

Assessment of Creativity in K-12 Education: A Scoping Review

Benjamin Bolden* , Christopher DeLuca, Tiina Kukkonen,
Suparna Roy and Judy Wearing

Queen's University, Kingston, Canada

Over the past two decades, creativity has emerged as one of the core 21st century learning objectives within K-12 education systems around the world. While some literature has demonised assessment as something that inhibits creativity, a growing body of research supports feedback-driven teaching—also known as formative assessment or *assessment for learning*—as an effective pedagogical approach across contexts and content areas. Given this empirical foundation, we propose that assessment for learning holds powerful potential for helping students to learn about being creative. To examine intersections of creativity and assessment in K-12 educational contexts, we carried out the scoping review study reported here, with the aim of advancing understanding of how assessment can support and promote creativity in classroom contexts. Fifty-one research articles were selected for review, based on inclusion criteria which required that articles (a) reported the collection and analysis of quantitative or qualitative data, (b) addressed K-12 classroom or extra-curricular contexts, (c) addressed the formative or summative assessment of creativity for pedagogical intent, (d) were peer-reviewed, and (e) were published in English. Analysis of the research revealed two dominant and consistent themes. Firstly, multiple studies indicated the importance of defined criteria for effective and useful creativity assessment within K-12 classroom contexts. Secondly, a number of studies identified the particular value of self-assessment and/or reflection in supporting creativity. We discuss implications of these findings in relation to educational policies and practices that seek to promote creativity, and areas for future research.

Over the past two decades, creativity has emerged as one of the core 21st century learning objectives within K-12 education systems around the world (Craft, 2010; Shaheen, 2010; Fullan & Langworthy, 2014). Creativity has been recognised for its potential to enhance personal wellbeing (Seligman & Csikzentmihalyi, 2000; Hennessey & Amabile, 2010), promote economic success (IBM, 2010), and help students to negotiate rapid and ongoing social change (Craft, 2011). Through both policy mandates and curriculum documents, teachers across educational systems are now expected to explicitly integrate creativity into their teaching across subject areas (e.g., Canada: Ontario Ministry of Education, 2016; BC Ministry of Education, 2016; U.K.: Department for Education, 2014). Alongside this increased emphasis on creativity, there has been a continued expansion of assessment and accountability frameworks in public education, urging teachers to not only promote creativity but also to assess it. Accordingly, the assessment of creativity has emerged as a pressing concern for educators worldwide (Lucas et al., 2013).

*Corresponding author: Queen's University, 511 Union Street, Kingston, ON K7M 5R7, Canada. Email: ben.bolden@queensu.ca

Despite policies and curricula that seek to promote and assess creativity, much of the extant research suggests that teachers and schools are more likely to stifle creativity than nurture it (Cachia et al., 2010; Csikszentmihalyi & Wolfe, 2014; Sternberg, 2015). In addition, assessment has been identified as one of the primary culprits inhibiting creativity in schools (Lucas et al., 2013). Research has demonstrated that when learning experiences involve competition and comparisons to others (i.e., normative assessments), emphasis on extrinsic features of the task, and the pressure of evaluation (i.e., summative assessments), they can cause anxiety and undermine students' motivation and capacity for creativity (Collins & Amabile, 1999; Runco, 2003; Hennessey, 2010). Not surprisingly, teachers often resist assessing creativity because they fear assessment will discourage a student's self-expression, or simply because they believe creativity is too subjective to assess (Lucas et al., 2013).

While some literature has demonised assessment as something that inhibits creativity, our goal in this article is to explore the ways in which assessment can support it. Our interest stems from the fact that teachers are now required to simultaneously nurture student creativity as a core learning goal as well as finding meaningful ways to assess this learning. We therefore take an expanded view of classroom assessment which includes both its summative (i.e., grade-based) and formative (i.e., pedagogical) functions. In Black and Wiliam's (1998) initial literature synthesis on formative assessment—also known as *assessment for learning* (AFL)—the authors found that AFL demonstrated potential achievement gains with mean effect sizes of 0.4–0.7 standard deviations. Since then, there has been a growing body of literature to support AFL as an effective pedagogical approach (e.g., Marshall & Drummond, 2006; Hume & Coll, 2009; MacPhail & Halbert, 2010; Earl, 2013; Allal, 2019; Andrade & Brookhart, 2019; Chen & Bonner, 2019). In particular, integrating AFL has been linked to (a) improved student achievement (Gardner, 2006; Taras, 2007), (b) enhanced metacognitive abilities (Earl, 2013; Andrade & Brookhart, 2019), (c) increased motivation and positive self-perception (Harlen, 2006), and (d) enhanced teacher instruction (Harrison, 2005; Lee & Wiliam, 2005). Importantly, Hattie's (2009) meta-analysis of pedagogical strategies found that AFL is among the most significant approaches for improving student learning in a variety of disciplines. As empirical research strongly supports the notion that formative assessment can enhance learning across contexts and content areas, we propose that assessment for learning holds powerful potential for helping students learn how to be creative.

Black and Wiliam (2006) have identified five key AFL strategies:

1. Clarifying and understanding learning intentions and criteria for success;
2. Engineering effective classroom discussions, questions, and tasks that elicit evidence of learning;
3. Providing feedback that moves learners forward;
4. Activating students as instructional resources for each other;
5. Activating students as owners of their own learning.

To flesh out how these strategies may be put into practice within the context of nurturing student creativity, we draw from recent studies that provide examples of their application in classroom contexts. Specifically, the clarification and understanding of learning intentions and success criteria (Strategy 1) can be addressed by providing

feedback to students in reference to descriptive rubrics, supported by examples of high and low quality work (Lindström, 2006). Engineering effective classroom discussions (Strategy 2) can be supported through open dialogue and by cultivating an atmosphere of mutual respect amongst teachers and students (Davies et al., 2012). Providing feedback that moves learners forward (Strategy 3) can involve explicitly encouraging imaginative thinking (Schacter et al., 2006), reference to creative habits of mind (Lucas, 2016), and commenting on students' creative products in a manner that finds a balance between not being too harsh (dampening students' creative motivation) and not being harsh enough (not helping students align their work with contextual expectations) (Kaufman & Beghetto, 2013). Activating students as instructional resources for each other (Strategy 4) can improve students' creative performances when peer discussion focuses on evaluating and improving ideas (Wang & Murota, 2016). Finally, activating students as owners of their own learning (Strategy 5) can be realised through enabling opportunities for student self-assessment (Deakin-Crick et al., 2005); minimising pressure and encouraging a structured yet flexible, self-directed learning experience (Davies et al., 2012); and by helping students to develop creative metacognition as a means for monitoring and developing their personal creative competence (Kaufman & Beghetto, 2013).

Our specific purpose in this article was to examine intersections of creativity and assessment in K-12 educational contexts in order to advance understanding of how assessment can support and promote creativity in classroom learning. The following questions guided our scoping review of the literature:

1. What is the extent, range, and nature of research activity addressing the use of assessment to support and evaluate creativity in K-12 classrooms?
2. What is known from the existing research literature about the use of assessment in K-12 classrooms to support and evaluate creativity?

Conceptual Framework

At the heart of this scoping review are the concepts of creativity and assessment. We used the following conceptual understandings of creativity and assessment to orient our interpretation and examination of the literature.

Creativity

As a broad operational definition of creativity in K-12 education, we looked to Simonton's (2012) succinct expression *Creativity = Originality x Appropriateness*, acknowledging the crucial element of context that mediates both what is considered original and what is considered appropriate (Plucker et al., 2004). According to Cropley's (2006) social approach to creativity, new and surprising behaviours arise when individuals deviate from the norm. However, for those behaviours to be useful, social acceptance of such deviation is also necessary. Creativity is thus characterised by two essential components: the production of something original (or new, or novel) within a particular context and the evaluation of its appropriateness (or value) within that context (Cropley, 2006). The development of novel ideas and behaviours is achieved through

divergent thinking, that is, the ability to produce flexible and original ideas by exploring many possible solutions. *Convergent* thinking, by contrast, is geared to finding solutions that fit within existing constraints (Gajda *et al.*, 2017). Thus, convergent thinking can be used to evaluate the appropriateness of novel behaviours, ideas and products.

When the context is a classroom, it is helpful to draw on Craft's (1996) recognition of 'little c creativity', which is the ordinary variety of creativity that all people, including young students, can demonstrate, existing on one end of a continuum, with 'big C creativity' reserved for exceptional creators such as Stravinsky, Einstein and Georgia O'Keefe, on the other.

Research supports the notion that it is possible for creativity to be learned (Csikszentmihalyi, 1996; Dweck, 2006; Lucas & Claxton, 2010). It follows that it is also possible to assess the development of creativity in ways useful to both learners and teachers (Lucas, 2016). However, despite recognition that 'an important aspect of supporting children to develop their creativity is teacher engagement with, and sound application of, assessment' (Blamires & Peterson, 2014, p. 155), the use of assessment strategies to support student creativity remains underdeveloped (Collard & Looney, 2014; Lucas, 2016).

Assessment

Western classroom assessment practices maintain two dominant and widely accepted purposes: summative and formative. Summative assessments inform decisions about the results of an educational process and are used to summarise student understanding with respect to learning expectations (Brookhart, 2004). Summative assessments typically occur after the learning period and relate to subject area learning (i.e., not learning skills, behaviours, or dispositions) and often take the form of a numerical or letter grade. This form of assessment is intended to provide evaluative statements on what a student has learned and is able to do by the end of a learning cycle, as well as in relation to established curriculum standards. Historically, evidence for grades has been based primarily on test results or larger-scale projects (e.g., essays or reports); however, there is an increasing push towards diversifying summative assessment practices to enable students to demonstrate their learning in a variety of ways. Large-scale standardised assessments administered at school district, state/provincial, or national levels also provide evaluative judgements on student learning in relation to expected levels of performance for specific grade levels.

In contrast, formative assessment, or its more contemporary designation, *assessment for learning*, is the process of actively and continuously engaging students in assessment activities (including self-, peer, and teacher-based feedback) throughout learning periods, with the goal of improving achievement and developing students' self-regulation and metacognitive functions (Assessment Reform Group, 2002; Willis, 2010). According to Black and Wiliam (2009), these practices establish 'where learners are in their learning, where they are going, and what needs to be done to get them there' (p. 7). Formative assessment is supported by socio-developmental and socio-constructivist learning theories that recognise the importance of classroom context, social interactions, and developmental learning continuums (Brookhart, 2004, 2011; Black & Wiliam, 2006). From a socio-developmental position, formative assessment

employs students' metacognitive abilities (in particular self- and co-regulation) to actuate their learning by engaging them in self- and peer assessment processes, as supported by the use of explicit assessment criteria and learning goals (Earl, 2013; Andrade & Brookhart, 2019). Formative assessment also builds on the notion that student learning is fundamentally a socio-constructivist process in which students learn with and from their peers through collaborative assessment tasks and processes. Formative assessment can operate in conjunction with standards-based and accountability frameworks by providing continuous evidence on a student's progress toward educational standards, forming the basis for targeted teaching and learning (Lee & Wiliam, 2005; Stiggins, 2005).

Measurement and assessment of creativity

In their guide for assessing creativity in students, Treffinger et al. (2002) distinguish between measurement and assessment. The authors' conceptualisation of *measurement* refers to the use of instruments or testing procedures to obtain quantitative data related to student achievement—a conceptualisation that parallels summative assessment, as described above. Treffinger et al. explain that measurement has long been used to examine individual creativity (e.g., Torrance Tests of Creative Thinking). In contrast, they conceptualise *assessment* as making use of several other data sources to understand students' strengths and need for improvement—a conceptualisation that parallels formative assessment, or assessment for learning, as described above. Treffinger et al. identify the following sources for gathering information about creative abilities: behaviour or performance data (e.g., creative products, performances, or accomplishments), self-reported data (e.g., personal checklists, attitude inventories), rating scales (e.g., ratings from teachers and parents who are in a position to describe a student's creative characteristics), and tests (e.g., a set of standardised tasks or questions).

Reliability and validity considerations are important in both measurement and assessment conceptions of creativity and pose differing challenges depending on the context. Reliability is improved by using more standardised measurement conditions and is statistically strengthened by using large volumes of aggregated data on student responses to creativity scales and inventories. However, measurement scales are often limited in their diverse representations of creativity, narrowing the creativity construct, and limiting the validity of score interpretations in relation to more complete descriptions of creativity. At the classroom level, where teachers are able to use multiple assessments to gauge student creativity, validity can be improved by teachers and students clearly defining and ensuring mutual understanding of the construct. Yet, at this level, reliability is difficult to achieve in traditionally defined ways and depends instead on consistency of teacher scoring and student performance across assessments.

Method

We employed a scoping review method to 'examine the extent, range, and nature of research activity' (Arksey & O'Malley, 2005, p. 21), addressing the assessment of creativity in K-12 educational contexts. We followed the five-stage iterative framework

proposed by Arksey and O'Malley (2005): (1) Identify the research question(s), (2) Identify relevant studies, (3) Select studies, (4) Chart the data, and (5) Collate, summarise, and report the results.

Scoping review research question

The primary research question was chosen to set parameters for study selection while allowing for broad coverage of the phenomenon of interest (Arksey & O'Malley, 2005): *What is the extent, range, and nature of research activity addressing the use of assessment to support and evaluate creativity in K-12 classrooms?* This question focused the review on the assessment of creativity within our target context (i.e., K-12 classrooms), while allowing for inclusion of a breadth of learning situations (e.g., different subject areas, different teaching/learning structures, different locations) and conceptions of both creativity and assessment. We also developed a second research question to focus on the findings of the relevant research: *What does existing research literature tell us about the way in which assessment in K-12 classrooms supports and evaluates creativity?*

Identification of relevant studies

Keyword searches were conducted in the Education Source and ERIC electronic databases within EBSCO Host, as well as the PsycInfo database, in October 2017, without limiting the start date. The search terms were: 'assess*, AND creativity, AND education', with the exclusory subject terms 'NOT tertiary, NOT university, NOT college, NOT higher education.' Additional parameters included peer reviewed journal articles only, in English. Arksey and O'Malley (2005) identify that the purpose of a scoping review is not to assess quality. We made the decision to include only peer-reviewed articles as a limited strategy for quality control. The search generated 1,382 references in EBSCO Host and 1,007 references in PsycInfo (see Table 1 for details), many of which were duplicated across databases.

Study selection: inclusion and exclusion criteria

Inclusion and exclusion criteria eliminate irrelevant literature generated by the search which does not address the review's focus (Arksey & O'Malley, 2005). To be selected

Table 1. Scoping review search results

Database	Search terms	Limiters	Search results
EBSCO Host (Education Source & ERIC)	Assess* AND creativity AND education, NOT tertiary NOT university NOT college NOT higher education	Scholarly peer- reviewed journals; English language	1382
PsycInfo	Assess* AND creativity AND education, NOT tertiary NOT university NOT college NOT higher education	Scholarly peer- reviewed journals; English language	1007

for inclusion, we required that, in addition to fulfilling the database search criteria of being peer-reviewed and published in English, articles had to (a) report the collection and analysis of quantitative or qualitative data, (b) address K-12 classroom contexts, and (c) address the assessment of creativity. The abstracts of all articles were read separately by two members of the research team who collated and finalised lists of relevant articles. A third researcher acted as arbiter for abstracts that prompted disagreement. The complete article was reviewed if it was unclear from the abstract whether the article met the inclusion criteria. As we became more familiar with the literature, new criteria were developed to guide decisions of inclusion and exclusion (Arksey & O'Malley, 2005), which were then re-applied to all articles. For example, we delineated our concept of *classrooms* to include both traditional K-12 classrooms and school-based extra-curricular settings. It became apparent that our preliminary search captured many studies that had not focused on classroom assessment in the way that teachers and learners specifically employed assessment of creativity in classroom contexts (our interest), but rather on the external assessment of student creativity traits or behaviours without pedagogical intent—these studies were excluded. We also encountered studies that assessed classroom interventions designed to promote creativity (e.g., by externally administering individual creativity tests to students before and after the intervention), but that did not in fact investigate assessment within the teaching and learning contexts (i.e., the interventions did not include any pedagogical assessment by the students themselves, peers, or teachers). These studies, too, were excluded. By the conclusion of the article selection process, we had identified 51 studies for review that fitted our inclusion criteria and directly addressed our research questions.

Charting the Data

Our next step in the review process was to chart the data, which involved 'sifting, charting and sorting' material in relation to key information and themes (Arksey & O'Malley, 2005, p. 26), including:

- Author(s), year of publication, study location
- Study participants (numbers of teachers and/or students)
- Context (grade level, subject area)
- Aims of the study (research focus)
- Method
- Instruments used
- Important findings

Overview of the research reviewed

The studies reviewed spanned publication dates from 1978 to 2017 and represented a broad variety of research designs (e.g., case study, experimental, quasi-experimental). However, numerous studies did not explicitly specify the research design, leaving the reader to make assumptions about the design based on the methods and instruments used. For example, Anontenko and Thomson (2011) describe their process of

collecting ‘qualitative data’ and creating ‘case files’ for analysis, but do not mention case study as their research design. Hence, we identified the research design only when it was clearly stated. The studies included a range of qualitative ($n = 18$), quantitative ($n = 26$), and mixed ($n = 7$) methods. Adapted from the definitions outlined by Treffinger *et al.* (2002), the instruments used to collect data pertaining to creativity assessment included behaviour and/or performance observations ($n = 12$), self-reported data ($n = 6$), rating scales and rubrics ($n = 19$), tests ($n = 12$), questionnaires ($n = 11$), and interviews, either individual or in groups ($n = 14$).

The studies represent multiple international research contexts: 16 conducted in Asia, 15 in North America, 14 in Europe, two in Africa, one in Australia, and three spanning multiple continents. They assessed the creativity of elementary-aged students ($n = 27$), secondary students ($n = 15$), and some addressed that of both elementary and secondary students ($n = 9$). With regard to participants, some of the studies involved both teachers and students ($n = 21$), some involved only teachers ($n = 14$), some involved only pre-service teachers ($n = 4$), and some only student participants ($n = 12$). Of the studies that reported specific subject areas, 17 studies were focused on the arts (visual arts, music, drama, digital arts), 14 on STEM (science, technology, engineering, and mathematics), five on English/Language Arts, and two on the humanities.

Collating, summarising, and reporting the results

Based on our reading and analysis of the 51 research articles selected for detailed review, we organised articles into four broad categories of research focus: (a) student and teacher factors influencing assessment of creativity ($n = 25$), (b) systemic factors also influencing assessment of creativity ($n = 7$), (c) self, peer and teacher formative creativity assessment ($n = 13$), and (d) frameworks to support and assess creativity ($n = 8$). (Two of the studies spanned more than one category and are therefore discussed more than once in the results section.) Within each of these categories we identified sub-categories of research focus, as detailed in Table 2.

The intent of a scoping review is to provide an overview of all the reviewed studies, as opposed to synthesising or aggregating findings (Arksey & O’Malley, 2005). We therefore provide brief descriptions of each study in the following results section.

Results

By providing an overview of each reviewed study, organised according to the research focus, we respond in this section to our primary research question: *What is the extent, range, and nature of research activity addressing the use of assessment to support and evaluate creativity in K-12 classroom education?* We include details about location, participants, context, and methods. We also include the key findings of each research study, thereby addressing our second research question: *What is known from the existing research literature about the use of assessment in K-12 classrooms to support and evaluate creativity?* In the section summaries, we highlight themes and patterns identified across the study findings.

Table 2. Categories and sub-categories of research focus

Categories	Sub-Categories
Student and teacher factors influencing assessment of creativity	<ul style="list-style-type: none"> • student capacity to recognise creativity ($n = 5$) • teacher recognition of creativity ($n = 5$) • teachers' conceptions of creativity ($n = 8$) • teacher orientations towards the assessment of creativity ($n = 7$)
Systemic factors influencing assessment of creativity	<ul style="list-style-type: none"> • cultural influences ($n = 3$) • influence of standardisation ($n = 5$)
self, peer and teacher formative creativity assessment	<ul style="list-style-type: none"> • self-assessment ($n = 7$) • peer assessment ($n = 3$) • teacher assessment ($n = 3$)
Frameworks to support and assess creativity	<ul style="list-style-type: none"> • framework development through examination of students' creative work ($n = 3$) • framework development through examination of teachers' perspectives on the assessment of creativity ($n = 2$) • testing established assessment frameworks ($n = 3$)

Student and teacher factors influencing assessment of creativity

Researchers have examined various student and teacher factors influencing the assessment of creativity in classrooms. These factors include (a) students' capacity to recognise creativity, (b) teachers' recognition of creativity, (c) teachers' conceptions of creativity, and (d) teachers' orientations towards the assessment of creativity.

Students' capacity to recognise creativity. Findings vary concerning the capacity of students to recognise creativity and thereby meaningfully being able to assess their own and/or peers' creative work. Three of the articles selected for review described research addressing student recognition of creativity in relation to its assessment, and two addressed students' conceptions of creativity.

Students' capacity for creativity assessment—Kaufman et al. (2016) compared 242 American elementary school children's self-assessment, using a 4-point Likert scale of their creativity in visual, verbal, and scientific tasks, to external raters' consensual assessments of the work. The self and external raters' assessments were significantly related, providing evidence that these children were modestly aware of their creativity even though they tended to underestimate it. Grohman et al. (2006) found different results with older students. They compared the ability of 100 Polish 15- to 17-year-olds to assess their own and their peers' creative ideas for originality and uniqueness in standardised tasks against the assessment of external experts. In this case, there was a significant tendency for the teenage students to overestimate the originality of their peers' creative ideas, and of their own to an even greater extent. Highly divergent thinkers in this study were less accurate when judging the originality of their own

ideas than those of their peers. Runco (1991) also examined the relationship between the capacity of students to assess their own creativity and divergent thinking, but with younger students. Runco gave 107 American elementary students three tests for self-assessment of creativity and three for divergent thinking tasks, and found a moderate correlation between the two variables, indicating a likelihood that children with a capacity for divergent thinking may have an increased ability to meaningfully assess their own creativity.

Students' conceptions of creativity—Research indicates that students' conceptions of creativity can both hinder and support accurate assessment of their own and peers' creative activity. In a collaborative inquiry involving interviews with 131 students, teachers and parents across six UK secondary schools, Bullock *et al.* (2002) found that students assessed length and visual presentation of their creative products to be the most important elements, thinking that 'more equals better' (p. 336). Students also focused on detail, spelling, and grammar in their self-assessments of creative work, rather than creativity. Conversely, Halverson *et al.* (2014) found that the adolescents in their American study were effective in their assessment of creative products. They conducted focus groups with 38 students aged 13–17 who evaluated youth-produced autobiographical short films based on the verisimilitude of the story, its fit with a recognisable genre, and how well the creative decisions supported the story and the genre. The students considered that decisions that bent the expectations of story and genre without breaking them were most creative. Accordingly, the researchers concluded that peers are an appropriate evaluative audience for youth-produced digital art. An evident difference between the two studies is that the participants in the second were provided with criteria for their assessment of creativity, which likely influenced the appropriateness of their assessments.

Section summary—Taken together, these studies demonstrate a lack of consistency in the literature concerning the capacity of students to meaningfully assess their own or their peers' creative work. The studies do, however, highlight some of the factors that seem to influence student capacity for creativity assessment, and therefore merit further attention: age, divergent thinking, conception of creativity, and teachers' support of students' self and peer assessment of creative work (e.g., identifying assessment criteria for students).

Teachers' recognition of creativity. In order for teachers to assess creativity, they must be able to recognise what it is they are assessing and whether or not it is present in students' work. Five research studies addressed teachers' recognition of creativity and indicated that teachers may experience challenges in recognising it.

Okoh (1983) compared how teachers in Nigeria assessed the creativity of 289 elementary students to those students' performance on a 'specially developed and standardised' (p. 377) verbal creativity test, designed to take local Nigerian cultural conditions into account. Surprisingly, the lower the teachers rated the students' creativity, the higher they scored on the creativity test. Runco (1984), however, found more positive evidence of teacher capacity to recognise and assess

student creativity. In an American study, six teachers rated the creativity of their 240 students based on a detailed list of researcher-derived adjectives, including: self-directed, curious, conforming, flexible, exploratory, unique, original, imaginative, uninhibited, and challenging. The teacher ratings were moderately related to student performance on a divergent thinking test, adapted from Wallach and Kogan (1965). When compared with Okoh's study, Runco's findings suggest that teachers may be better positioned to recognise student creativity when they are supported in trying to identify it (e.g., when provided with specific assessment criteria).

Researchers have also considered how personal experience of creativity may affect teachers' capacity to assess it. In a Hong Kong study, Wong et al. (2014) administered the *Test for Creative Thinking – Drawing Production* (Urban & Jellen, 1995/2010) to 618 teachers and 631 students. The students scored significantly higher than the teachers. The study findings did not include evidence that this low capacity of the teachers to personally demonstrate creative thinking inhibited their ability to recognise creativity in the work of their students, but the researchers did raise this potential concern.

The capacity of a teacher's ability to assess creativity being affected by their personal experience of it was more directly examined in a study of six secondary music teachers in the UK. Using individual interviews, Odena and Welch (2007) found that teachers with composing experience and practical knowledge of different music styles had more open views with regard to the process of creativity and were more prepared to recognise student work as being creative when it did not necessarily keep to the style or structure of the activity. The researchers concluded that improved domain knowledge may improve teachers' recognition of creativity in student work. In a quasi-experimental study that examined the pre- and post-intervention assessment ratings of two visual art teachers in Malaysia, Samah et al. (2016) similarly reported findings which demonstrated that the teachers' abilities to assess student creativity were supported by their expertise and background in art and design.

Section summary—The studies in this section suggest that teachers may experience challenges in recognising creativity due to a lack of understanding of the construct. The research also indicates, however, that teachers may be more effective in assessing creativity if they have the benefit of training and development related to the construct. Teachers may assess creativity more effectively, for example, if they have personal experience of creative work, or if they are provided with a list of creative behaviours or components of the creative process. These are both ways to enhance or refine teachers' conceptions of creativity, and therefore their recognition and assessment of creativity.

Teachers' conceptions of creativity. Eight of the studies selected for review addressed how teachers conceptualised creativity, with four focusing on how teachers' conceptions influenced their assessment of students' creativity generally, and four focusing on how their conceptions influenced their assessment of students' creative work.

Teachers' conceptions of creative students—Four correlational and descriptive survey research reports selected for review addressed teachers' conceptions of creative students. In an American study, Swenson (1978) found no correlation between the creativity ratings of 36 teachers of disadvantaged children and the students' performance on the figural form of the Torrance Test of Creative Thinking, but did find statistically significant relationships between the teachers' creativity ratings and student performance on intelligence tests, particularly for female students. Gralewski and Karwowski (2013) obtained similar results when they measured the creativity of 589 Polish high school students, using various measures (i.e., standardised tests and self-reports), and compared these to ratings of the students' creativity provided by 178 of their teachers. The teachers rated the students' creativity on a five-point scale without reference to a definition of creativity or a list of characteristic behaviours. Their ratings related somewhat to the researchers' ratings of the students' creativity, but not well. Instead, teachers' ratings of creativity were strongly associated with students' school functioning, whether they were male or female, and intelligence in male students. Extending this work, Gralewski and Karwowski (2016) tested 131 secondary teachers for their implicit theories of creativity (i.e., creativity as adaptation versus creativity as innovation) and related these theories to teachers' ratings of their students' creativity. Findings indicated that teachers who associated creativity with adaptation tended to assess the creativity of females more accurately, whereas teachers who associated creativity with innovation tended to assess the creativity of males more accurately.

Aljughiman and Mowrer-Reynolds (2005) found an array of conceptions of creativity among 36 elementary teachers in the US: 88% of survey respondents agreed that creativity involved original ideas; 35% of respondents agreed that creativity involves producing artistic products; 35% agreed that creativity involves intelligence; only 26% recognised self-expression as an aspect of creativity; and only 14.7% recognised a connection between divergent thinking and creativity. These varying conceptions of creativity were evident in teachers' conceptions of creative students as: intelligent (27%), enthusiastic about learning (44%), deep thinking (47%), possessing a rich vocabulary (50%), artistic (58%), and thinking differently (92%). The authors concluded that teachers 'often confuse characteristics of gifted high achievers with creative characteristics' (p. 27).

Teachers' conceptions of students' creative work—Four of the reviewed research reports addressed teachers' conceptions of students' creative work. Mõistlik and Selke (2011) surveyed 61 Estonian elementary and secondary music teachers to capture their notions of musicality and the criteria they use to assess their students in musical activities. Survey results indicated that while these teachers valued creativity, and thought they were assessing it, they were actually assessing musical knowledge. Kokotsaki and Newton (2015) asked 17 pre-service secondary music teachers in the UK to holistically assess the creativity of nine student-produced musical compositions. The music compositions were rated as highly creative when they were appropriate to the task, and used a range of musical elements and devices, while imagination, originality, and variety were identified to a lesser extent as significant criteria. The researchers concluded that the pre-service teachers needed to acquire more

experience and improve their knowledge of creative composition. In earlier research, Newton (2010) examined 60 UK pre-service elementary science teachers' holistic assessment of the creativity of students' scientific explanations. The pre-service science teachers tended to identify the explanations as creative when they were correct, or when they demonstrated imagination, even if the explanations were implausible. In an American study, Long (2014) asked 15 elementary school teachers to assess student responses to open-ended, scientific questions for creativity using a holistic rating of 1 to 5, and to provide comments justifying their rating. The range of factors addressed in these comments differed for each teacher, leading the authors to suggest 'that judgement about creativity is probably personal' (p. 191). Appropriateness of the scientific response was the most frequent criterion (9) used to identify creativity, followed by novelty (5), and thoughtfulness (1).

Section summary—The research addressing the influence of teachers' conceptions of creativity on their assessment of students' creativity indicates that teachers conceptualise and therefore assess creativity in diverse ways, that often do not correspond to the way in which creativity tests and expert raters conceptualise and assess creativity. Research has identified this discrepancy both in teachers' assessments of general student creativity and of students' creative work. An emergent pattern in this limited literature is that when assessing general student creativity and students' creative work, teachers are likely to value novelty or originality to some extent, but are more likely to value appropriateness (i.e., intelligence and successful school functioning in terms of student attributes and a correct or suitable response in terms of their creative work).

Teachers' orientations towards assessment of creativity. Seven of the reviewed studies identified teachers' orientations towards the assessment of creativity, and how these various orientations influence their assessment of creativity.

Myhill and Wilson (2013), for example, examined how 32 UK middle school (12- to 13-year olds) teachers' views of creativity manifested in their teaching and assessment of poetry. Interviews and classroom observations elicited the common theme of 'a relatively limited conceptualisation of what creativity entails' (p. 105), and a finding that some teachers totally opposed critiquing creative work. Also using interviews and observations, Gardiner (2017) found a similar reluctance to view feedback as a teaching and learning strategy for creativity among five Australian teachers mentoring 17-year-old students in independent playwriting projects. The researcher traced this limited view of assessment back to a belief in 'intrinsic creativity: that naïve talent is 'noble' and should be kept free from the corrupting influence of teaching' (p. 121). Through a survey of 285 pre-service music and visual arts teachers in Hong Kong that examined creativity and assessment in arts education, Leong and Qiu (2013) found that respondents indicated a far greater understanding of how to support and assess skill development over creativity, and a belief that they should focus their teaching on tests and exams rather than on assessment practices that foster creativity. In the US, eight pre-service teachers were asked about their perceptions of creativity by Antonenko and Thompson (2011) and described creativity as a broad concept that could not be pinned down or

reduced to a list of adjectives. These future teachers indicated a general preference for a ‘subjective’, holistic assessment of creativity.

Meanwhile, in a survey conducted by McCammon *et al.* (2010) of 98 elementary and secondary drama and theatre educators from four countries (Canada, Jamaica, US, and Norway), teachers indicated that they believed it was important to assess student achievement in creativity (average of 4.0 on a 5-point scale), although they indicated to a lesser extent (3.0) that they know how to assess creativity achievement. The teachers reported that they believed the best way to assess student creativity achievement was by means of student self-report or self-critique, and peer feedback or critique, followed by teacher-administered rating rubrics. In a similar research design in Slovenia, Rozman (2009) surveyed 50 elementary teachers working in grades 1 to 3 about creativity in music education. All respondents reported including opportunities for musical creativity in their classes, and all indicated that they provide feedback to students about their musical creativity, most frequently based on (a) developed criteria for a descriptive judgement; (b) originality, (c) congruence with the task, and (d) effort.

Leong (2010) examined teachers’ classroom creativity assessment practices not by reviewing teachers, but by reviewing 529 K-12 music and visual arts students in Hong Kong. The students reported that creative activities (77%), assignments (79%) and classroom performance (76%) were the most common assessment methods they encountered in visual arts in elementary school, while in music classes, performance exams (94%), written exams (88%), and classroom performance (63%) were most common. Consequently, students reported that elementary music classes did not teach them creative activities (0%) or creative thinking (7%), in contrast to visual arts classes: creative activities (67%) and creative thinking (53%). Similar patterns in assessment were reported for secondary visual arts and music classes, with creative activities (93%) being common in the visual arts, but not in music (29%).

Section summary—It is difficult to identify any meaningful pattern amongst the findings in this section, other than the indication that teachers’ orientations to the teaching and assessment of creativity are highly variable. While some studies indicated that teachers’ limited, broad, or vague conceptions of creativity were accompanied by avoiding creativity assessment (Myhill & Wilson, 2013; Leong & Qui, 2013; Gardiner, 2017), or resorting to holistic assessment (Antonenko & Thompson, 2011), other studies indicated that some teachers did value assessing creativity, and were making efforts to do so (e.g., visual arts teachers in Hong Kong, Leong, 2010; drama teachers in Canada, Jamaica, the US and Norway, McCammon *et al.*, 2010; and music teachers in Slovenia, Rozman, 2009).

Systemic factors influencing assessment of creativity

Amongst the research studies selected for review, seven addressed systemic factors influencing assessment of creativity. Specific themes identified in this category included: (a) cultural influences, and (b) influence of standardisation on assessing creativity.

Cultural influences. Three of the research studies addressed cultural influences in relation to teachers' assessment of students' creative work, mainly through cultural comparative studies.

In a Singapore study, Soh (2000) surveyed 117 elementary and secondary teachers from different cultural backgrounds on a range of self-reported creativity-fostering behaviours. In the study, Chinese teachers reported being less inclined than non-Chinese teachers (Malaysian, Indian, Eurasian, and others) to engage in judgement-related behaviours about creativity, such as commenting on students' ideas. Rostan et al. (2002) examined judgements of 7- to 13-year-old children's art made by 30 judges—15 educated in North America and 15 educated in China. The judges included parents, teachers, art critics and artists. Assessments made by the two groups using researcher- and judge-developed criteria were found to be more alike than different. However, only the North American-educated judges identified the art students' life drawings to be, on average, more creative than the work of those who weren't art students.

Hennessey et al. (2008) conducted a study to determine if the Consensual Assessment Technique for Product Creativity (CAT) (Amabile, 1982) was a reliable strategy in non-western contexts. This assessment technique involves experts in a particular field judging product creativity, without training or any instruction on how to render ratings. Research in the West has endorsed the reliable and valid assessment of product creativity by a consensus of experts (Hennessey et al., 2008). To determine if the assessment technique was equally reliable elsewhere in the world, the researchers examined how elementary teachers from the US, Saudi Arabia, China and South Korea assessed the creativity of collages and stories created by children in their local area. Across all four cultural contexts, judges' ratings of product creativity, when compared with the other ratings in the same context, were found to be highly reliable. While the reliability is impressive, there is no indication of how teachers were conceptualising creativity, along with the conception of creativity they were in consensus about. The research did not examine how creativity was differently perceived between cultures.

Section summary—Of note in considering these three studies is that while they all addressed a cultural background, each had a different focus. The first examined whether cultural background influenced how teachers engage in assessment of creativity, and found teachers of a Chinese background to be more reticent in judging creativity; the second examined whether cultural background influenced teachers' assessment of creativity in students' life drawings, and found slight differences; and the third examined whether cultural background influenced teachers' likelihood to be in agreement about the products they identify as creative, and also found teachers from all represented cultures to be equally agreeable. While each study differed in intent, they do suggest that culture might be a factor in recognising and assessing creativity, and that additional research examining cultural influences within creativity assessment would be valuable.

Influence of standardisation on assessment of creativity. Four studies in this review addressed the impact of standardised curricula, including standardised testing on creativity assessment in K-12 classrooms.

The perceptions of eight teachers interviewed about the effects of standardised testing on student creativity in grades 5 to 7 in Ontario, Canada were considerably negative (Dishke-Hondzel, 2014). These teachers felt standardised testing caused them to focus their assessment of student work on improving standardised achievement scores, an emphasis incongruous with supporting student creativity. However, these teachers also acknowledged that the testing emphasis improved literacy and numeracy skills, which may support students' future creativity.

In an American study, three elementary teachers using literacy portfolios with their students as authentic tools to encourage student creativity, leadership, and decision-making, relayed distress at the possibility of their state mandating literacy portfolios for student evaluation (Irwin-DeVitis, 1996). Informal interviews and discussions revealed their belief that mandated content would stifle students' creativity, and that the complexity and creativity of current portfolio practices could not be effectively reduced to a single score for evaluation purposes.

Bullock *et al.*'s (2002) previously mentioned U.K. study, involving interviews with 24 teachers, reported that the importance of achieving good grades within a standardised testing context curtailed the teachers' encouragement of creativity in their secondary students' projects because the teachers felt obliged to guide their students to achieve the standard. These teachers reported that the set criteria for assessment, as well as the need for students to achieve good grades, constrained students' ability to be creative. Similarly, Leong and Qiu's (2013) previously discussed survey of 285 pre-service music and visual arts teachers identified the influence of the prevalent testing culture in Hong Kong, with respondents indicating they 'commonly feel pressured by school ranking practices to teach towards the test or exam... and find it difficult to give room for students to answer in different ways' (p. 610).

A case study exploration of ninth-grade South African technology teachers' use of the design process in their teaching hints at other environmental pressures influencing the assessment of creativity (Singh-Pillay & Ohemeng-Appiah, 2016). Of the 30 teachers surveyed and interviewed, 21 employed the design process as a rigid step-by-step process and were preoccupied with seeking ease in grading, due to work load and time pressures. In one participant's words: "I guide them all the way, there is no room for learners to be creative or to discuss with peers, they can be creative in arts and culture, there is too much marking... I want end products that are the same and easy to assess" (p. 78).

Section summary—The perception by teachers that their assessment of students' creative work was influenced by standardised curricula and testing was a strong theme within these four studies. Specifically, teachers felt pressure to use assessment to constrain rather than support student creativity, and also felt that test-based standardised curricula encouraged convergent rather than divergent learning.

Formative self-, peer and teacher assessment to support creativity

Thirteen articles reported research that described formative creativity assessment as applied in classrooms (i.e., classroom practices intended to support students' creativity with assessment). These articles addressed the following dimensions of formative

assessment: (a) self-assessment, (b) peer assessment and (c) teacher assessment of creativity.

Formative self-assessment. Seven research studies addressed self-assessment as a means to support the development of student creativity, encompassing (a) interventions to promote creativity through self-reflection, and (b) use of technology to support self-assessment.

Interventions to promote creativity through self-reflection—Four of the studies involved examining creativity-enhancing interventions that promoted self-reflection, a strategy for self-assessment.

Using a treatment and a control group, Eow et al. (2010) examined 69 Malaysian 13- and 14-year-old students developing their own computer games. The treatment group was instructed to use a four-stage approach (discover, dream, design, and destiny), designed to facilitate self-reflection throughout the creative process, while enhancing creative perceptions. The approach first allowed students to *discover* their own potential, knowledge and skills in relation to the ‘Game Maker’ program, and were then asked to brainstorm (or *dream* of) ideas of what their game would be like, *design* the games, and then reflect upon the foreseeable *destiny* of their game. The control group applied "self-paced learning, followed by a do-it-yourself session" (p. 1131). The researchers found that the four-stage approach fostered students’ creative perceptions compared to the control group, as measured by the Khateni-Torrance Creative Perceptions Inventory.

In the United States, Clements (1991) also made use of an experimental design to examine a model used to stimulate reflection in a Grade 3 Logo computer programming environment. The 73 students were introduced to characters like the ‘Problem Decider’ (to think about what a problem means), the ‘Representer’ (an artist), and ‘Detective Selective’ (to select proper coding processes). These characters served as metaphors to represent various strategies for solving problems and were used as hints or prompts by teachers (who acted as facilitators of learning) to support and structure the children’s approach to the program. Ultimately, these metaphors guided students to reflect upon their strategies. After 25 weeks of the treatment, it was found that the Logo programming group had significantly higher scores on the Torrance Tests of figural and verbal creativity than the control group.

An Israeli study designed to foster creativity through perspective-taking involved 286 students aged 10-14 in an experimental design. Doron (2017) had the students in the experimental condition actively engage with media content by re-inventing scenes from a popular cartoon. In a series of exercises, the students were asked to make connections between emotions and various pictures, locations within the school, and various facial expressions in the cartoon. The researcher found that supporting students to reflect on and experience various perspectives enhanced their divergent thinking skills as measured by pre- and post-intervention scores using the Tel Aviv Creativity Test.

Kim et al. (2016) developed a model to foster creativity through the use of visual thinking in English classes in a Korean middle school. In an experimental study, students used tablet technology over the course of a semester to represent and share with classmates and teachers their understanding of the curriculum content through

drawings. Students were encouraged to reflect on and adjusted their representations in response to peer and teacher feedback. Six classes in the study made use of this approach and six did not. One teacher taught all 12 classes, consisting of 270 students. At the end of the semester, students in the treatment group scored significantly higher on the originality, abstractness of titles, and elaboration subscales of the Torrance Tests of Creative Thinking-Figural form.

Section summary—The evident theme of these intervention studies is that reflection and self-reflection (strategies for self-assessment) are conducive to increased creativity. Also of note, however, is that while the interventions targeted increased reflection, teachers were very much involved in supporting the students' use of these various reflection techniques. They would, for example, actively guide students through creative processes (Clements, 1991; Eow *et al.*, 2010), lead students in reflection exercises (Kim *et al.*, 2016; Doron, 2017), and introduce teacher and peer assessment feedback as a means to guide and inform students' reflection (Kim *et al.*, 2016).

Use of technology to support self-assessment—In addition to the study conducted by Kim *et al.* (2016) described above, three further studies addressed the use of technology to support self-assessment of creative work.

In a quasi-experimental study involving two classes of 21 sixth-grade students in Taiwan learning painting skills with a tablet, the class that experienced 'learning with reflection support' demonstrated greater brushwork originality than those 'learning with direct teaching in replication,' when evaluated by three expert and experienced art teachers (Ho *et al.*, 2017). With the tablet, the students felt 'braver' in trying new techniques because they were able to delete 'bad and wrong paintings' (p. 63). The researchers underscore the tablet's role in providing the means to encourage reflection while drawing, which enhances artistic expression.

Davidson (1990) examined Grade 8 students' use of composition software to set their own limericks to music in the US. Interviews with students revealed the software allowed students with no previous experience with music or computers to discover relationships between notes on a score and modify melodies to suit their evolving preferences. The students used self-assessment techniques, including monitoring and shaping their musical creations as well as critically appraising their own work.

In a Taiwanese quasi-experimental design study involving 182 tenth-grade students across five classes in a STEM project to create racing cars, some students employed a 3D printer coupled with modeling software, while the others created their cars manually. Students using the 3D printer outperformed the others, according to a revised version of the Creative Product Semantic Scale (Besemer & Treffinger, 1981), in both the sophistication and novelty of their creations, due to their enhanced capacity to assess and revise their products, thanks to the feedback the 3D digital modelling software provided (Chien, 2017).

Section summary—A common theme amongst these studies examining the use of technology to support self-assessment of creativity was that the various technologies facilitated both learning of content but also self-reflection and assessment. The technologies enabled students—with relative ease—to experiment with and assess

multiple possibilities before committing to a final product. The studies demonstrated that technological supports can enhance students' monitoring of their creative work and thereby support the assessment of their own work to enable subsequent refinements.

Formative peer assessment. Three of the studies selected for review directly addressed the role of formative peer assessment in supporting creativity.

In a Taiwanese quasi-experimental study of 53 sixth-grade students, Liu et al. (2016) found that the treatment group, who experienced the peer review process using researcher-developed storytelling rubrics, produced more sophisticated stories than the control group. The researchers concluded that the peer feedback served to 'build a sophisticated level of reflection upon creative work and activities' (Liu et al., 2016, p. 286). In addition, the researchers found that receiving the peer review did not negatively impact on students' creative self-efficacy. The researchers identified that a significant aspect of the success of the peer feedback process was the role the rubric criteria played in helping students to understand the teachers' expectations.

In a Taiwanese quasi-experimental study evaluating the development of a computer game with a peer-based assessment approach, involving 167 sixth graders divided between a control group (game development without peer assessment) and an experimental group (game development with peer assessment), data from open-ended student questionnaires supported the use of peer assessment for cultivating creativity (Hwang et al., 2014). Students who gave and received peer feedback with reference to a rubric asserted that playing and evaluating their peers' games helped them improve their in-depth thinking, creativity and motivation. For example, one student stated, "the comments given by others made me pay attention to what needed to be improved and to think about some problems I did not notice" (Hwang et al., 2014, p. 140). Of note is that the students not only identified *receiving* the peer feedback as helpful, but also the process of considering and *assessing* their peers' work (e.g., "after playing their games, I had better ideas about designing the island") (Hwang et al., 2014, p. 140).

In a study with 127 Chinese tenth-grade students, Wang and Murota (2016) investigated the integration of peer instruction into technical creativity education and found that peer discussion facilitated the generation of creative ideas and products in relation to webpage design. In the model they examined, students discussed their ideas with a peer after teacher instruction and independent idea generation. They then refined the ideas through discussion with peers in a continuous cycle until a product was generated. Two teachers then rated the creative products using a researcher-developed rubric. The researchers found that if students already had original ideas, peer discussion improved creative performance. However, facilitating idea generation from weaker students required teacher instruction. Ultimately, Wang and Murota (2016) recommended a hybrid-type of peer instruction—one that combined peer discussion and explicit teacher instruction to facilitate creative idea generation and product creation for all students.

Section summary—The research on peer assessment suggests that it can be effective in supporting students' learning when structured with purposeful criteria. In addition, the peer feedback process might be equally valuable for the student receiving the

feedback as for the one providing the feedback. However, as Wang and Murota (2016) identified, peer feedback should likely not be the primary or sole feedback for assessment of creativity, but rather coupled with teacher feedback.

Formative teacher assessment. Three research articles focused directly on examining formative assessment (as opposed to summative assessment) as used by teachers to support creativity.

Baer (1998) reported on two experimental American studies that involved 130 middle school students, suggesting how student creativity is influenced by the expectation of teacher assessment. Results showed the expectation of graded assessment diminished the creativity of middle school girls but not boys. Similarly, the expectation of receiving ungraded, constructive feedback did not impact on boys' creativity but did negatively impact on the girls' creativity, although to a lesser extent than the expectation of graded assessment.

Gardiner's (2017) Australian case study, described earlier, explored six secondary student-teacher dyads involved in a playwriting project. Teachers initially assumed a 'passive non-interventionist' role, not wanting to 'corrupt' innate creativity (p. 121). When the teachers responded to student drafts with negative feedback, the students, having limited knowledge of playwriting, over-amplified the feedback in their scripts. Closer to the deadline and frustrated with student progress, the teachers became increasingly prescriptive with their feedback. Gardiner, advising against passive pedagogy and reactionary feedback, advocated 'shift[ing] the mentoring dynamic from vertical to horizontal (and back again) as appropriate... to scaffold and complement the student's vision' (p. 125).

Levenson (2011) observed and analysed elementary school math lessons to examine how teachers can facilitate collective creativity. The qualitative study involved one Grade 6 and two Grade 5 classes in Israel. Through field notes and observations, Levenson identified the value of a teacher acting both as a group member and leader. Acting as a member (i.e., offering ideas and solutions towards solving the problem) motivated students to follow the teacher's example. Acting as a leader (i.e., explaining a mathematical process) provided students with a tool to apply to other problems. Similarly, another teacher connected a new concept to a previously learned concept. These connections helped students reframe past experiences in ways that led to new insights. Levenson also identified the value of a teacher fostering a safe environment, where students felt comfortable challenging the teacher, and so felt safe enough to introduce new ideas. Levenson described a teacher's guiding feedback in detail during a Socratic-style lesson (that began with an open-ended question) as a means to stimulate collective creativity. As students contributed divergent suggestions, the teacher responded with such comments as: "There are many ways," "Can someone explain what she did?" "Why not?" and "You're using the commutative property of multiplication. But, it's really the same as [his] answer" (p. 222). Such prompts for flexible thinking and reflective reframing elicited students' connections to past experiences, stimulated new insights, and encouraged students to build on each other's thoughts.

Section summary—The studies focused on formative teacher assessment to support creativity examined quite different aspects of the phenomenon. Baer's (1998) study

found that the expectation of both summative and formative assessment negatively impacted on creativity for girls but not boys. Gardiner (2017) found teachers to be both unforthcoming with feedback to support creativity (in early stages) and overly prescriptive in later stages. Levinson's (2011) findings illustrated how a teacher can, through questioning, guide learners to greater creativity through Socratic questioning.

Frameworks to support and assess creativity

Eight studies focused on the development of frameworks to support and assess creativity. Three of these studies described the development of frameworks based on examination of students' creative work, two reported studies involved gathering teachers' perspectives on the assessment of creativity in order to develop frameworks, and three studies tested established assessment frameworks.

Examining students' creative work to develop frameworks. Three research reports described studies that examined creativity in students' work in order to identify key elements that are important for teachers to monitor and assess in various subjects or contexts.

Tan et al. (2014) developed and empirically validated a 'dialogic framework for characterising, measuring and fostering students' collective creativity (CC) in the context of computer-based collaborative problem-solving (CPS)' (p. 412). The framework consisted of four theoretically-based dimensions of dialogue—reflexive dialogue, divergent production dialogue, convergent production dialogue, and prosocial dialogue—with a total of 20 associated codes (e.g., planning, elaboration, justification, and questioning). The researchers used these codes to analyse interactional computer data generated by 141 secondary student dyads in Singapore as they engaged in collaborative problem-solving tasks. Applying the framework in this way enabled the formative assessment of each student dyad's creative problem-solving approaches and highlighted statistically significant differences in dialogues between successful and unsuccessful pairs. The researchers suggested that this framework could be employed as a formative assessment tool to 'help students and teachers foster more productive peer dialogic interactions that can help promote deeper knowledge-building and more effective collaboration and creativity in joint problem-solving practices' (p. 431).

With the objective of assessing and improving learning in engineering design contexts, Worsley and Blikstein (2016) conducted a qualitative study to better understand where students' ideas come from and how to assess their progress in open-ended learning environments that require creativity. They challenged 13 American students (10 from Grades 9-12 and three post-secondary) with an engineering design task. Each student was video-recorded while completing the task, then interviewed regarding the reasoning behind their design. Through grounded theory analysis of video recordings and interviews, the researchers developed a theoretically- and empirically-based framework consisting of four reasoning strategies: unexplained, materials-based, example-based and principle-based. In addition, they developed two coding schemes to enable assessment of students' reasoning in design tasks based on

the four strategies identified in the framework—one scheme to classify the overall reasoning strategy used and one to identify the combination of reasoning strategies used. The researchers proposed that the reasoning strategies framework and associated coding schemes provide a formative assessment tool that educators and students can use to assess and enhance students' reasoning in engineering design and similar creative tasks.

In a qualitative study involving participants from Romania and Mexico, Pelczer and Rodríguez (2011) asked 91 students (high school and university) and 63 teachers (middle and high school) to complete a problem-posing task in order to assess their mathematical creativity. Problem-posing involves creating a problem to which one does not know the solution. In analysing the problems posed by participants and their responses to follow-up questionnaires, the researchers identified three criteria which provide a framework to facilitate assessment of mathematical creativity in problem-posing: (a) first level problems utilise only domain-specific algorithms, (b) second level problems combine domain-specific rules with knowledge from another domain, and (c) third level problems are characterised by innovative reformulation of knowledge and techniques from a completely different domain. In addition, the researchers proposed a complementary framework to assess the novelty of the problem posed that included three criteria—algebraic, conceptual, and methodological novelty. According to the researchers, these assessment frameworks provide empirically-based criteria that can be used to assess and develop mathematical creativity among students engaged in problem-posing tasks.

Examining teachers' perspectives to develop frameworks. Two studies involved gathering data from teachers on the assessment of creativity in order to develop frameworks.

Wang et al. (2014) led five panel discussions in Taiwan with experts, including five outstanding elementary school teachers to develop a model for scientific imagination. The data generated through concept-mapping exercises (focused on unpacking scientific imagination) were combined with a review of literature, qualitative interviews, classroom observations, and document analyses to yield a model outlining four domains of scientific imagination: personality, picture in mind, process, and surroundings. Each domain describes characteristics, attributes and qualities that teachers can track and foster. For example, within the personality domain, teachers could monitor and cultivate openness to challenges, curiosity, and discipline-specific knowledge. Wang et al. (2014) advocate this model as a framework to help teachers foster and assess students' scientific imagination.

Nielsen (2015) developed a framework for assessing students' innovation competency through a series of interviews and group discussion sessions with 28 secondary school teachers in Denmark. In a three-step process to enable development and validation of the framework by expert teachers, Nielson identified five competencies of innovation: creativity, collaboration, navigation, action and communication. He also identified sub-competencies for each, along with associated skills. For example, the creative competency has three sub-competencies: The student is able to (a) 'be open in idea-generating processes,' (b) 'work with ideas in a critical fashion,' and (c) 'independently interpret a task or problem issue' (p. 323). Nielson associated seven skills, or assessment criteria, with these sub-competencies, including, for example, that the

student is able to ‘generate new/unexpected ideas/solutions ... generate different non-idiosyncratic ideas ... [and] be open to ideas from oneself and others’ (p. 323). Nielson claims the framework provides a comprehensive set of assessment criteria for the assessment of innovation competency.

Research to test frameworks. Three studies involved the testing of previously established creativity assessment frameworks.

Lindström’s (2006) multi-year study confirmed the reliability and validity of a framework designed to assess creativity in the visual arts. The study involved 500 Swedish students, aged five through nineteen. Two teachers assessed each student’s portfolio as well as a videotaped interview in which the student described their art-making processes. The assessment of creative ability framework included three product criteria (visibility of the intention, colour form and composition, craftsmanship) and four process criteria (investigative work, inventiveness, ability to use models, and capacity for self-assessment), with four levels of performance for each criterion. Statistical analyses indicated a high level of inter-rater agreement between the two assessors. However, with regard to assessment of creative processes, Lindström emphasised the importance of the student interviews, as “It was not until we supplemented the students’ logbooks with the videotaped interviews that different assessors arrived at similar results” (p. 59). Lindström concluded from the study that the multi-dimensional nature of the assessment criteria, addressing visual design and work habits (i.e., product *and* process), mitigated the danger of ‘undue emphasis on skills in the use of materials and techniques on one hand, and...[assessors’] idiosyncratic preferences on the other’ (p. 59).

Lucas (2016) developed and trialed one of five dimensions of a creative habits of mind framework with 17 UK schools. The five habits of mind include: imaginative, inquisitive, persistent, collaborative and disciplined. Each habit includes three sub-habits. For example, inquisitive includes: wondering and questioning, exploring and investigating, and challenging assumptions. For each sub-habit, additional ranges of strength, breadth, and depth can be assessed. Teachers found the rubric to be an effective formative assessment tool to track students’ creativity but felt the number of sub-habits and associated levels made the formative application rather burdensome. For students, using the tool for self-assessment allowed for the development of a ‘new vernacular with which to describe their behaviour and monitor different dimensions of their learning’ (p. 286).

Ellis and Lawrence (2009) conducted a case study at one school to investigate the use of the Creative Learning Assessment (CLA) model as a means of evidencing, supporting, and promoting primary children’s creative learning in arts-based contexts in the UK. This model, designed to support qualitative assessment by teachers in creative arts subjects, was comprised of an observation framework, a portfolio of children’s work with reflective commentary, and a five-point scale of progress based on national curriculum statements. One of the objectives of the CLA continuum was to provide teachers with a view of children’s creative learning development over time through formative practices. The observational framework asked questions like “in what ways are children able to take risks and experiment in their learning?” and “do they generate ideas, questions, and make connections?” (p. 4). The CLA model

enabled teachers to become more aware of their students as learners and build their confidence. Through reflective and evaluative practices supported by portfolios, children were able to review their own learning, deepen their knowledge through articulating understandings, and become more independent as learners. Ultimately, findings indicated that using the model helped teachers recognise elements of creativity and therefore observe, assess, and develop creative learning with their students.

Section summary—Taken together, these studies assert the value of empirically-based frameworks to support teachers' and students' formative assessment of creativity in various domains, including STEM fields and visual arts. However, it is important to note that STEM-based studies focused on the development of creativity assessment frameworks and not on testing the use of these frameworks with students. This suggests the need for additional studies that explore the implementation of creativity assessment frameworks with students across a variety of disciplines, including STEM fields.

Discussion

The overall purpose of this scoping review was to determine the *extent, range, and nature of research activity addressing the use of assessment to support and evaluate creativity in K-12 classrooms*. We also sought to learn what research has discovered about the intersections of creativity and assessment in schools, i.e., *What is known from the existing research literature about the use of assessment in K-12 classrooms to support and evaluate creativity?* In this discussion section, we respond to our overall study purpose by first presenting an overview of the research studies reviewed. We then respond to our second research question by discussing key themes related to the intersections of creativity and assessment in schools. We conclude by identifying the implications of the reviewed research for practice, limitations of our review process, and directions for future research.

Key study findings

The extant research on the intersection of creativity and assessment in schools points in varied directions, with implications for teacher education, teacher practice, and assessment theory. Among our analysis of the research, two dominant and consistent themes emerged. First, 15 studies indicated the importance of defined criteria and/or frameworks for effective and useful creativity assessment within K-12 contexts. Second, 10 studies identified the particular value of self-assessment and/or reflection in supporting creativity. These findings offer insight into how to maximise the effectiveness of formative and summative assessment practices.

The importance of creativity assessment criteria. When considering the use of assessment in K-12 classrooms to support and evaluate creativity, the studies in this review indicate the importance of creativity assessment criteria. With the caveat that we did not appraise the quality of the studies, their results indicate that assessment of creativity is more accurate when assessors (teachers, peers, creators) are provided with

criteria to support their understanding of the conception of creativity they are assessing. For example, teachers seemed to assess creativity more precisely in Runco's (1984) study, when they were provided with a list of creativity-related adjectives, than those in Okoh's (1983) study, who assessed students' performance without criteria. Gralewski and Karwowski (2013) also found that teachers, when rating students' creativity without reference to a definition of creativity or a list of characteristic behaviours, were not accurate in their rating of creativity.

A common problem with teachers' assessments of creativity, as indicated by studies in this review, appears to be that teachers tend to assess the academic appropriateness of students' behaviours and products as desirable over their originality or novelty, i.e., to value convergence over divergence. For example, Swenson (1978) found that teachers' ratings of students' creativity actually correlated more significantly with the students' performances on intelligence tests than creativity tests. In a related finding, Aljughiman and Mowrer-Reynolds (2005) identified that teachers conflated characteristics of high academic achievers with creative characteristics. The survey results of M\"ostlik and Selke (2011) indicated that teachers valued creativity, and thought they were assessing it, but were actually assessing content knowledge. Long (2014) found that teachers identified answers that were 'scientifically appropriate' as creative. Newton (2010) found that teachers identified answers that were 'correct' as creative. Kokotsaki and Newton (2015) found that teachers rated student products as creative when they were appropriate to the task, while imagination, originality, and variety featured to a lesser extent as significant criteria. These studies demonstrate a strong bias in favour of convergence over divergence in teachers' creativity assessments.

The studies reviewed also indicated that students who engaged in self- and peer assessment of creativity favoured appropriateness over novelty. Bullock et al. (2002) identified that, without assessment guidance, secondary students assessed length and visual presentation of their creative products to be the most important elements, along with detail, spelling, and grammar. Conversely, Halverson et al. (2014) found the students in their study—who *had* been provided with criteria—were effective in their assessment of student-created short films, identifying as most creative those that bent the expectations of story and genre without breaking them, i.e., balancing appropriateness and originality. In further support of the importance of assessment criteria, Liu et al. (2016) examined a peer feedback process used by sixth-grade students to support creative work and attributed its success to the students' consideration of criteria articulated in a teacher-provided assessment rubric.

Considered together, the reviewed research suggests that making use of assessment criteria can help students and teachers to accurately and meaningfully assess creativity. This finding aligns directly with contemporary classroom assessment theory across disciplines that argues the need for explicit standards and criteria to be used throughout formative and summative assessments (Brookhart, 2004, 2011; Black & Wiliam, 2009). Applied to creativity, making criteria explicit at the onset of learning could serve, for example, to correct an over-emphasis on the appropriate/valuable aspect of creativity rather than the novel/original aspect when assessing students' products and behaviours. Clearly defined criteria could also serve to support the practice of teachers, such as those surveyed by McCammon et al. (2010), who responded that they believed it was important to assess student creativity, but to a lesser extent

that they knew how to assess it. Criteria might also be of benefit to those teachers who currently favour holistic creativity assessment (e.g., Antonenko & Thompson, 2011) or avoid creativity assessment altogether (e.g., Myhill & Wilson, 2013; Leong & Qui, 2013; Gardiner, 2017); access to clearly defined criteria could help teachers develop the confidence they need to meaningfully assess and thereby support students' creative work.

The need for assessment criteria to support teachers in their work nurturing students' creativity has not gone unnoticed. Eight studies amongst those reviewed here focused on frameworks to support and assess creativity. Five of these studies were conducted in order to develop frameworks (e.g., Pelczer & Rodriguez, 2011; Tan *et al.*, 2014; Wang *et al.*, 2014; Nielsen, 2015; Worsley & Blikstein, 2016) while three of the studies (Lindström, 2006; Ellis & Lawrence, 2009; Lucas, 2016) tested frameworks in school contexts, with findings identifying their effectiveness, and further emphasising the value of clearly articulated conceptions of creativity (i.e., through frameworks or assessment criteria) to support meaningful and useful assessment of creativity in K-12 classroom contexts.

The value of self-assessment. Another consistently emerging theme in the literature was the value of self-assessment in supporting student creativity. Findings of 10 of the studies indicated the significance of reflection and self-reflection (strategies for self-assessment). As a core assessment for learning strategy, self-assessment encourages students to use criteria to reflect on their own work as well as the work process (Black & Wiliam, 2006). As a result, self-assessment has potential to promote both creative products and processes. Clements (1991) found that students using a model to stimulate reflection on their problem-solving strategies in a computer programming environment scored significantly higher on figural and verbal creativity than the control group. In a more recent corresponding study, Eow *et al.* (2010) found that, compared to the control group, facilitated self-reflection with students who designed computer games fostered their creative perceptions. Doron (2017) found that encouraging students to reflect on and experience various perspectives when re-inventing scenes from a popular cartoon enhanced their divergent thinking skills. Kim *et al.* (2016) examined an intervention in which students used visual thinking via tablet technology to reflect on their understanding of English language curriculum content through drawings; the treatment group subsequently scored significantly higher than the control group on the Torrance Tests of Creative Thinking-Figural form.

Analysis of the studies reviewed suggests also that technology can support student self-assessment, that in turn supports creativity. Ho *et al.* (2017) identified that students learning painting skills with a tablet benefitted from the reflection-support the technology provided and so demonstrated greater originality in their artwork. Similarly, Davidson (1990) identified that students composing music with computer software benefitted from being able to critically appraise their work (i.e., self-assess), while Chien (2017) identified that students designed more sophisticated and novel racing cars when they were able to access a 3D printer and modeling software that enabled them to assess and revise their products. Liu *et al.* (2016) found peer feedback inspired students to engage in sophisticated reflection on creative work (story-writing).

The reviewed studies additionally indicated that peer assessment can elicit self-assessment, that in turn supports student creativity. Hwang et al. (2014) identified that assessing peers' creative work (computer game development) provoked students to reflect on, assess and improve their own creative products. Wang and Murota (2016) similarly identified that students in a technical education context refined creative ideas through discussion with peers, i.e., the discussion facilitated their ability to self-assess and enhance their own ideas.

Taken together, these studies suggest that self-assessment is key to enhancing student creativity. It is worth recognising, however, that across these studies teachers were very much involved in supporting the students' use of the various reflection and self-assessment techniques described, for example by actively guiding students through creative processes (Clements, 1991; Eow et al., 2010), leading students in reflection exercises (Kim et al., 2016; Doron, 2017), introducing teacher and peer assessment feedback as a means to guide and inform students' reflection (Kim et al., 2016; Wang & Murota, 2016), providing assessment rubrics (criteria) to focus peer assessment, that in turn provoked self-assessment (Hwang et al., 2014; Liu et al., 2016), and providing access to technology that enabled experimentation and assessment of multiple possibilities before refining a final creative product (Davidson, 1990; Kim et al., 2016; Chien, 2017; Ho et al., 2017). These reviewed studies indicate teachers play an essential role in guiding and supporting students' self-assessment of their creative work.

Implications for policy, practice, and research

As educational systems across the world continue to endorse creativity as a core learning aim for students (Craft, 2010; Shaheen, 2010; Fullan & Langworthy, 2014), while simultaneously calling for greater levels of assessment and accountability, policies and practices that bridge assessment and creativity in schools are needed (Lucas et al., 2013). The findings of this scoping review study suggest there is value in employing assessment as a learning tool for students' creativity, despite the long-standing counter-argument that assessment only deters creativity. In fact, certain forms of assessment appear to support formative development of creativity and enable effective summative judgements. In particular, within this review, assessment strategies that include (a) explicitly establishing and defining criteria for creativity and creative processes, behaviours, and products; and (b) engaging students in supported and particularly teacher-supported self-assessment emerged as positive supports for creativity in classrooms. Both of these assessment strategies were foundational principles of the Assessment Reform Group's (2002) initial articulation of assessment for learning, and continue to be dominant features of a student-centered assessment system (Black & Wiliam, 2006; Earl, 2013).

Accordingly, educational policies and practices that seek to promote creativity should consider the use of explicit learning and creativity criteria throughout the teaching, assessment, and learning process, and the active engagement of students in self-assessment opportunities. Coupling assessment policies directly with curricular policies which are focused on creativity is a key step in supporting practice. Specifically, it is valuable to describe how curricular content (across disciplines) supports

creative development (processes, behaviours, and products) in students and how assessment for learning strategies integrate with curriculum and instruction to facilitate this learning. Importantly, policies need to consider the linkage between formative assessments and summative assessments in supporting and reporting on student creativity. Given the two key findings garnered from this study, there is evidence to highlight the seamless flow of criteria from formative to summative uses within the assessment process and the active engagement of students in assessment as they work towards summative products. Making the connection between assessment and creativity explicit in policies will inevitably support classroom practice.

A central outcome of this study was the identification of variable findings across the extant literature, and a clear call for additional research focused on assessment in classroom settings as teachers work to support students' creativity. The majority of studies examined in this scoping review focused on one specific assessment tool or protocol rather than a system of classroom assessment or a suite of assessment approaches. Future research in this area should move beyond a tool-oriented view of assessment (i.e., how one assessment tool or strategy works) toward understanding assessment as an integrated process with instruction leading to summative judgments (Black & Wiliam, 2006). Reconsidering how teachers leverage a variety of assessment approaches to spur creativity in students is the next step for research. Pursuing this line of scholarship through classroom-based studies, with teachers and students, is key.

In alignment with the previous suggestion for future research, there is also a need to continue exploring the ways teachers and system administrators are interpreting and negotiating the challenges of integrating assessment and creativity in classrooms. Learning from exemplary educators, who are finding innovative strategies to fit these pieces together, will seed developments in classroom assessment and instruction.

Finally, a third area for scholarship is to look at the longer-term influence of integrated assessment strategies on students' sustained creativity. Given the value of self-assessment in promoting creativity, there is reason to believe that employing self-assessment will support students' metacognitive development and enhance their self-regulation skills (i.e., they will become better learners long-term) (Earl, 2013). Examining the effects of coupling self-assessment learning strategies with creativity development might prove useful in determining the ways classroom assessment augments the creative process and contributes to sustained creative activity.

Limitations of the review process

In conducting scoping reviews, it is necessary to establish parameters to delimit reviewed literature (Arksey & O'Malley, 2005). We established a set of parameters to narrow our initial 2389 retrieved articles to 51 focused articles. Hence, results reflect only research that fits within our established parameters: English-language articles that (a) reported the collection and analysis of quantitative or qualitative data, (b) addressed K-12 classroom or extra-curricular contexts, and (c) addressed the formative and summative assessment of creativity for pedagogical intent. In sum, our findings reflect the review of a narrowly focused body of research, which points to a fairly limited research base addressing the intersection of classroom assessment and creativity.

An additional important limitation to recognise is that the studies reviewed were conducted using various methodologies, instruments, and across contexts. Many of the reviewed studies, for example, employed self-reported measures, which can be significantly influenced by personal biases. Furthermore, not all quantitative studies reported reliability indices for the various creativity scales employed, nor explicitly discussed validity. Of those that did, there was a fair amount of variability in reliability co-efficient. This limitation points to broader issues facing measurement and assessment within the field of creativity: the lack of highly reliable scales for teacher use across contexts and limited discussions on the validity of assessments in relation to various definitions of creativity. Recognising the variation and limitations of research methods, scales, and contexts across the reviewed studies, we elected to conduct a descriptive analysis of the relationships and patterns we identified amongst their findings. This process should not be misinterpreted for a meta-analysis or quantitative synthesis of the studies reviewed.

Conclusion

It is evident from this review that despite systemic trends towards the teaching and learning of creativity and increasing levels of assessment in schools, research and policies related to the assessment of creativity or the uses of assessment to support creativity are still emerging. This study points to two consistently emerging findings that provide a useful foundation for future assessment policy, practice, and research to promote creativity, while recognising that there is still significant opportunity to generate a robust conceptual and empirical basis for the relationship between creativity and assessment in K-12 education contexts. Given that assessment strategies have been documented to promote learning across other domains (Marshall & Drummond, 2006; Hume & Coll, 2009; MacPhail & Halbert, 2010), exploring their unique application to creative processes, behaviours, and student work remains promising ground.

Author contribution statement

Benjamin Bolden and Christopher DeLuca designed the project. Tiina Kukkonen managed the electronic article searches and oversaw the data analysis. Suparna Roy and Judy Wearing analysed and categorised the data. Benjamin Bolden wrote the manuscript with contributions from Christopher DeLuca, Tiina Kukkonen, Suparna Roy, and Judy Wearing.

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Data availability statement

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Ethical guidelines

As this article reports a scoping review study, no participants were involved and an ethical review was not required.

Conflict of interest statement

The authors report no conflict of interest.

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