Chapter 2
A Systematic Literature Review of Children's Creative Inquiry

Mathilda Marie Joubert

2.1 Introduction

There is a rich history of research on children's engagement with creative inquiry. The history of creativity can be traced back over 2000 years throughout antiquity (Glăveanu & Kaufman, 2019; Runco & Albert, 2010), but it is widely accepted that Guilford's seminal 1950 presidential address to the *American Psychological Association* (APA) created a watershed moment, heralding the genesis of modern creativity research (Fasko, 2001; Glăveanu & Kaufman, 2019). Guilford's speech to the APA was televised nationally in America and urged researchers to stop focusing just on the creativity of great thinkers like Einstein, and instead focus on the creativity of 'every man' [sic]. Since then, the field of creativity research has grown exponentially, and creativity has become a desirable educational goal.

Inquiry learning has a similarly rich history, rooted in the seminal work of John Dewey more than a 100 years ago. Dewey advocated for the importance of learning by doing, engagement in discovery and reflection, as opposed to mere memorisation of facts, and the resultant shift in teacher role from deliverer of knowledge to facilitator of learning (Barrow, 2006; Glauert & Manches, 2012; Hatzigianni et al., 2020; Lazonder & Harmsden, 2016). Dewey's work was embraced early within science education, and acceptance by other domains has been growing steadily since the 1960s, particularly enhanced by Bruner's discovery learning movement (Lazonder & Harmsden, 2016).

Definitions of creativity and inquiry abound, but there is general consensus that creativity involves the generation of original ideas that have value or are appropriate to the task at hand, whilst inquiry involves a process of learning through

M. M. Joubert (✉)
Sheridan Institute of Higher Education, Perth, WA, Australia
e-mail: mjoubert@sheridan.edu.au

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self-directed discovery, experimentation, problem-solving and reflection. Creativity and inquiry each have their discrete histories, yet these concepts regularly intersect with each other. There are many synergies between creativity and inquiry learning, including processes of play, exploration, problem-solving, agency, curiosity, reflection and reasoning, as articulated by Cremin et al. (2015). Glauert and Manches (2012) point out that creativity and inquiry are not contradictory, but have different emphases. Arguably the most pronounced difference is the focus on the generation of divergent, alternative or original ideas in creativity, which is of lesser importance in inquiry learning.

Creativity and inquiry often occur together in educational contexts. The purpose of this chapter is to provide an up-to-date, reliable and comprehensive view of how children's creative inquiry is being conceptualised in the scholarly literature through a systematic literature review. For this literature review creative inquiry is defined as the ability to generate new and alternative ways of addressing problems, answering questions or expressing meaning in the pursuit of learning. In this definition, the pursuit of learning is the value or purpose that is inherent to most definitions of creativity. This chapter investigates children's creative inquiry across different domains before focusing on the specific representation within Science, Technology, English and Mathematics (STEM) learning. We hope that this will provide a broad scholarly grounding for this book on children's creative inquiry in STEM.

This chapter first describes the methodology used to conduct this systematic literature review, including the search methodology which led to the identification of 206 peer-review journal articles and the screening procedure that identified the 78 studies included in the final analysis. Next a systematic analysis is presented that reports on the representation of studies based on: location of study, phase of education, domain, methodology, construct focus and point of view. Subsequently, a thematic analysis is presented through the lens of the Murcia et al. (2020) *A to E of Children's Creativity Framework,* which identifies aspects of the creative product, person, place, and process. Finally, the implications of the findings of this systematic literature review for educational research, policy and practice are discussed.

Creativity theories abound in the literature, yet Kaufman and Glăveanu (2019) conclude that "there is no (successful or widely accepted) grand theory of creativity … nor, truly, is there any particular need for one" (p. 38), arguing that the concept of creativity is too multifaceted to be captured in a single theory. Nonetheless, many scholars have attempted to frame different perspectives of creativity with numerous resultant models and frameworks being proposed. Some of the most prominent models include the Wallas (1926) *Stages of Creative Process Model* (preparation, incubation, intimation, illumination, verification), the Rhodes (1961) *Four Ps Model* (person, process, product, press), the Finke et al. (1992) *Geneplore Model* (generate, explore), the Amabile (1996) *Componential Model of Creativity* (domain relevant skills, creativity-relevant processes, intrinsic motivation), Csikszentmihalyi (1999) *Systems Model* (person, field, domain), the Kaufman and Beghetto (2009) *Four Cs Model* (Big-C creator, Pro-C professional, little-c everyday creativity, and mini-c subjective creativity), to the Glaveanu (2013) *Five As Framework* (Actors, Audiences, Actions, Artifacts, Affordances). Smith and Smith

(2010) point out that many of these models of creativity are not well contextualised within educational contexts to address children's creativity. The Murcia et al. (2020) *A to E of Children's Creativity Framework,* has been chosen to frame this literature review, because it particularly addresses the question of what children's creativity looks like within educational learning contexts.

2.2 The A to E of Children's Creativity Framework

Murcia, et al. (2020) proposed the literature-informed, empirically-tested *A to E of Children's Creativity Framework* (see Fig. 2.1) as a way of summarising key perspectives on children's creativity. The framework captures four different dimensions of children's creativity:

- Creative Products: two essential criteria are required for outcomes to be judged as creative: originality and fitness-for purpose, and both need to be present.
- Creative Persons: three perspectives on who does the original thinking are presented: children engaged by the educator's creativity, children engaging in creative doing and children engaging in creative thinking.
- Creative Places: the elements that educators can employ to create environments that enable children's creativity are organised into three categories: resources, communication and the socio-emotional climate.
- Creative Processes: the characteristics that children display when engaging in creative processes are summarised as the *A to E of Children's Creativity*: **A**gency, **B**eing curious, **C**onnecting, **D**aring and **E**xperimenting.

2.3 Methodology

A systematic literature review was conducted, based on the methodology advocated by Siddaway et al. (2019), to provide a reliable, evidence-based view of how children's creative inquiry is represented in the scholarly literature. A diagrammatic representation of the search methodology employed is provided in Fig. 2.2.

A database search was conducted to identify relevant sources for the review on *ProQuest*, which incorporates a range of educational, arts, social sciences and psychological databases, including *Art, Design & Architecture Collection*, *ERIC*, *ProQuest Central*, *PsycINFO*, *Public Health Database*, *SciTech Premium Collection* and *Sociological Abstracts*. The *Boolean* search terms used were "creativ*" AND "inquiry" AND "children" in the abstract or title of the study. Only studies written in English were included, and the search was restricted to peer-reviewed journal articles. The synergies between creativity and inquiry were of particular interest in this review; therefore both of these search terms had to be present for an article to be selected. The focus was also limited to research on young people and therefore

PRODUCT: Criteria for creative outcomes				
ORIGINAL			FIT-FOR-PURPOSE	
PERSON: Perspectives on who does the original thinking				
CHILD ENGAGED BY EDUCATOR'S CREATIVITY		CHILD'S CREATIVE DOING		CHILD'S CREATIVE THINKING
PLACE: Elements of an enabling environment				
RESOURCES		COMMUNICATION		SOCIO-EMOTIONAL CLIMATE
Intentional provocations		Intentional learning conversations		Stress and pressure free environment
Stimulating materials		Hearing and valuing children's ideas		Non-prescriptive
Adequate materials for everyone		Open inquiry questioning		Non-judgemental
Time for creative exploration		Facilitating dialogic conversations		Allowed to make mistakes
PROCESS: Characteristics of children's creative thinking				
AGENCY	**B**EING CURIOUS	**C**ONNECTING	**D**ARING	**E**XPERIMENTING
Displaying self-determination	Questioning	Making connections	Willing to be different	Trying out new ideas
Finding relevance and personal meaning	Wondering	Seeing patterns in ideas	Persisting when things get difficult	Playing with possibilities
Having a purpose	Imagining	Reflecting on what is and what could be	Learning from failure (resilience)	Investigating
Acting with autonomy	Exploring	Sharing with others	Tolerating uncertainty	Tinkering and adapting ideas
Demonstrating personal choice and freedom	Discovering	Combining ideas to form something new	Challenging assumptions	Using materials differently
Choosing to adjust and be agile	Engaging in "what if" thinking	Seeing different points of view	Putting ideas into action	Solving problems

Fig. 2.1 The *A to E of creativity: a framework for children's creativity* (Murcia et al., 2020)

the search term "children" was added. No specific age group limitation was specified to capture all studies relating to children's creative inquiry. No alternative search terms were used for creativity and inquiry since these were the primary constructs under investigation. The literature review does not include related constructs like problem-solving, innovation, active learning or problem-based learning unless coupled with a focus on creativity and/or inquiry.

The initial database search yielded 206 peer-review journal articles containing the three required search terms in the title or abstract. These records were reviewed,

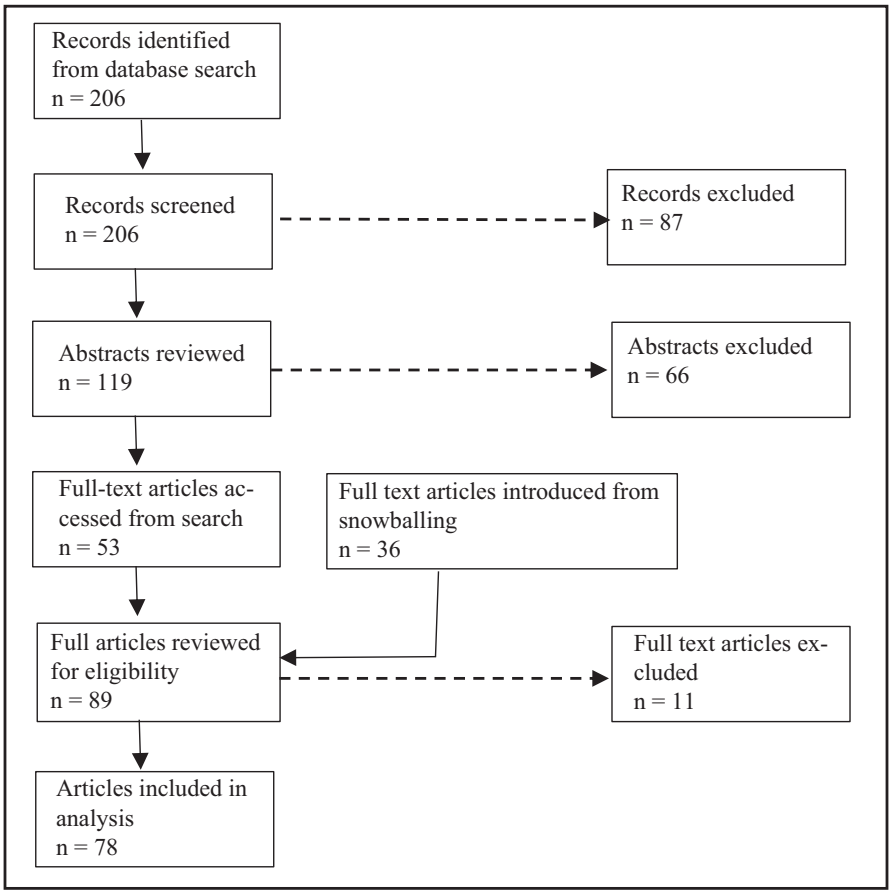

Fig. 2.2 Systematic literature review search process. (Adapted from Kupers et al., 2018)

and 87 were discarded when children's creative inquiry was not the focus of the article, but the three related search terms were just incidentally present in the title or abstract, e.g. an 'inquiry' into 'children's' nutrition using 'creative' approaches to motivate children to eat. Abstracts of the remaining 119 articles were reviewed. A further 66 studies were excluded once full abstracts were reviewed when quality or content criteria were not met.

Using a snowballing approach, 36 further studies were introduced at this point. The initial database search did not pick up these studies because one of the three search terms did not appear in the abstract. However, cross-referencing revealed that they did indeed address the core concepts of children's creative inquiry being reviewed. Nine of the new sources introduced at this point were not journal articles, whilst still meeting quality and content criteria, e.g. peer-reviewed book chapters or commissioned literature reviews for organisations like the *European Commission*.

Cooper (2003) points out that it is commonplace for rigorous systematic literature reviews to include both published and unpublished research.

A total of 89 full-text studies were reviewed. A further 11 studies were excluded after the full-text review for not meeting the quality or content criteria.

The 78 studies included in the analysis were first coded based on demographic markers: location of study, phase of education, domain, methodology, construct focus and point of view. Subsequently, a thematic analysis was conducted to identify key themes in the literature. The Murcia et al. (2020) *A to E of Children's Creativity Framework* was used as the structure for discussing the thematic review, since it provides an up-to-date, research-informed and empirically tested framework of children's creativity.

2.4 Systematic Analysis Results

The geographical location where each study originated is captured in Fig. 2.3. It is clear from the results that creative inquiry is a phenomenon with international currency. Studies from North America and Europe dominate, and 16 of the 26 European studies were from England. The strong representation of studies from English speaking countries is most likely a reflection of the literature search limitation to studies published in English. Ten of the studies were coded as non-specific, because the research was not situated in a particular context, e.g. literature reviews.

A summary of the phases in education explored in each study is provided in Fig. 2.4. Creative inquiry is evidently a phenomenon that spans the age range. The data indicates that research into creative inquiry is strongly represented in early years and primary learning contexts. The inclusion of the word 'children' in the search criteria may have limited the number of studies exploring creative inquiry in older children and adolescents.

The studies included in the analysis were coded based on the subject domain(s) represented. The results are summarised in Fig. 2.5. Thirty of the studies were not linked to a specific subject domain, e.g. many early years studies, and numerous

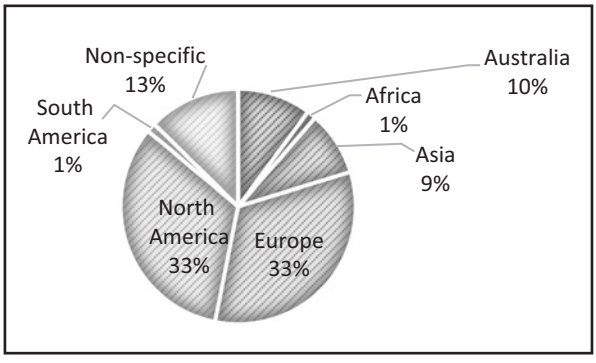

Fig. 2.3 Geographic origin of studies

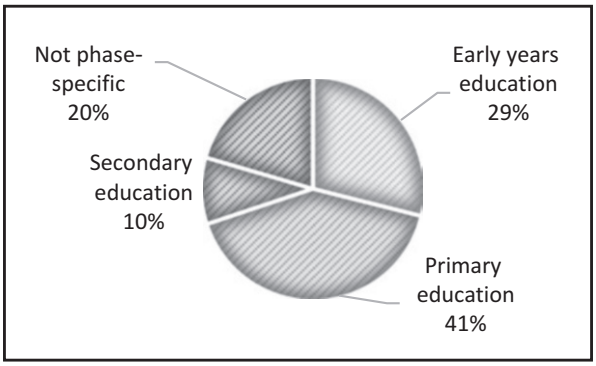

Fig. 2.4 Phase of education of studies

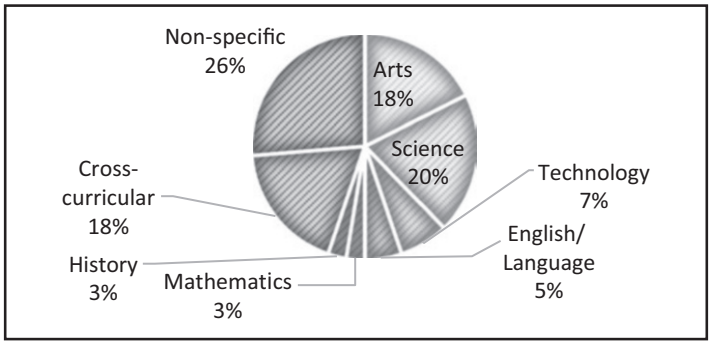

Fig. 2.5 Disciplinary domain of studies

studies were coded in multiple domain categories if creative inquiry in more than one subject domain was the focus of the study. The data indicates that creative inquiry is studied across a wide variety of subject domains. STEM domains and arts domains are strongly represented in the data, suggesting that when creativity and inquiry are studied together, creativity research's traditional arts bias disappears. Intentional use of cross-curricular teaching strategies as a vehicle for creative teaching and learning is also strongly represented in the scholarly literature.

The studies were coded based on the research methodology employed, adapting the categories used by Friedman-Nimz et al. (2005). The results are summarised in Fig. 2.6. There is a strong bias towards qualitative studies in the literature addressing children's creative inquiry. This could be explained by the strong representation of early childhood studies, studies from Western cultures, and studies within mainstream educational contexts rather than psychological laboratories. Friedman-Nimz et al. (2005) noted that creativity and gifted education literature was historically mostly quantitative, but the trend was shifting in the early 2000s, whilst Cremin et al. (2012) noted that early years research in Western cultures was mostly qualitative and mostly quantitative in Eastern cultures. Preiss et al. (2016) noted a bias

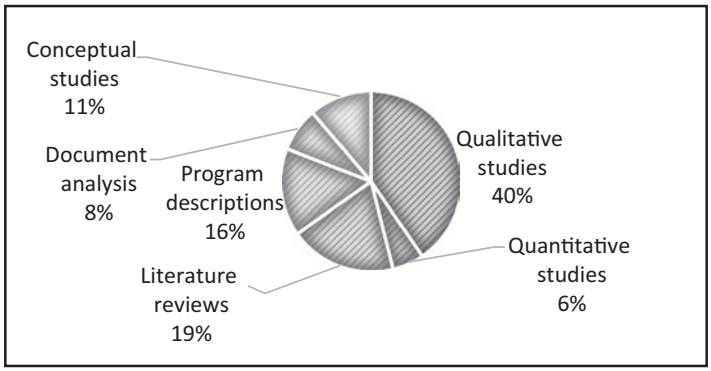

Fig. 2.6 Methodology employed

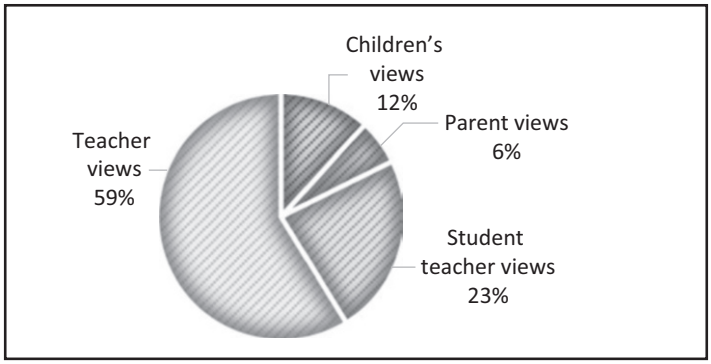

Fig. 2.7 Point of view represented

towards quantitative, psychometric studies in South America and Cremin et al. (2012) identified that a measurement focus was strong in psychological literature, whereas educational studies of creativity were more influenced by qualitative approaches. The high proportion of literature reviews is also interesting.

A small number of studies (17) investigated participant perspectives about creativity and/or inquiry. The results of the points of view represented in perspective studies are presented in Fig. 2.7. It is clear that there is a great sparsity of studies directly exploring children's perspectives on creativity and inquiry.

Whilst creativity and inquiry were set as the search criteria for this systematic literature review, not all studies address both of these constructs with equal weighting. Some studies focus on creativity with only incidental references to inquiry, or vice versa. A wide variety of other related constructs are also investigated alongside a focus on creativity and inquiry in the literature. Figure 2.8 indicates the primary constructs studied in the 78 studies included in the analysis. The results reveal that apart from the major focus on creativity and inquiry, other prominent related constructs in the literature include thinking skills, critical thinking, play-based learning

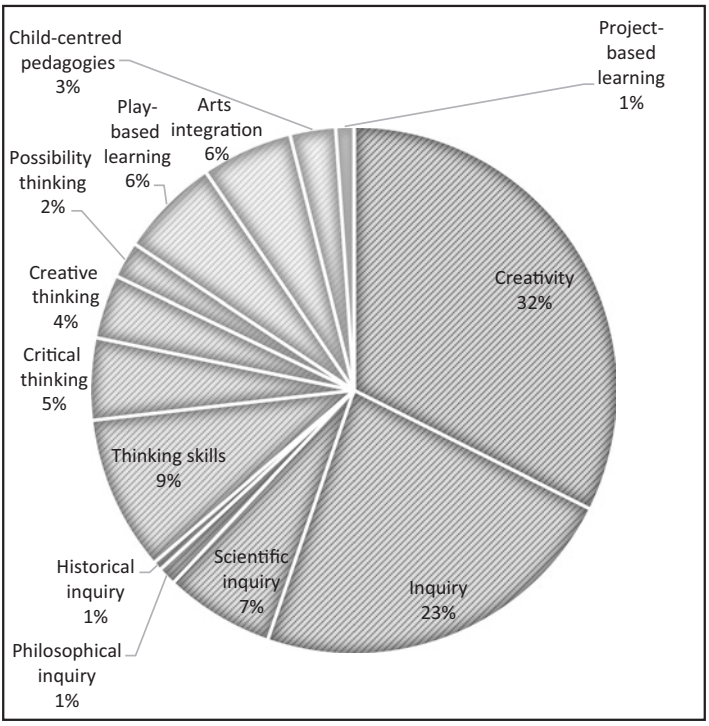

Fig. 2.8 Main constructs studied

and arts integration. The interrelationships between these related constructs are beyond the scope of this study, but worthy of further investigation.

2.5 Thematic Analysis Results

The 78 studies included in the systematic review were analysed thematically, using the Murcia et al. (2020) *A to E Framework of Children's Creativity* as the structure for discussing the results according to the themes of Creative Product, Person, Place and Process.

2.5.1 Product: Criteria for Creative Outcomes

There is remarkable consensus in the literature reviewed on the two key criteria required for outcomes or products to be deemed as creative according to the Murcia et al. (2020) framework: originality (also expressed as novelty or newness), and

fitness-for-purpose (also expressed as appropriateness or value), with these two criteria forming part of most definitions of creativity (Glăveanu & Kaufman, 2019). Whilst there is agreement on what defines a creative outcome, there have been differing views on who can be capable of generating such creative outcomes, with several studies discussing the tensions between democratic versus elitist or genius views of creativity, even questioning whether children are indeed capable of creativity (Cremin, et al., 2012; Kupers et al., 2018; Pavlou, 2013). Glăveanu (2011) eloquently argues for a shift away from a deficit view of children, common in psychological literature, which questions the ability of children to fulfil the twofold definition of creativity, towards a cultural capital view that sees children as "the mere embodiment of creativity" (Vygotsky, cited in Glăveanu, 2011, p. 122). In the educational literature which dominates this literature review, there is an accepted view that children are capable of creativity, albeit at the mini-c level, which represents creative outcomes that are original and valuable at an individual, rather than a historic level (Beghetto, 2019).

Despite general agreement by researchers on the core criteria for creativity, teachers do not always share these views. In a systematic review of studies on teacher conceptions of creativity, Mullet et al. (2016) found that teachers' views of creativity were "limited, vague, or confused" (p. 27) and poorly aligned with researchers' views, an argument reinforced by Davies et al. (2018) that teachers do not fully understand creativity. Within a science learning context, McGregor and Frodsham (2019) identified the tension for teachers between valuing the correct answer and valuing a child's imaginative, but potentially wrong, explanations. Barrow (2006) also recognises that differing interpretations of inquiry have led to teacher confusion. This contradicts findings by Cheung (2012) that teacher beliefs around creativity align well with research. However, another interesting tension in the literature is the disconnect between espoused and enacted views of what constitutes creativity. Cheung (2012) identified that whilst teacher beliefs around creativity align with researcher views, their teaching practices do not support their beliefs.

2.5.2 Person: Perspectives on Who Does the Original Thinking

Murcia et al. (2020) discuss the person aspect of creativity through the lens of the child, distinguishing between three different perspectives: experiences where the child is engaged in learning by the educator's creativity (but not necessarily being creative themselves), opportunities for the child to engage in creative doing (i.e. creating something new by following a set of instructions), and experiences where the child engages in creative thinking themselves. The key distinguishing factor is the question: who does most of the original thinking? In contrast, the literature reviewed for this chapter tends to prioritise viewing creativity in education from the teacher perspective. The most common perspective of creativity in teaching and learning represented in the 78 studies reviewed is when the teacher uses creative teaching strategies to engage students in productive learning. This is particularly

true for studies advancing an arts integration approach to teaching subject matter in other domains, e.g. STEM (D'Olimpio & Teschers, 2017; Hendrix et al., 2012; Inwood & Sharpe, 2018; Nichols & Stephens, 2013).

Several publications explored the distinction, first described by the UK's *National Advisory Committee on Creative and Cultural Education* (NACCCE, 1999) and Joubert (2001), between teaching creatively, where the teacher uses creative teaching methods to make the learning engaging to students, and teaching for creativity, where teachers teach in a way that students learn the subject content and develop their creative skills in parallel (Benson & Lunt, 2011; Davies et al., 2018; Durham, 2019; Harris & De Bruin, 2018; McGregor & Frodsham, 2019). Beghetto (2019) instead uses the terminology of teaching through creativity, teaching about creativity and teaching for creativity. Despite significant advances in describing and providing guidance to teachers on teaching creatively and teaching for creativity, there is consensus across the literature that teachers still lack procedural knowledge and deep understanding to embed teaching for creativity in their teaching practice (Beghetto, 2019; Davies et al., 2018; Harris & Ammermann, 2016; Ucus & Acar, 2019).

Another distinction in Murcia et al. (2020) is the difference between children's creative doing and their creative thinking, reflecting the difference between an expressive view and a cognitive view of creativity (Cremin et al., 2012). This distinction has also been described as the difference between a focus on ideas and inspiration, or a focus on creating through embodied action, thus asking: is creativity about the head (a perspective biased by psychological literature) or the hands (the dominant view in arts and craft disciplines) (Glăveanu & Kaufman (2019)? In the studies reviewed for this chapter, the expressive view is more prevalent in studies representing artistic domains and in early years inquiry learning contexts, and the cognitive view is more prevalent in the science domain studies and strongly aligned to scientific, historical and philosophical inquiry learning contexts. In creative production contexts, creative doing is strongly foregrounded in studies situated within STEM and other technology domains (Benson & Lunt, 2011; Chesky & Wells, 2017; Donohue & Schomburg, 2017; Hatzigianni et al., 2020; Maxwell et al., 2019). However, Smith and Smith (2016) reinforces the importance of balancing inquiry and 'fabrication' to ensure that learners engage in both creative thought and action. In summary, navigating the dynamic interplay between teacher creativity and child creativity, and between creative thought and action remain barriers to embedding creativity in teaching and learning and thus deserves further investigation.

2.5.3 Place: Elements of an Enabling Environment

Murcia et al.'s (2020) creativity framework identifies what teachers can do to create an environment conducive to creativity, classified into three categories: resources, communication and socio-emotional climate. Despite significant research into the

features of an enabling environment and the pedagogies that can support creativity, the studies reviewed for this chapter indicate that teachers still lack clarity on the specific actions they can take to teach for creativity (Glauert & Manches, 2012; Harris & Ammermann, 2016; Preiss et al., 2016; Ucus & Acar, 2019) and their beliefs often fail to translate into their classroom practice (Cheung, 2012; Davies et al., 2018; Durham, 2019; Lucas & Venckutė, 2020). Teaching for creativity is a complex, multifaceted, phenomenon, full of tensions and contradictions, with no simple recipe. True to the nature of creativity, teaching for creativity involves tolerating ambiguity and uncertainty.

The multidimensional part that teachers play in creating an environment conducive to creative inquiry learning expressed through the literature can perhaps best be presented as a series of creative contradictions that need to be balanced carefully and contextually by the teacher. These creative contradictions fall into four areas:

- The role the educator plays: playing a passive role or an active role in "orchestrating" children's creative inquiry (Heindl, 2018); standing back, as a deliberate pedagogical choice or intervening by "meddling in the middle" (Craft et al., 2012; Cremin et al., 2012); being a play partner or allowing students to engage in free play and exploration (Cremin et al., 2012); and role modelling the creative process or playing a supporting act to children's creativity (Davies et al., 2014; Thompson, 2017).
- The tasks the educator sets: balancing play with work (Pui-Wah & Stimpson, 2004); pursuing academic learning goals or developing learner creativity (Beghetto, 2019; Ogu et al., 2018); establishing opportunities to develop creative thought or opportunities for creative action (Smith & Smith, 2016); facilitating creative action and embodied engagement or facilitating reflection on creative action and development of metacognition (Cremin et al., 2015; Glauert & Manches, 2012; Fels, 2008); encouraging logical reasoning and convergent thinking or encouraging fluency in divergent thinking (Glauert & Manches, 2012; Gregory et al., 2013); and fostering independence of thought or encouraging interdependence, dialogue and collaboration (Cooper, 2018; Cutcher & Boyd, 2016; Davies et al., 2013; Heindl, 2018; Thompson, 2017).
- The pedagogy the educator employs: providing freedom and flexibility or structure and order (Biermeier, 2015; Davies et al., 2013; Dobson & Stephenson, 2017; Ucus & Acar, 2019); providing student choice, direction and autonomy or planning and steering the learning process according to a deliberate plan (Cheung, 2012; Pavlou, 2013; Smith & Smith, 2016); providing scaffolding, heuristics or process constraints or providing space for student-led inquiry (Glauert & Manches, 2012; Lazonder & Harmsden, 2016); creating unpredictability and introducing uncertainty or driving towards closure and solutions (Beghetto, 2019; Cremin et al., 2012; Green & Somerville, 2015); and engaging in open-ended questioning or closed-ended questioning (Cheung, 2012; Thompson, 2017).
- The space the educator creates: creating a safe, supportive climate or deliberate cognitive challenge (Chen, 2001; Cremin et al., 2012); creating an environment, space and time for creativity to flourish organically or deliberately teaching cre-

ative thinking strategies (Benson & Lunt, 2011; Cremin et al., 2015; Harris & De Bruin, 2018); intentional provision of provocations or allowing time to experiment, play and explore (Biermeier, 2015; Craft et al. 2012; Ogu et al., 2018); dominance of teacher talk and guidance or student talk (Cremin et al., 2015; Hendrix et al., 2012; Maxwell et al., 2019; Schoevers et al., 2019); and prioritisation of teacher questioning or encouraging student questioning (Alfonso 2017, Cooper 2018; Ogu et al., 2018).

2.5.4 Process: Characteristics of Children's Creativity

At the heart of the Murcia et al.'s (2020) *A to E Creativity Framework* is a set of behaviours that children display when acting and thinking creatively, called the A to E of creativity: **A**gency, **B**eing curious, **C**onnecting, **D**aring and **E**xperimenting. Each of these categories is represented by the literature reviewed for this chapter. Some key observations are discussed below.

'Agency' is discussed as a major theme in 17 of the studies reviewed. 11 of these studies report on early years contexts, five on primary school contexts and two do not specify an age range. No studies situated in secondary education explore agency as a central theme. Whilst agency gains more attention in the education of younger learners, Davies et al. (2013) emphasise that there are creative benefits for students of all ages from enhanced agency: "there is strong evidence from across the curriculum and age-range that where children and young people are given some control over their learning and supported to take risks with the right balance between structure and freedom, their creativity is enhanced" (p. 85). Cremin et al. (2012) recognise that when learners engage in creative activity, they can experience flow (Csikszentmihalyi, 1996), but when learners have agency in creative activity, flow can be sustained. Despite acknowledgement in the literature that agency is an important enabler of children's creativity, Glauert and Manches (2012) conclude that most classroom inquiry processes are teacher-led, not student-led, contradicting the original intention of inquiry learning.

The characteristics involved in children 'Being curious' according to the *A to E Creativity Framework* are strongly represented in the literature reviewed, particularly in early years learning and science domain studies. The subcomponents of questioning and engaging in 'what if' thinking align well with the concept of possibility thinking (Craft et al., 2012; Burnard et al., 2006), which is driven by children's questioning, in particular children engaging in posing 'as if' and 'what if' questions. Lucas and Venckutė (2020) also note that key characteristics of creativity are "curiosity and intellectual restlessness" (p. 2). Whilst Murcia et al. (2020) found evidence of teacher questioning, but not student questioning in their digital technology case study, Ogu et al. (2018) describe how children's questioning was driving the scientific inquiry, and Alfonso (2017) explains how children's questions were used to "ignite the study" of a topic (p. 64). Cremin et al. (2015) note that teacher and child questioning are central to both inquiry learning and creative learning, but

that the focus in the former is more on questioning and ideas, and in the latter more attention is paid to curiosity and play.

'Connection making' is recognised as a key subcomponent of creative inquiry (Cremin et al., 2012; Mullet et al., 2016; Thompson 2017). This includes making remote connections through play (Russ & Doernberg, 2019), making personal connections to the topics of study through creative learning (Harris & De Bruin, 2018) and children making connections to their own lives through inquiry learning, leading to their "connected, meaningful, and worthwhile participation in the world" (Serebrin & Wigglesworth, 2014, p. 21). The increasing shift in recent decades towards research recognising creativity as a social phenomenon (Cremin et al., 2012; Lucas & Venckutė, 2020), has made collaboration, or the ability to connect to others, another key focus in creativity literature, including the studies reviewed for this chapter. The systematic review by Davies et al. (2013) concludes that "there is strong evidence that pupil creativity is closely related to opportunities for working collaboratively with their peers" (p. 86). Beghetto (2019) postulates that the sociocultural view of learning may indeed suggest that all learning is, by definition, a creative act (at mini-c level), since learning is socially constructed.

In this review, collaboration is represented as a key component of creative inquiry learning across all education phases and various subject domains, including science, technology and mathematics. Benson and Lunt (2011) advocates the value of children collaborating, which is often counter-cultural in design and technology contexts that may prioritise individual work, whilst Ogu et al. (2018) explain that through interaction with their peers, children can learn more than they could have alone in a science inquiry context, activating their zone of proximal development (Vygotsky, 1962). The concept of children forming a 'community of inquiry' is also crucial in the philosophical inquiry tradition explored by D'Olimpio and Teschers (2017) and Green and Condy (2016). Finally, making connections through reflection and metacognition is another theme strongly represented (Chen, 2001; Cremin et al., 2012; Glauert & Manches, 2012; Hendrix & Eick, 2014; Pavlou, 2013; Pui-Wah & Stimpson, 2004; Spector & Ma, 2019). Cremin et al. (2015) note that the concept of reflection is better developed in inquiry literature than creativity literature.

'Daring' to be different as children take risks, explore alternative or divergent lines of thinking and practice tolerating uncertainty are critical characteristics of children's creativity, and also one of the crucial distinguishing lines between inquiry and creativity (Cremin et al., 2015; Glauert & Manches, 2012; Lucas & Venckutė, 2020; Murcia et al., 2020). In this systematic literature review, the characteristics of daring to be different were observed in various domains (arts, science, mathematics, history, technology) and across all phases of education. Encouragement to take risks can increase ideational fluency in computer games development tasks in secondary school (Eow et al., 2010) and learners can develop comfort with ambiguity through exposure to unpredictability and uncertainty that underpin creative pedagogies in primary science learning (Green & Somerville, 2015). Russ and Doernberg (2019) identified how divergent thinking and flexibility of thought were features of both creativity and play in early learning contexts. There are significant benefits for learners from engaging in divergent thinking in science learning contexts (Glauert

& Manches, 2012), and Lucas and Venckutė (2020) points out that these benefits can extend beyond the immediate learning context since creativity develops dispositions of "tolerance for uncertainty, risk, and ambiguity, and the capacity to be adaptable and flexible", which "facilitate higher learning, long-term employability, and upward social mobility" (p. 2).

Despite these advantages, the contribution of divergent thinking in science and mathematics learning contexts is often undervalued because of the valuing of 'correct' answers above the generation of original or alternative ideas (Glauert & Manches, 2012; McGregor & Frodsham, 2019). Standardised assessments can also be detrimental to the development of divergent thinking by valuing "convergence of thinking" based on one right answer (Harris & De Bruin, 2018, p. 227). In addition, teacher views on creativity can passively discourage divergent thinking. Mullet et al. (2016) demonstrates that, whilst researchers associate creativity with behaviours including openness, risk-taking, questioning of authority, and nonconformity, teachers associate creative behaviours in students with socially conformist behaviours, e.g. high intellectual ability, maturity and artistic ability.

'Experimenting' and its subcomponents identified in Murcia et al. (2020) e.g. playing with possibilities, tinkering and solving problems, are strongly represented in the literature reviewed. Experimenting through experiential learning has its roots in child-centred learning philosophies of Bruner, Dewey, Fröbel, Malaguzzi, Montessori, Piaget, Rousseau, Steiner, and Vygotsky represented in the early years learning studies. However, experimenting is just as important for the development of creativity in older students, as Cooper (2018) reminds us: "we learn to be creative by experimenting …" (p. 645).

Biases towards different subcomponents of experimenting are discernible in the literature. The concept of play is strongly represented in early years studies (Craft et al., 2012; Cremin et al., 2015; Dere, 2019; Desouza, 2017; Marsh et al., 2018; Russ & Doernberg, 2019) with Craft et al. (2012) even describing play as a logical necessity for possibility thinking in the early years. There is strong research evidence for a significant correlation between play and divergent thinking (Russ & Doernberg, 2019) and Hui et al. (2019) concludes that "an abundance of research findings supports the positive effects of play on imagination, problem-solving, and the thinking skills associated with creativity" (p. 71). Play is more closely associated with the concept of creativity than with inquiry (Cremin et al., 2015). It is also more closely associated with arts and technology domains than scientific domains, except where an arts integration approach is used as a vehicle for learning in science inquiry contexts (D'Olimpio & Teschers, 2017; Marsh et al. 2018; Ogu et al., 2018). Despite this early learning bias towards play, Davies et al. (2013) advocate for the benefits of play at all ages to facilitate creative skills development.

Tinkering is most strongly represented in digital technology and design technology contexts in the data. Smith and Smith (2016) describe how tinkering allows ideas to collide, with creativity occurring at these "collision points" (p. 31). Problem-solving is closely associated in the literature with scientific inquiry, critical thinking and science and STEM learning contexts (Chesky & Wells, 2017; Cremin et al.,

2015; Donohue & Schomburg, 2017; Heindl, 2018; Marsh et al., 2018; Smith & Smith, 2016; Thompson, 2017). The benefit to children of engaging in problem-finding and problem-solving is articulated by Thompson (2017): "When the students are asked to both define and solve a problem, the thinking is more independent…" (p. 39). This links back to the first characteristic of children's creativity, agency, reinforcing the *A to E of Children's Creativity Framework's* interconnectedness.

2.6 Representation of STEM Studies

This analytic literature review explored the research literature on children's creative inquiry across different subject domains. When the information is filtered to only the 34 studies focusing particularly on creative inquiry in STEM contexts, 12 studies are situated in pure science contexts, ten in science & art integration, nine studies in technology and three in mathematics contexts. With regards to phase representation, eight of the STEM studies were situated in early years learning, 18 in primary and one in secondary learning contexts. Inquiry is a key focus in 23 of these studies and creativity a major focus in 20. There was overlap in each of these categories with some studies representing more than one of these foci. The thematic analysis filtered for STEM studies indicate that the following creative inquiry themes were represented in STEM studies: agency, questioning, play, collaboration and dialogue. Each of these themes was presented in studies spanning different STEM sub-disciplines, e.g. science and technology, and at different age ranges, including early years learning and primary settings. A theme focusing on children's engagement in creative production, as opposed to creative thinking, was strongly represented in technology contexts, but not in other STEM disciplines. Digital technology's role in enabling creativity, is another theme strongly represented in the technology literature (Hatzigianni et al., 2020; Marsh et al., 2018).

Whilst many studies describe children's creative behaviours in STEM learning contexts, the contribution of some creative behaviours, e.g. divergent thinking, are still too often undervalued, particularly in science and mathematics learning contexts (Glauert & Manches, 2012), and teachers often struggle to recognise or integrate creativity in science lessons (Davies et al., 2018). This reinforces the document analysis conducted by Heillmann and Korte (2010) who counted the number of references to creativity within European curricula and policy documents to create a subject ranking based on the relative representation of creativity in each subject domain. Mathematics scored the lowest and science, the third-lowest of all subjects.

2.7 Conclusion

This systematic analysis demonstrates that children's creative inquiry is a phenomenon studied worldwide, in all phases of education, across different subject domains and using a variety of methodologies, with a preference for qualitative studies. There is a great sparsity of studies directly reflecting children's point of view on creative inquiry, which should be a priority for future research. The interrelationships between creativity, inquiry and other related constructs, e.g. problem-solving, active learning, and play-based learning are worthy of further exploration.

The search terms used for this study could present a possible limitation. Because all three search terms (children, creativity and inquiry) had to be present in the abstracts, studies focusing exclusively on either children's creativity or children's inquiry may have been excluded. Only studies published in English were included, potentially biasing the data towards a Western perspective. Studies investigating related constructs, e.g. problem-solving, innovation, active learning or problem-based learning, would also have been excluded unless coupled with a focus on creative inquiry. Finally, the search was limited to children's creative inquiry, thereby possibly missing studies dealing with creative inquiry in older students where the word "children" may not have been used.

The thematic analysis of the 78 studies included in this review identified several important implications for future educational research, policy and classroom practice. Navigating the dynamic interplay between teacher creativity and child creativity, and between creative thought and action remains barriers to embedding creativity in teaching and learning and thus deserves further investigation.

There is a significant body of research into the features of an enabling environment and the pedagogies that can support creativity, yet research demonstrates that teachers still lack clarity on the specific actions they can take to embed creative inquiry and to teach for creativity. Teaching for creativity is a complex, multifaceted phenomenon, full of tensions and contradictions, with no simple recipe. True to the nature of creativity, teaching for creativity involves tolerating ambiguity and uncertainty. This chapter identified creative contradictions from the literature that need to be carefully and contextually balanced by educators to enable learner creativity. Teachers need to develop comfort with this ambiguity, reconciling the implied contradictions and extending their behavioural repertoire to confidently teach for creativity.

The five sets of behaviours characterising children's creativity presented in Murcia et al.'s (2020) *A to E Framework of Children's Creativity*: **A**gency, **B**eing curious, **C**onnecting, **D**aring and **E**xperimenting, are strongly represented in the literature. However, the contribution of some of these behaviours is still too often undervalued in STEM learning contexts. It is recommended that the underrepresentation of creativity in curriculum documents should be redressed, and that initial teacher training should focus on the contribution of creative inquiry in all STEM learning contexts. We hope that this book will make a valuable contribution to

representing and enabling the inherent creative possibilities in a wide variety of STEM learning contexts.

Joubert (2001) identified five alliterating barriers impeding the embedding of creativity in education: language lessons (inconsistent language resulting in a lack of clarity and understanding on what creativity is), political problems (creativity regarded as conflicting with an academic standards agenda), ideological impediments (dualistic thinking between progressive and traditionalist pedagogies), bureaucratic burdens (slow public policymaking constraining pedagogical innovation) and creative constraints (a vacuum of visionary, creative leadership willing to take risks). This review identified another barrier: a rhetoric-reality rift.

Despite decades of focus on developing student creative inquiry capabilities in policy and research, there is still a disconnect between rhetoric and reality in classrooms. Teachers value creativity, but they find it hard to recognise creativity in the classroom; despite enthusiasm for inquiry learning, very little inquiry learning is observed in classrooms; teacher views still largely diverge from researcher views on creativity, with teachers prioritising conformist behaviours above original thinking behaviours; teacher classroom practices often contradict their beliefs when it comes to teaching for creativity; there is still limited understanding and a lack of confidence amongst teachers to teach for creativity; and creativity is generally not embedded in classroom teaching practice (Barrow, 2006; Cheung, 2012; Davies et al., 2018; Durham, 2019; Lucas & Venckutė, 2020; McGregor & Frodsham, 2019; Mullet et al., 2016; Ucus & Acar, 2019). There are, however, some glimmers of hope: teacher views can be shifted to align more clearly with researcher views through specific creativity teacher training, and teacher classroom practice can adapt to implement the pedagogies of creativity and inquiry through immersive professional learning experiences (Dole et al., 2016; Mullet et al., 2016; Myers, 2012). This remains an underrepresented perspective in the research literature, and we recommend further research focusing on how to facilitate teacher shifts in pedagogical practice to effectively embed teaching for creative inquiry in classroom contexts. Research into repairing this rhetoric-reality rift also needs to be implemented in preservice and in-service teacher training.

Finally, this review has demonstrated that creativity and inquiry are occasionally overlapping yet mutually enriching pedagogical practices. The most exciting research and practice often happen at the intersections: between creativity and inquiry, between the cognitive and expressive focus of creativity, crossing the divide between active, play-based learning and rigorous academic learning, and where different subject areas collide. There are rich research traditions in early learning, arts education and philosophical inquiry fields that can enrich our understanding of creative inquiry in STEM domains. Let's celebrate creativity at these crossroads.

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Mathilda Marie Joubert is Director of Excellence and Innovation at Sheridan Institute of Higher Education in Perth, Western Australia, where she lectures in both the Education and Business Faculties. She is a true cross-disciplinarian with degrees in education, music, languages, cognitive neuropsychology and business, and her PhD study is investigating the assessment of children's creative thinking skills. Outside academia her background includes primary and secondary teaching and system leadership roles in education, and working internationally as innovation consultant in industry, with companies including Coca-Cola, Diageo, Philips and Unilever. Mathilda was a Research Fellow to the UK's National Advisory Committee on Creative and Cultural Education where she worked alongside Sir Ken Robinson to advise the government on the promotion of creativity in education and co-authoring the Committee's seminal report *All Our Futures: Creativity, Culture and Education* (NACCCE, 1999). She has been a long-term advisor to the Australian, Lithuanian and British governments on creativity in education, including serving as the expert advisor for Critical and Creative Thinking Skills to the Australian Curriculum, Assessment and Reporting Authority (ACARA).