasks involving logical thinking, deduction, and implementing set techniques (de Vink et al., 2022). However, little is known about other CT measures or results in younger children, and thus more work is required *The teachers' perspective:* Although teachers are keen to nurture creativity in the classroom (Bereczki & Kárpáti, 2018), their understanding of creativity tends to differ from that of researchers (Dawson et al., 1999; Mullet et al., 2016; Westby & Dawson, 1995), particularly so with CT because teachers emphasise novelty over value. Teachers' ratings of creative children correlate poorly with children's psychometric performance and ratings (Gralewski & Karwowski, 2019; Hoff, 2011). However, teachers tend to prefer appropriate answers over novel (divergent ones), potentially suggesting that CT skills may be valued by educators (Beghetto, 2007; Cropley, 1996)—though work needs to verify this. Training teachers on creativity improves their perspectives and understanding of it (Urhahne & Wijnia, 2021; van de Watering & van der Rijt, 2006) *Developmental slumps:* Very limited work, though one recent study indicated that while young children show greater CT than DT, they converge over childhood, and there was no evidence of slumps across the school years (Eon Duval et al., 2022). It may be that the early educational focus in many schools on correct, logical responses promotes CT over childhood, precluding developmental declines (Eon Duval et al., 2022) *Different school types:* Less evidence than with DT, but similarly growing recent evidence that children who attend alternative schools (e.g. Montessori, Steiner) outperform those attending mainstream ones on figural CT measures. While there is no concrete consensus explaining why yet, it has been proposed that the lower focus on rigorous structure, generalised curricula and standard assessment tools, and more on independence, hands-on, play-based and self-directed learning, peer-tutoring found in alternative schools, and that typically avoid standardised assessments, may facilitate children's creative expression. More work is needed, however, including on diverse CT measures *Culturally and educationally diverse populations:* Far less work than on DT. Chinese children in Hong Kong showed slighter better CT than French children on figural and verbal measures (Cheung et al., 2016); however, Chinese children in France showed greater figural CT than Chinese children in Hong Kong (Lau et al., 2013). Much more work is needed on similarities and differences in CT in culturally and educationally diverse populations and the underpinning mechanisms (Cheung et al., 2016)

What Is Creativity?

Although defining creativity is not without controversy, a broad but widely accepted definition is that it is the ability to generate novel and useful ideas (Acar et al., 2017; Gayle, 2022; Runco & Jaeger, 2012; Said-Metwaly et al., 2020; Stein, 1953). Under this definition, creativity has been assessed using several approaches, including psychometric assays (standardized tasks given to participants by experimenters), self-reporting (participants' answering questions about themselves) and other-reporting (having others such as caregivers or peers answer questions about participants) personality and attitude assessments, and indeed real-life creativity indicators (such as type of employment, enrolment in arts-based classes, and so on). This has—as with some other areas of psychology—generated significant debate in broader creativity research on the validity and reliability of measures, and indeed how well they correlate with one another (El-Murad & West, 2004; Ford & Harris, 1992; Parkhurst, 1999; Simonton, 2018; Weiss et al., 2021). However, given that our focus is on the relationship between creativity and education, detailing these debates is beyond the scope of this review. We have thus elected to focus on considering creativity as the ability to generate novel and useful ideas which involves two distinct but key skills; divergent thinking—the capacity to produce multiple novel ideas, solutions or possibilities; and convergent thinking—homing in on single, correct solutions from a range of options (Cropley, 2006; Evans et al., 2021; Guilford, 1967). Divergent thinking involves thinking fluently (to produce many ideas), originally (to produce rare ideas), flexibly (to produce diverse ideas) and elaborately (to produce detailed ideas) (Runco, 1992; Runco & Acar, 2012). Conversely, convergent thinking requires processes such as logical thinking, accuracy, precision, deduction and the ability to integrate these types of thinking skills, to evaluate a range of potential solutions and identify the optimal one (Cropley, 2006). We focus on divergent and convergent thinking because they are the most widely used measures of creativity, particularly in the realm of education, and thus afford a comprehensive perspective of how different types of schooling experiences and academic skills are related to creativity over childhood. Importantly, also, in the PISA Assessment and Analytical Framework, creative thinking is broken into three facets: (1) generate diverse ideas; (2) generate creative ideas; and (3) evaluate and improve ideas—facets that are nicely captured by both divergent and convergent thinking (PISA, 2022).

It is important to also note that while divergent and convergent thinking are often treated as opposing cognitive skills (Eysenck, 2003), both are required for creativity. The former allows the production of multiple novel ideas, and the latter affords the evaluation of ideas to optimise their value. Despite this, a core issue in creativity research—including in education-focused work—is that divergent thinking has received far more scientific focus than convergent thinking (see Table 1), and researchers often use the former as a proxy for overall creative ability (Cropley, 2006; Runco & Acar, 2012). Further, despite, as noted, there being multiple ways to measure divergent and convergent thinking, the most common ones include psychometric assays, self-reporting and other-reporting, and of these, psychometric assays are by far the most commonly used (Weiss et al., 2021), and which thus comprise much of the focus of this manuscript.

The Help or Hinder Debate

One of the most interesting and vibrant debates in developmental and education psychological research over recent decades is whether schools help or hinder creativity (Beghetto & Plucker, 2006; Craft, 2005; Cropley, 1996; Fasko, 2001; Gajda et al., 2017; Gralewski et al., 2016; Guilford & Vaughan, 1962; Karwowski, 2022; Kaufman & Beghetto, 2009; Kim, 2011; Moran, 2010; Robinson, 2006; Westby & Dawson, 1995). Some argue that formal education—defined as a compulsory, structured education system which typically follows a programme or curriculum (UNESCO, 2011)—is not appropriately structured or equipped to fulfil the creative potential of young people. In particular, the focus on standardised assessments, conformity, rote learning and rule following, as well as the administrative pressures on teachers, and the lack of capacity for one-to-one learning opportunities that typically characterise formal education, is suggested to stifle children's creativity (Agnoli et al., 2018; Craft, 2005; Kim, 2011; Noddings, 2013; Richards, 2001; Runco et al., 2017; Torrance, 1967; Westby & Dawson, 1995). Conversely, others contend that creativity, often linked with intelligence, is learned and sharpened at school in the same way skills like numeracy and literacy are, and that broader experiences associated with attending schools such as exposure to informational diversity, collaboration, widening social networks and creativity-focussed classroom activities are particularly beneficial to the development of creative thinking (Barbot & Said-Metwaly, 2021; Dewey, 1938; Gajda et al., 2017; Karwowski, 2022; Karwowski et al., 2020; Kaufman et al., 2023; Paris et al., 2006).

A fundamental problem is that directly testing whether formal education shapes creativity is extremely difficult in many populations. Ostensibly, the purest test would involve comparing two samples of children from the same culture, one of which attends school and one of which does not (and matched on other potential confounding variables such as age, socio-economic status and cognitive ability) on their creative abilities over time. This would allow researchers to determine whether, and how, attending school is detrimental or beneficial to creativity. If the children who attended school displayed a markedly different pattern in their creativity over the school period to those who did not, it would provide strong evidence that exposure to formal schooling does impact creativity. However, running this kind of study is almost impossible given that in 2018 the World Bank estimated that 90% of all children attended primary school, and in most (post industrialised) societies where schooling is compulsory and truancy is often criminalized, attendance rates are close to 100%. Further, there are several cognitive (Archambault et al., 2009), socio-economic (Winding & Andersen, 2015) and health (Fernandez-Haddad & Lara Gonzalez, 2023) issues associated with children who do not attend school, or have dropped out. This makes any prospective comparisons difficult. As such, researchers generally seek more indirect avenues to assess the association between creativity and formal education.

Creativity, Academic Achievement, School and Classroom Experiences

A large body of work has examined the relationship between measures of creativity and markers of academic achievement (typically measured by test results, grades or numeracy and literacy skills). Here, evidence of a positive association is taken as support for the concept that schools promote creativity. Although published findings are mixed, a meta-analysis of 120 studies reported a modest but positive relationship between creativity—which was largely based on divergent thinking measures—and academic achievement (Gajda et al., 2017). Importantly, the effect was stronger when creativity was measured using psychometric tests (such as task batteries) than when using self-report measures, and similarly, when academic achievement was measured using standardized achievement tests (e.g. maths or spelling tests) compared to overall grades. There was also a stronger effect for verbal measures of creativity than nonverbal ones and during middle school compared to earlier and later school stages (which were consistent). The authors suggested that divergent thinking skills such as fluent, flexible and original thinking, alongside problem-solving and deductive reasoning may be critical for learning. They also suggested that creativity potentially facilitates the consolidation and processing of new knowledge, including educational material. It was argued that the stronger effect during the middle school period may reflect its importance as a developmental stage for thinking skills (Gajda et al., 2017). In line with this, creativity has been positively linked with children's executive functions (Krumm et al., 2018) and cognitive control (Zabelina & Robinson, 2010), higher-level cognitive processes that help individuals attend to, and process, relevant information and ignore irrelevant material. A recent study also showed that creativity, as measured by psychometric tests and self-report measures, accounted for a significant proportion (18%) of 15–18-year-old Australian children's performance on standardized academic assessments of school taught subjects (e.g. English, maths, arts, technologies, sciences and humanities) even after controlling for personality and grade point average (Kaufman et al., 2023). The authors suggested that creative skills such as divergent thinking, flexibility, and convergent thinking are beneficial for academic achievement (Kaufman et al., 2023).

Although most work seems to suggest a positive relationship between divergent thinking and academic achievement, some studies have indicated that this relationship may be weak, or that individuals may be more creative outside of educational contexts. For example, in a study involving over 2000 13–18-year-old Spanish students, Ai (1999) found that divergent thinking, measured by the Torrance Tests of Creative Thinking (a widely used divergent thinking psychometric test battery) showed little relationship with academic performance (in terms of grades). However, the relationship was stronger with other, less widely used, psychometric measures of divergent thinking (Ai, 1999). Similarly, Turkish university students rated themselves as more creative in out-of-school contexts than in-school contexts across several domains—with the only exception being that of science and technology (Runco et al., 2017). The authors suggested that this may reflect the administrative pressures and high student-to-teacher ratio in schools and teachers which precludes supporting individual work and independence, and thus developing core creative skills (Runco et al., 2017). However, it is of course important to note that this study focussed on

adults and in university settings, and whether the same factors hold for earlier education experiences should be further examined.

There has, as mentioned, been far less attention on the association between convergent thinking and academic achievement. This is somewhat surprising given that many school tasks involve evaluating different responses and converging on correct ones. For example, solving mathematical problems is a fundamental skill taught from primary school. While divergent thinking may help pupils approach mathematical problems from different angles and produce original answers, convergent thinking affords strategy selection and narrowing in using existing knowledge (Cropley, 2006; de Vink et al., 2022). In Dutch 9–13-year-olds, children who showed stronger verbal convergent thinking performed better on single- and multi-solution mathematical problems than those with weaker CT performance (de Vink et al., 2022). This was suggested to potentially be because these types of problems involve logical thinking and implementing set techniques—skills associated with convergent thinking (de Vink et al., 2022). Another study found that self-report measures of convergent and divergent thinking were positively associated with school exam performance in Chinese 15–17-year-olds (Yang & Zhao, 2021). The effect was stronger for convergent thinking and middle-achieving students (compared to low or high-achieving students). However, the authors did note that the validity of the questionnaire used in this context was unlikely to be as strong as psychometric tests. As such, while promising, much more research is needed to validate these findings and continue to measure the relationship between convergent thinking and other measures, including psychometric ones, of academic achievement.

Another avenue of research is to document the influence of school and classroom experience and activities on children's creativity, though this has received much less attention than metrics of academic achievement. Typical classroom environments involve children sitting for several hours a day, focusing on set tasks, and being encouraged to comply, to avoid becoming distracted, and to ask task-relevant questions—conditions which have been argued to be detrimental to creative expression and development (Ershadi & Winner, 2020; Kim, 2011; Robinson, 2006). However, some research indicates that suitable school infrastructure and teachers' classroom approaches can promote creative skills. In a large-scale review, Davies and colleagues identified several pedagogical features that appear to enhance children's creativity, encompassing those related to the physical environment, pedagogical and psychosocial factors and external partnerships (Davies et al., 2013). In terms of the physical environment, having flexible use of spacious and open indoor and outdoor areas and allowing students to freely and imaginatively use resources and materials was identified as beneficial for students' creativity. In terms of classroom experiences, using novel, engaging, diverse and realistic tasks, including physical materials and technological instruments afforded creative expression. Additionally, adopting game-like or play-based approaches to learning was found to foster creativity. Finally, establishing partnerships with external organisations such as local museums and galleries was shown to improve creative motivation (Davies et al., 2013)—though we stress that this type of collaboration may be inaccessible for many schools around the world. Recent work has also highlighted the importance of peer collaboration activities on divergent

thinking in the classroom. Spanish 9–10-year-olds who were given reading and writing tasks in the context of classroom cooperation over 2 months showed an improvement in divergent thinking, as measured by psychometric testing. Those who were given the same tasks in a non-cooperative (i.e. standard curricula) context did not improve (Segundo Marcos et al., 2020). Cooperative learning in the classroom encourages students to engage in dialogue with peers, share ideas and evaluate concepts under a shared goal, which may encourage divergent thinking (Segundo Marcos et al., 2020). Other work shows that 10–11-year-old children who engaged in mind mapping via constructing a digital world to design, develop and create coursework at school showed higher divergent thinking on psychometric tests than those who did not (Yu-Sheng. Su et al., 2022). Further, providing teachers with professional development courses on how to teach with creativity improved 9–13-year-olds self-rated creativity over 8 months (Conradty & Bogner, 2020).

Relatedly, there is also some evidence that targeted classroom interventions can successfully promote creativity in schools. Secondary-school Chinese children exposed to the 'Learn to Think' intervention program, in which teachers actively promoted a range of thinking methods including divergent thinking within school subjects showed greater divergent thinking skills when solving puzzles than control group participants not exposed (Hu et al., 2013). Further, 8–10-year-old Italian children who engaged with an intervention focussing on encouraging positive narrative techniques in fairytales and storytelling were subsequently rated as displaying higher creativity in a storytelling task (Ruini et al., 2022). Finally, over 10 weeks, 10–14-year-old Israeli children who engaged with an intervention encouraging perspective-taking (viewing a situation from another's point of view) within media use showed a significantly greater increase in psychometrically assessed divergent thinking compared to control children (Doron, 2017).

These studies suggest that core creative skills are often linked with assays of academic achievement and that creative thinking can potentially be improved in children with appropriate pedagogical methods, interventions, and infrastructure—suggesting many educational experiences do positively benefit creative development. However, more work is needed given the findings, at least in young adults, that individuals perceive themselves as more creative outside of educational contexts than within. For example, longitudinal studies on executive functions (a suite of cognitive processes allowing individuals to flexibly achieve goals), and in particular working memory (the capacity to hold information in mind in an accessible form), show that they develop more during school semesters than outside of them (Finch, 2019). Does the same hold for creativity? How long do the effects of interventions last? Can qualitative methods be used to better understand how school and classroom activities shape convergent and divergent thinking? Are developmental trajectories across school experiences the same for convergent and divergent thinking? Further, work is needed to shed light on the direction of relationships, and whether, for example, schooling facilitates creativity or vice versa. Research of this kind will also help educators develop classroom experiences to encourage creative thinking.

The Teacher's Perspective

In addition to the implementation of classroom-based activities, research has also examined how teachers perceive creative children, whether it aligns with how these children behave in the classroom, and its potential influence on their creative performance. Commonly documented findings are that there are teachers who find it difficult to identify creative children (Gralewski & Karwowski, 2016) and that there are discrepancies between teachers' perceptions of creative children and how creative children actually behave (Paek et al., 2020). For instance, teachers' ratings are typically weakly correlated with children's performance on psychometric assays of creativity (Gralewski & Karwowski, 2019; Hoff, 2011), self-assessments (Beghetto et al., 2011), parent and peer ratings (Chan, 2000; Lau & Li, 1996). Teachers also rated (fictitious) creative children as being disruptive in the classroom (Scott, 1999) and characterised creative children (measured by psychometric creativity tests) as having low capacities for creative thinking, problem-solving, inventiveness and independence, and as having rigid thinking styles (Gralewski & Karwowski, 2016). Further, studies indicate that when it comes to children's and adolescents' responses to classroom questions, teachers ignore creative questions by students (Beghetto, 2007; Scott, 1999), prefer relevant answers over novel ones as well as obedience to authority, and report the latter as impulsive and disruptive (Beghetto, 2007; Cropley, 1996). In the meta-analysis described above by Gajda et al. (2017), the finding that divergent thinking was more strongly associated with standardised achievement tests than overall grades was suggested to potentially be because teachers prioritise appropriate answers over unexpected or original ones (i.e. divergent responses). Thus, students learn that it is not beneficial to be creative in classroom responses, particularly in terms of divergent thinking (Gajda et al., 2017).

Another key issue is that many teachers may lack an understanding of what creativity is, particularly in terms of how researchers conceptualise it. While researchers emphasise novelty and value, studies suggest that teachers tend to focus only on novelty when defining creativity, and thus have a product-focused understanding of it (Dawson et al., 1999; Mullet et al., 2016; Westby & Dawson, 1995). In a large-scale systematic review, Mullet and colleagues found that while researchers also generally highlight both the role of individual factors including personality and the social environment in creative cognition, teachers often consider it a subject-specific skill and tend not to recognise environmental influences (Mullet et al., 2016). This in turn led teachers to rate some characteristics that researchers associate with creativity, including impulsiveness, as undesirable (Mullet et al., 2016). Similarly, Akyıldız and Çelik (2020) reported that Turkish EFL teachers had very little understanding of what creativity is and how to identify (and implement) creative activities in the classroom.

These misconceptions are likely to have important implications for how teachers scaffold creativity in educational settings. If teachers struggle to identify creativity and creative children, they are unlikely to adapt learning and task requirements and difficulty accordingly (Urhahne & Wijnia, 2021). Research shows that when teachers' judgements of children's academic skills are accurate, individual support and frequent feedback promote classroom learning (Behrmann & Souvignier, 2013;

Helmke & Schrader, 1987). Further, teachers' characteristics impact their interaction with students. Teachers who identify themselves as creative and imaginative tended to support and encourage creative children, even if their classroom behaviours were not easily manageable. Conversely, those who identified as orderly, pragmatic and structured preferentially encouraged children with these characteristics (Gurak-Ozdemir, 2016). In a systematic review, Bereczki and Kárpáti (2018) concluded that teachers were keen to foster creativity in the classroom. However, given they struggle to identify creative thinking and have insufficient knowledge of ways in which creativity can be supported, developing methods to implement in the classroom is rare. This may also explain why there is a lack of research documenting effective classroom strategies for improving student creativity.

Thus, in schools or classrooms where teachers are not provided with the tools or training to harness creativity in their pupils, it may not reach its full potential. Researchers have recommended that teachers are given the right parameters, training, and support to make accurate judgements about children's capacities (Urhahne & Wijnia, 2021; van de Watering & van der Rijt, 2006) and subsequently calibrate their pedagogical approaches accordingly. This includes research-led training on understanding creativity, feedback on judgment accuracy, training focusing on teachers' diagnostic skills, professional development programmes, creativity awareness raising and encouraging reflection when making judgements about students. Indeed, creative and professional development training has a marked impact on teachers' definitions and understanding of creativity, bringing it closer to researchers' conceptualisations (Mullet et al., 2016). Such training also moved teachers' perceptions that creativity was innate and possessed only by some children, to it being something that can be harnessed in all children (Mullet et al., 2016; Patston et al., 2021). Importantly, also, a recent review of studies in Spain and Italy found that providing teachers with access to research-led creativity-based programs and training enhanced children's divergent thinking compared to control groups (Ruiz-del-Pino et al., 2022). In sum, this body of work highlights how attending school alone may provide some benefits, but giving teachers the appropriate training, infrastructure, and support can have an additional marked positive impact on children's creative skills.

Schools, Slumps and Bumps?

A contentious issue in the field of children's creativity is the presence or absence of developmental 'slumps', and the potential role of educational contexts on them. Early work by Torrance, a highly influential figure in the study of creativity, identified a discernible decrease in children's divergent thinking across multiple countries at around 9–10 years of age (Torrance, 1967, 1968). This effect was subsequently termed the 'fourth-grade slump' and evoked a wave of educational research studying developmental patterns of creativity in school-aged children, with findings providing supporting and contrasting evidence for a fourth-grade slump, and indeed slumps at different time ages (for a detailed review, see Said-Metwaly et al., 2020).

A variety of explanations have been proposed to explain developmental slumps in divergent thinking, many of which revolve around education and the increased pressures to conform in new environments. Torrance (1967) initially suggested that divergent thinking slumps occur during times of school transitions, such as moving from primary to secondary school. Such transitions often involve increased stress and expectations to conform to new rules, norms, structures and social environments, and thus uniqueness may not be appropriate (Kim, 2011; Torrance, 1967). Social contexts are known to differentially influence children and adolescents; being observed by an adult appears to be detrimental to children's divergent thinking but beneficial to early adolescents (with no effect on late adolescence; Camarda et al., 2021). Kim (2011) found in a large sample of US children that the capacity to generate novel and rare ideas (originality) and open-mindedness improved up to fifth grade (10–11 years), then decreased during high school years, before increasing again in adulthood. It was suggested that the increased desire to conform and meet convention during high school may underpin these slumps in creativity (Kim, 2011).

Despite these claims, concrete evidence that slumps result from changes in educational contexts or pressures of conformity that come with school environments remains elusive. Notwithstanding that many studies have failed to find evidence of slumps—in part likely because of inconsistencies in methodology across studies and that the timing of reported slumps such as the fourth-grade one does not coincide with changes in many educational contexts and cultures (Said-Metwaly et al., 2020). Further, a recent study found that 4–12-year-old Swiss children from mainstream and Montessori schools—where in the latter there is less expectation to conform to school structures and norms, and less peer pressure—showed similar developmental trajectories in divergent and convergent thinking (Eon Duval et al., 2022). This indicates that the expectations around social norms in schools does not explain developmental slumps. Others have also theorised that potential slumps result from cognitive or biological reasons rather than educational ones. For example, it has been argued in middle childhood that there is a cognitive trade-off, wherein as skills such as logical reasoning or evaluative ability begin to peak, divergent thinking suffers a temporary decline (Charles & Runco, 2001; Lubart & Georgsdottir, 2004). Another suggestion is that the rapid maturation of the prefrontal cortex facilitates higher cognitive functions such as divergent thinking at this age (Barbot & Tinio, 2015), though evidence for each these hypotheses are not convincing. There is also very little work examining the developmental trajectory of, and the presence or absence of slumps in, convergent thinking. To our knowledge, just two studies have mapped its pattern over childhood, both of which found no evidence of any slumps in European children (Eon Duval et al., 2022; Gralewski et al., 2016), but more work is needed to validate these findings.

Although much more work is required, particularly using consistent measures (Said-Metwaly et al., 2020), these studies potentially indicate that convergent and divergent thinking show distinct developmental trajectories and thus may have different societal influences. Whether any temporary declines in divergent thinking are due to educational factors remains inconclusive. If so, research is needed to examine why these factors appear not to influence convergent thinking in the same way. One proposal is that early school pedagogy tends to focus on skills associated with

convergent thinking more than divergent thinking (e.g. developing optimal solutions to problems), which may explain its greater overall performance in younger children and the lack of slumps in the former (Eon Duval et al., 2022). We encourage future researchers to continue to test hypotheses such as these.

Comparing Creativity in Children Attending Different Types of School

Comparing creative performance from children from schools with different philosophies can provide powerful insights into the way different educational approaches and kinds of school experiences may promote or impede creative thinking. To this end, over the last 5–10 years, a small, but growing, number of studies have drawn comparisons in creativity between children attending 'mainstream' schools and those attending schools with alternative philosophies, such as Montessori and Steiner schools. The latter types of schools, while still relatively rare, are increasing in popularity, and are seen to promote expression and creativity. In many populations, mainstream schools follow regulated curricula and structured lessons, employ standardised assessments and group children by age, have a somewhat hierarchical, teacher-led structure, and learning materials are usually written-based. Conversely, schools with Montessori philosophies emphasise independent, self-directed and hands-on learning using materials, and intense peer collaboration, typically avoid standardized assessments and have less formal structure (Randolph et al., 2023). Steiner schools are broadly similar to Montessori ones, though where Montessori schools emphasise learning practical skills through structured play, Steiner schooling emphasises free play, flexible thinking, as well as moral and social growth, and typically involves very little structure at all (Stehlik, 2019). Both Montessori and Steiner schools also typically include multi-age classes and encourage peer-learning.

In general, the evidence suggests that children who attend mainstream schools show lower creative skills than those attending Montessori or Steiner schools. In one study, 6–8-year-old UK children attending Steiner schools produced more creative drawings than those from Montessori and mainstream schools (who performed similarly to one another), when asked to complete incomplete figural fragments (Kirkham & Kidd, 2017). The authors suggested that this may result from Steiner schools' comparatively higher encouragement of imagination and pretence compared to the others' (Kirkham & Kidd, 2017). Similarly, across two studies, 4–12-year-old Swiss children attending Montessori schools outperformed those attending mainstream ones on figural (drawing-based) psychometric measures of divergent and convergent thinking, after controlling for intelligence (Denervaud et al., 2021; Eon Duval et al., 2022). Further, children in the Montessori schools showed greater flexibility in their semantic network structure, indicative of being better able to connect diverse concepts (Denervaud et al., 2021). Finally, 7–11-year-old French children in Montessori schools outperformed those in mainstream schools on measures of verbal (alternate uses task) and figural (making drawings from parallel lines) psychometric measures of divergent thinking, where responses across tasks were combined into a single creativity score (Besançon & Lubart, 2008).

These studies imply that attending alternative schools facilitate children's convergent and divergent thinking more so than mainstream ones. Although the exact reasons behind these findings are unclear, some have suggested that a lack of pressure and social norms in these environments (i.e. no formal assessments, grades, homework) may better allow children to fulfil their creative potential than those in mainstream schools (Eon Duval et al., 2022). Others contend that, in addition, the greater diversity in social experiences involved in alternative schools, including peer-tutoring and multi-age classes, may enhance creative thinking (Denervaud et al., 2021). It is also possible that the large class size (and lower student–teacher ratio) involved in Montessori or Steiner-style schools, which in turn lends itself to developing social relationships, peer learning and collaboration, may also be beneficial for creativity (Randolph et al., 2023). Finally, the greater encouragement of imagination and pretence, particularly in Steiner schools, may also support creativity—particularly in the form of divergent thinking—compared to children attending Montessori and mainstream schools (Kirkham & Kidd, 2017).

This line of work is still in its infancy and more needs to be done to validate and unpack these findings as well as establish underpinning mechanisms. For example, research could attempt to disentangle whether social experiences associated with Montessori or Steiner schools, such as peer-tutoring, and integration with multi-age classes facilitate creativity, or whether a lack of formal assessments or homework (or indeed a combination of these) contribute to creativity differences. Further, most of these studies included solely figural measures of creativity, and more studies including verbal measures are required—particularly given the stronger link between academic achievement and performance on verbal creativity measures compared to figural ones. It is also possible that creative parents are more likely to send their children to Montessori or Steiner schools, making it hard to truly conclude that differences in creative performance are a result of school philosophies or other factors, such as genetics or differences in the promotion of creativity at home (Eon Duval et al., 2022). Given the growing popularity of schools with alternative philosophies, there is a unique opportunity to examine how they impact children's creative thinking.

The Importance of Studying Culturally and Educationally Diverse Populations

Much of the discourse surrounding creativity and education is based on empirical and theoretical work from Western populations. Although this is true of most psychological research, there are important reasons to believe that research beyond these samples may be particularly informative to this debate. Notwithstanding the increasingly global nature of business and industry, school philosophies, attendance rates (and expected attendance), teacher approaches and availability of educational resources often markedly vary across cultures, and are known to impact academic achievement (Rawlings et al., 2023). In some communities, access to formal education is extremely limited or indeed undesirable (Ninkova et al., 2022). Variation of this kind may allow assessment of—directly or indirectly—how these factors may influence creative development. Global research and cross-cultural studies (studies

directly comparing two or more populations) examining the development of creativity (or related skills) provide another angle with which to understand how formal education may or may not underpin creative skills. Children in culturally diverse contexts have different levels of integration into formal education and/or attend schools with markedly different approaches, values and learning experiences. Presenting research on children across distinct cultures with different educational experiences sheds important yet often overlooked light on how these experiences may influence creativity and introduce novel literature and perspectives to the debate.

Much of the comparative cross-cultural research on creativity has compared children from Western backgrounds to those from Eastern ones, typically on divergent thinking measures. An overarching theoretical narrative is that Western populations tend to stress the importance of novelty, and uniqueness, and prioritise ideas that significantly diverge from existing ones. Conversely, Eastern populations focus more on usefulness, harmony and integration into existing environments. Some also suggest that Western cultures tend to conceptualise creativity as a general skill and emphasise individual creative achievements, while Eastern ones consider it domain-specific and focus on social features of creativity, such as team-based creative achievements (Niu, 2019). This has led to a widely held perception that Western children are more creative than their Eastern counterparts, particularly on (individual) psychometric measures (Cheung et al., 2016; McCarthy, 2019), with some early studies supporting this notion (Jaquish & Ripple, 1985; Straus & Straus, 1968; Torrance, 1974).

However, this has been challenged by other work suggesting that Eastern children can outperform Western ones on measures of divergent and convergent thinking, which may in part result from schooling effects. For example, Chinese children in Hong Kong outscored French children on a battery of verbal and figural psychometric measures of convergent and divergent thinking (Cheung et al., 2016). This was suggested to potentially result from a curriculum and education reform in Hong Kong to focus on creative skills (Cheung & Lau, 2013; Cheung et al., 2016). It may also be that the different focuses of Eastern and Western schools lend themselves to different facets of creative thinking. Across several studies comparing German and Chinese children, the former showed stronger divergent thinking skills in the domain of practical knowledge (such as listing diverse uses for everyday objects). In contrast, the latter performed better at using divergent thinking skills for academic skills such as mathematics (Shi et al., 1995; Zha, 1986, 1998). This indicates that creativity may manifest in different ways depending on the curricula and approach to schooling children are exposed to.

Work outside of the East–West dichotomy is also highly informative regarding the role of school- and non-school-related experiences in creative development. Some research shows that in line with much Western-based research, formal schooling and specific educational policies can boost children's creativity and associated skills. As one example, in 2016, Rwanda launched a competence-based curriculum to foster learning beyond literacy and numeracy with a view to providing children with twenty-first-century skills such as problem-solving and creativity. Subsequent research reported that school attendance and academic achievement in Rwandan children were associated with cognitive flexibility—the ability to 'think outside the

box', consider information from different perspectives, and adapt to changing environments (Bayley, 2022). In Brazilian 7–17-year-olds, educational grades were positively associated with figural divergent thinking, psychometrically tested (Wechsler et al., 2010). Brazilian children in private schools also perceived their classroom climate as higher in creativity, and evaluated themselves as more creative than their publicly educated peers (Fleith & Alencar, 2012). Köster et al. (2020) compared psychometric divergent thinking in 8–9-year-olds from urban Germany and rural Cameroon. Although specific educational details were not discussed, the samples were described as having distinct educational systems (though both attended school). It was noted that the Cameroonian schools employ a strict hierarchical relation between students and teachers. They found that German children generated more, and more unique, ideas than the Cameroon sample. Although the contribution of educational differences across cultures to these results is unclear, it may suggest that in line with data from Montessori and Steiner schools, schools with comparatively stricter authoritarian approaches may hinder creativity to some extent.

Other work, however, suggests that children with little formal schooling engagement can be highly creative, and even outperform school-attending peers. Dahlman and colleagues compared divergent thinking performance between homeless children in Bolivia who reported little school attendance to those who lived at home and reported higher school attendance—but otherwise matched for socio-economic status. The homeless children with less schooling scored higher on psychometric divergent thinking fluency and flexibility than the children with more exposure to school (Dahlman et al., 2013). The authors suggested that because the main daily activity of the homeless children involved producing income (i.e. buying and selling goods on the streets), this may have equipped these children with greater divergent thinking and problem-solving skills (for similar results with homeless children in South Africa on intelligence and spatial reasoning measures, see Richter & Walt, 1996). In another study, 4–12-year-old Congolese BaYaka forager and Bondongo fisher–farmer children, where schools are frequently closed and lessons usually delivered for only 1–2 h per day, performed poorly (compared to Western norms) on an experimental innovation task, requiring reshaping a pipe cleaner into a hook to retrieve an out-of-reach reward from within a transparent tube (Lew-Levy et al., 2021). However, before the experiment, the children were given the pipecleaners to interact with and they showed impressive creativity with the pipecleaners outside of the experimental context, making them into toys, jewellery and suspenders (Lew-Levy et al., 2021). This perhaps indicates that in populations with low engagement with formal schooling, experimental settings in which children complete tasks under close supervision by an adult (as is common in formal schooling settings) may not be optimal for creative expression, but in natural settings, such children can be highly creative (Lew-Levy et al., 2021; Rawlings, 2022; Rawlings & Reader, 2024). Such findings are also in line with the 'Hidden Talents' framework, which argues that some cognitive and social abilities, including creativity, can be enhanced through early life adversity. It proposes that failure on school-typical measures (such as arithmetic) does not necessarily reflect deficits in these domains and instead difficulties skills such as using symbolic systems (Frankenhuis et al., 2020). It also argues, in turn, that we should adjust our measures to maximise ecological validity

for children outside of school contexts (Frankenhuis et al., 2020)(Frankenhuis et al., 2018, 2020).

Future research should continue to study educationally, geographically and culturally diverse populations, and, where possible, report the level of schooling samples typically receive. As noted above, much research, particularly in Western populations, indicates a positive relationship between measures of divergent and convergent thinking and academic achievement, and studies with some Asian, Rwandan and Brazilian populations are in line with this. However, in many Indigenous and hunter-gatherer populations, access to formal education is extremely limited or undesirable (Ninkova et al., 2022), yet ethnographic work shows these children often exhibit remarkable problem-solving skills in their everyday lives (Hewlett, 2021; Lew-Levy et al., 2020a, b). Research could examine whether the experiences and skills honed by children who grow up without schooling influence their creativity by combining experimental and ethnographic measures. We must also reflect on our methodology when studying children in diverse cultural contexts and with different life experiences and skills, to ensure ecological validity (Broesch et al., 2022; Burger et al., 2022; Rawlings, 2022). Moreover, as formal schooling continues to reach more populations, studies could examine whether, and how, this access influences children's creativity as it does with other cognitive skills (Bayley, 2022; Rawlings & Legare, 2021; Rawlings et al., 2023).

Finally, given the variation in cultural norms and attitudes across diverse cultures, isolating effects that are due to educational factors and not due to other cultural influences can be difficult. This issue is of course not restricted to creativity, and indeed attempting to isolate effects potentially removes the context in which children grow up—their lived experiences (Burger et al., 2022; Kline et al., 2018; Rogoff et al., 2018). To allow a rich perspective of how cultural and educational variables may interact to shape creative development, we encourage future researchers to provide as much detail as possible on the educational and cultural contexts of their study samples. This will at least allow researchers to appropriately place the findings in their cultural context.

Linking Disparate Fields

Our goal here was to present and summarise literature from diverse fields that directly and indirectly contribute to the debate on whether education helps or hinders creativity. When presenting any work from disparate fields, a challenge is to find a way to link them together conceptually. We attempt to do so here as a point of departure but acknowledge that this is not at all easy and may require further refinement. In doing so, however, we argue that the relationship between creativity and formal education is shaped by a dynamic interplay between a range of factors, including academic achievement, school experiences, teacher perspectives of creative children and their capacity to identify them, cultural and educational experiences and school philosophies. We contend that there are strands of research described in this manuscript that can be theoretically linked together to provide a more holistic perspective of the help or hinder debate.

The research suggesting that children with lower engagement with formal education—who may face diverse problems to solve in their daily lives (Dahlman et al., 2013; Frankenhuis et al., 2020)—can be highly creative, could theoretically be linked with work showing children who attend alternative philosophy schools, which do not have as much academic or curricula rigour and structure as mainstream schooling, and who encourage creative problem solving, tend to outperform peers attending mainstream schools on measures of creativity. That is, taken together these lines of work suggest opportunities or conditions that afford more diverse experiences and problem-solving skills may benefit creativity. Likewise, successful programmes and interventions for promoting creativity in mainstream schools tend to be those that encourage peer collaboration, perspective-taking and problem-solving—all activities that are common in alternative philosophy schools. This can also be linked with hunter-gatherer and cross-cultural research; in the BaYaka children—who as described above have very little formal education but were highly creative outside of experimental settings—ethnographic work shows that around 75% of their subsistence teaching is done by other children, rather than adults (Lew-Levy et al., 2020a, b). Further, Cameroonian children who attend schools with a strict authoritarian structure showed lower divergent thinking than German children exposed to a less hierarchical environment (Köster et al., 2020). Such integration across fields strongly suggests that diverse experiences, peer collaboration and less hierarchical learning environments can be particularly beneficial to creativity.

Relatedly, findings suggesting teachers often perceive creative behaviours in the classroom negatively, and indeed are unable to identify creative children or individual and environmental predictors of it, are based on studies from mainstream schools (Gralewski & Karwowski, 2016; Mullet et al., 2016). It is theoretically likely that teachers from alternative philosophy ones, such as Montessori or Steiner schools, positively view such behaviours. This in turn may better allows identification of it and promotes creative expression in these settings. Teachers at Montessori or Steiner schools are typically required to have additional specialised and accredited training which includes creative pedagogies, which presumably allow them to identify, understand and harness creativity during school. In line with this, research in mainstream schools shows that targeted creativity training for teachers can help them better appreciate and identify creativity in the classroom (Mullet et al., 2016; Patston et al., 2021). Integrating these lines of work enhances the notion that creativity-specific training can help teachers better understand, appreciate and value creativity in the classroom. Given the increased focus on developing creativity in educational contexts, this kind of information could be valuable.

Linking strands can also provide insights into the influence of domains on creative and academic performance. Although recent research suggests that the evidence for developmental slumps in creativity is weak, it does seem to be stronger for specific tests and domains (particularly tests which are administered in a game-like manner Said-Metwaly et al., 2020). This can be theoretically connected with meta-analyses showing that the relationship between creativity and academic achievement is stronger for verbal measures compared to nonverbal ones (Gajda et al., 2017). Schools tend to have a stronger focus on verbal academic skills and most assessments are typically verbal rather than nonverbal. This again suggests that integrating

research from diverse fields can provide new insights into how developmental and educational experiences shape creativity.

These reflections are designed as a point of departure to begin integrating the disparate fields which all provide important insights into how the spectrum of educational experiences can shape children's creativity. We encourage future researchers to continue along this path, and indeed to introduce new lines of work that can contribute to the help or hinder debate.

Summarising Remarks and Directions for Future Research

With the increasing global economic and social value of creativity combined with formal education reaching ever more children, educators, policymakers and researchers have turned to asking the extent to which schools can influence creative development over childhood. There has been much debate over recent decades regarding whether attending school is beneficial or detrimental to children's creative development, with researchers strongly debating for both sides of the argument.

In this article, we have presented data and theory from disparate strands of research directly or indirectly examining the role formal schooling has on children's creativity. In doing so, we have shown that there is a large body of evidence showcasing how school environments can positively impact creative performance. Children's academic achievement and test performance are associated with divergent and convergent thinking, particularly in the verbal domain. There is also evidence that appropriate infrastructure and engaging children in particular activities at school such as collaborative learning, perspective taking or mind mapping, and interacting with external organisations such as local museums, positively impacts creativity.

However, we have also seen that children attending schools with alternative philosophies such as Montessori or Steiner schools seem to outperform those from mainstream schools on creativity measures. This indicates that these schools, which are less structured, more pupil-led and foster peer learning, are particularly beneficial for harnessing creativity. Often teachers are not appropriately trained to understand creativity in the same way researchers do, and consequently fail to identify creative children and see creative responses in the classroom negatively. Importantly, however, targeted training and appropriate resources (including time) can overcome these discrepancies and help teachers successfully curate pedagogical activities to facilitate creativity. We have also seen that in some populations with limited access to schools, children are remarkably creative outside of experimental contexts, meaning we must consider our methodology when drawing comparisons from samples such as these.

Throughout, we have identified several potential avenues for future research. Longitudinal work documenting how creativity develops with educational experience is lacking. As noted, work shows that, in European children, other cognitive processes including executive functions grow more during school semester than outside of it (Finch, 2019). Does this hold for creativity, and is this effect consistent across cultures and/or school types? What is the long-term effect of creativity-based classroom activities? Can we continue to develop classroom activities

that help children think more creatively, and indeed help teachers understand and identify creativity in their students? And can we use qualitative measures to supplement quantitative ones and further our understanding of what experiences children find particularly beneficial for creativity, and why? Can teachers be given the resources and training to encourage creative classroom responses?

The studies documenting that children who attend Montessori or Steiner schools outperform children from mainstream schools on verbal creativity measures pose intriguing questions about underlying mechanisms. Does the same pattern hold for nonverbal creativity? Is creativity facilitated by the lack of formal structure, standardized tests or heightened peer-tutoring experiences? Or the different social experiences between these kinds of schools? Is it the fact that teachers receive creative pedagogy training, allowing them to better understand and harness it? Likewise, research has shown that in many populations who have less exposure to formal schooling than (for example) those in post-industrialised societies, children are highly creative, particularly in natural contexts. Can we build on these findings to explore what experiences help them develop creativity? Do these findings hold for verbal and figural creativity?

The vast majority of the work presented in this article has focussed on divergent thinking. We still have comparatively little understanding of how convergent thinking—identifying the optimal solution from a range of options—interacts with formal schooling. This oversight is surprising given how convergent thinking ostensibly overlaps with many of the skills and experiences children require and acquire in schools. While recent work documented a relationship between convergent thinking and success on different types of mathematical problems, much more work is needed in this area. Researchers could, for example, examine the relationship between convergent thinking and social interaction, or whether classroom experiences impact it in the same way they do divergent thinking. Bilingualism has also been shown to be positively associated with convergent thinking—given that in many populations, children's mother tongue differs from the language they are taught in at school, studies could whether such experiences also enhance convergent thinking.

Finally, we have presented work here from a range of topics. Integrating them conceptually is no easy task, and while we have attempted to here, we encourage future researchers to build on this, including introducing relevant new fields that can help us better understand the complex and dynamic relationship between creativity and education.

Data Availability There is no data associated with this article.

Declarations

Competing Interests The authors declare no competing interests.

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