Chapter 5
Designing for Creativity in Interdisciplinary Learning Experiences

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Abstract In theory, a quality education involves multiple facets, including but not limited to content knowledge and twenty-first century skill development such as creativity. Applications for creative projects in classrooms take many forms, from solar system dioramas in elementary science to poetry writing in secondary language arts. However, the emphasis on creativity and its development typically falls to art teachers and art education programs. The emergence of makerspaces and other approaches to project-based learning and problem-based learning, learning environments serve as examples of practical applications for creative, interdisciplinary learning experiences. Exploring ways in which educators design, develop, and implement creativity-based learning experiences and promote innovative design reveals recommended practices and suggestions for both classroom assessment and research to evaluate adoption and outcomes.

1 Creativity and 21st Century Skills

General interest in and perceptions of creativity in formal education settings are increasing (Henriksen, Mishra, & Mehta, 2015). The reasons behind this renewed interest in creativity vary. However, global companies, such as Google and Apple, champion the need for fostering creativity skills by upholding examples of how creative individuals possess the power to innovatively solve problems and propose solutions (Henriksen et al., 2015). The result is a comingling of *innovation* and *creativity* as desirable components in a quality education. Regardless of framework or exclusive definition to define 21st century skills (see Partnership for 21st Century Skills, 2011) for one of the most commonly referenced inventories, creativity consistently ranks among those recognized as essential. From Steve Jobs, co-founder of Apple Inc. to Nikola Tesla, famed inventor of alternating current (AC) electricity supply system, individuals who possess the ability to think and work creatively,

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Table 5.1 Scenario of two students attempting to solve a math problem, adapted from Kaufman et al. (2016)

Student	A	B
Process	• Memorized the process • Replicated the steps • Provides correct answer • Cannot explain why	• Experience running a lemonade stand • Unconventional approach • Provides correct answer • Can explain how she reached it

brainstorm, use failure as a motivator, and act on ideas to create something new and useful are seen as role models. Kaufman, Beghetto, and Dilley (2016) eloquently described the underlying motive to creativity education, also depicted in Table 5.1:

> Consider two students who are asked to solve a math problem. One student simply memorized and reproduced the procedure demonstrated by the teacher to solve this type of problem. The student can produce correct answers, but doesn't really understand why. Another student had a new and personally meaningful insight about how to solve such problems based on her prior experiences running a lemonade stand. She too can produce correct answers. Her approach is a bit unconventional, but she has a clear understanding of why her method works. Although both students receive the same grade on their assignment, student two likely has a deeper understanding of this type of problem. (pp. 141–142)

The scenario itself describes how two students may approach problem solving, but consider for a moment the role of the teacher in these scenarios. How might the teacher adapt to work with both students? Bolden, Harries, and Newton (2010) noted a global call for teachers to better foster creativity in students in their work examining preservice teacher conceptions of creativity. Similarly, Eckhoff (2011) found that preservice teachers value creativity but are uncertain about how to define creativity education or how to implement it in the classroom. Generally speaking, the preparation for teachers to incorporate creativity education through either preservice teacher education or inservice teacher professional development varies widely from individual assignments within a course or workshop to entire sequences of courses (Bolden et al., 2010; Eckhoff, 2011; Lee & Kemple, 2014).

Without commonly accepted approaches to creativity education, educators will continue to struggle with striking a balance between content knowledge and essential skills when designing instructional strategies. Further, this struggle will continue to overshadow efforts like those demonstrated by Student B, rewarding achievement over proficiency.

Unfortunately, educators and administrators often view creativity as an important skill while simultaneously ignoring ways to foster and incorporate creativity into learning (Aljughaiman & Mowrer-Reynolds, 2005; Beghetto & Plucker, 2006). For example, creativity's role in the classroom has been overshadowed most recently by an emphasis on assessing math and science skills (Halverson, Lowenhaupt, & Kalaitzidis, 2015). The pressure on teachers to implement standardized curricula and/or prepare students for standardized assessments that do not address or foster creativity creates a short-sided dilemma. Yet, this dilemma sits in direct contrast to more than 60 years of research promoting the key role between creativity and learner success (Kaufman et al., 2016). Missing or overlooked from the conversation is the idea of designing and implementing interdisciplinary learning experiences that take advantage of current and emerging technologies to accomplish educational goals. Teachers can make strides toward solving this dilemma by situating creativity within the context of activities that draw from across disciplines and paying equal attention to both content and skills.

1.1 Solving the Dilemma

Approaches to fostering and assessing creativity in twenty-first century learning vary according to context. Developing creativity most often remains irrevocably intertwined with the arts (Deschryver & Yadav, 2015). Yet, continuing to relegate creativity to the arts and music curriculum represents the very heart of the issue, concurrent concern, and neglect. We cannot claim to view creativity as an important skill, on par with media or digital literacy, if we do not empower teachers in all subjects and grades to develop the skill. This lack of prioritization also represents a threat to future development of 21st century skills. Indeed, Kaufman et al. (2016) argued that interest in creativity will wane if we do not develop approaches that foster creativity. How then do we overcome the conflict, solve the dilemma, and give creativity a legitimate place in education?

The answers to these questions lie in drawing upon existing research and recommended practice related to interdisciplinary learning and assessment strategies. Creativity cannot be developed in isolation from other perspectives (Deschryver & Yadav, 2015). In the art classroom, learning strategies and activities incorporate both content skills and creativity skills blended together as teachers help learners grasp and practice both areas. Consider an introductory lesson on color theory where the instructor might use finger paints or even a mobile app that simulates real paint to help learners identify primary colors and begin blending the paints together to create secondary colors. The next step in the lesson might ask learners to paint an animal or scene. It is this latter action that incorporates creativity into the activity, requiring learners to imagine what he or she wants to draw and elaborating on that imaginary thought as the drawing takes shape on paper. To conclude the activity, the teacher might ask students to explain why particular colors were used, the animal or scene depicted, or a story that accompanies the picture. This scenario illustrates the recommendation that creativity should be taught and fostered within content-situated contexts (Mishra & Deep-Play Research Group, 2012). For successful development, both creativity and content deserve equal consideration (Rotherham & Willingham, 2009). Thus, any recommendations for teachers and administrators who truly want to give creativity an equal position in the classroom must work toward integrative strategies. However, the dilemma does not end with instructional integration. Assessment and evaluation methods must also evolve to encompass creativity. The key challenge lies in effectively evaluating creativity within the context of classroom assessment (Henriksen et al., 2015). In the previously mentioned scenario, teachers will most likely grade learners based on how well they applied color theory to the drawing and not apply any formal assessment criterion to the creative output from the learner. Teachers all too often placate children who exhibit creativity in the classroom offering simple praise rather than critical evaluation (Sefton-Green & Sinker, 2000). Rather than assess the creative artifact, it might be displayed in the classroom or taken home to share with family members. The learner's grade in class reflects how well he or she achieved the stated content goals for the instruction. Through their work to better integrate creativity skill development in learning Mishra, Henriksen, and the Deep-Play Research Group (2013) recognized the value in the creative process and recommended that teachers focus on better measurement of the end product. Until we update assessment measurement to more effectively evaluate creative skill development in conjunction with content knowledge, the dilemma will remain unsolved.

The following sections represent a review of the literature to establish guidelines and practices related to developing, assessing, and evaluating creative learning experiences in K12 settings. The rise in project-based (PjBL) and problem-based learning (PbBL), growing popularity of makerspaces, and emphasis on interdisciplinary efforts all afford opportunities to infuse creativity equally in consideration with content. Additionally, continuing research on creativity provides insight into better methods of assessment along with opportunities into scholarly exploration related to both creativity skill development and assessment. Resulting recommendations serve to inform and support practitioners and researchers in the fields of curriculum and instruction, instructional design, and instructional technology as organizations seek guidance and direction with respect to emerging and evolving trends.

2 Creative Learning Experiences

When considering how to approach the design of creative learning experiences, teachers should create a culture of creative thinking from the very first meeting, setting aside traditional activities for those that encourage self-guided exploration and design (Deschryver & Yadav, 2015). The question then becomes how to design and encourage self-guided exploration and structure learning activities to support creative thinking and content knowledge. One strategy involves drawing upon cognitive-creative skills that bisect disciplinary boundaries and provide the necessary context for divergent thinking (Mishra & Deep-Play Research Group, 2012). Cognitive-creative skills include emotional connections, visual representations, and critical thinking patterns (Root-Bernstein & Root-Bernstein, 1999) that assist the learner as he or she engages in the creative process, transforming content, and instruction into a creative product. In addition to engaging in the creative process, technology should be embedded seamlessly in the design with teachers helping learners determine when and when not to use particular technological tools (Halverson et al., 2015). For example, in the STEAM activity described below, the teacher worked with students to determine what technological tools should be used for information gathering purposes and depending upon the specific activity, other digital tools for creating media, such as a video to showcase the results of an activity. The popularity of digital devices contributes to the shift of consuming media to producing media (Deschryver & Yadav, 2015). Thus, activities might also capitalize on digital and media literacy skill development.

Makerspaces and PbBL, as discussed in detail below, represent a specific type of approach to incorporating creativity education in coordination with content that are different from general interdisciplinary approaches. For the purpose of this discussion, makerspaces and PbBL possess inherently interdisciplinary features through the nature of identifying problems and solutions, following the guidelines of a project, and/or engaging in a making activity that requires self-driven investigations. Moreover, not all interdisciplinary approaches occur in or possess the same qualities as makerspaces or PbBL activities. The possibility of an interdisciplinary approach taking a project format serves as the reasoning to differentiate between the two types of PBL strategies, and the two subtopics, makerspace/PbBL and interdisciplinary/PjBL, are addressed separately.

2.1 Makerspaces and Problem-Based Learning

Makerspaces have been defined as facilities that provide the necessary materials and equipment for users to "conceive, create, collaborate, and learn through making" (U.S. Department of Education [USDOE], 2016, *About the challenge*). While not a necessarily new concept, the experienced educator likely recognizes aspects of traditional career and technical education (CTE) programs, the spirit of the *maker movement* embraces open, social, and collaborative learning environments. What makes makerspaces a trending topic is the intersection of constructivism, constructionism, collaborative learning, and PbBL in conjunction with entrepreneurial and innovator interest (Lahart, 2009). The PbBL connection arises in relationship to the inherent situation in an authentic context that challenges learners to solve problems within a specific context (Friesen, 2013). Given the increasing interest of both makerspaces and PbBL, it then follows that teachers and administrators might struggle with how to adopt or adapt the idea in their own schools and classrooms. The emphasis on learning in a makerspace and role of the traditional teacher shifts from that of a traditional learning environment. Rather than instruct or take the lead in learning, adults work jointly with learners to collectively explore and create as the learners guide inquiry and the teacher provides intervention as necessary for skill acquisition (Chávez & Soep, 2005). By extension, the role of the student shifts to be more self-sufficient with reliance on intrinsic motivation to seek out and address gaps in personal knowledge and skill through personal inquiry. While possessing the potential to foster creativity skill development, activities conducted in a makerspace or as part of a PbBL activity are not inherently creative in and of themselves. Table 5.2 below summarizes the characteristics of PjBL and PbBL to help visualize how their concepts are similar and different.

Table 5.2 Project-based learning (PjBL) and problem-based learning (PbBL) characteristics, adapted from Buck Institute for Education (2015) and Larmer (2015)

Characteristic	PjBL	PbBL
Driving question, problem, or challenge	●	●
Sustained inquiry	●	●
Student independence	●	●
Feedback and revision	●	●
Authentic presentation	●	●
Requires 21st century skills	●	●
Interdisciplinary	●	◐
Emphasizes end product	●	
Emphasizes process		●
Prescribed steps		●
Typical classroom duration	Longer	Shorter

For a practical view, consider the following scenario. Students in an elementary science classroom are tasked with solving the problem of how to provide water to a new hydroponic garden in the school. A quick internet search might reveal hydroponic kits for purchase. Simply buying and implementing the kit does not engage the learners in creativity skill development. Alternatively, the students might discover an open-source lesson that instructs them on 3D-printed files to download and print along with a list of supplementary materials to purchase and assembly instructions. This option does require students to engage in some creativity skill development as they elaborate on the materials to customize the solution for their school. A more intensive approach would require the students to design the system from scratch using 3D modeling software and other materials, providing opportunities for students to develop both content knowledge and creativity skills. In the case of this latter example, students would be challenged to brainstorm, draft, develop, test, and redesign within a specific context, thereby practicing creativity skills and processes. Another potential makerspace/PbBL activity for the classroom includes posing a cultural and environmental problem to solve. The Kenya Weaving Project (Homestead Weaving Studio, 2013) highlights the far-reaching implications of PbBL and creativity. James Nampushi, a Maasai tribal member from southwestern Kenya, sought to identify solutions to rampant pollution from plastic bags and a shifting tribal society. Through researching ways to recycle or reuse the bags, communicating with community leaders, and contacting a weaver in Indiana, James learned how to weave and devised a plan that would eventually launch a sustainable business for his tribe. This plan involved learning how to collect and process old plastic bags for cleaning, using large wooden-framed looms to weave the bags into trays and baskets, and sell the woven items to local hospitality businesses to use in hotels and parks. Learners in makerspace or PBL activities who are given real-world challenges to solve must work through the creative process while applying content skills simultaneously.

2.2 Interdisciplinary Opportunities

Much like the makerspace and PbBL approach, classroom activities that cross discipline-specific boundaries also hold creativity opportunities. However, the practice of including creativity in the interdisciplinary approach does not often occur. All too often, mathematics and science lessons and activities fail to provide creative opportunities, and arts are increasingly allotted less time (Berry, R. Q. et al., 2010; Tillman, An, & Boren, 2015). The solution to this assumed dichotomy is to encourage the movement of creativity development into other contexts, as previously discussed. While not the only interdisciplinary approach, the science, technology, engineering, arts, and mathematics (STEAM) framework poses the unique context for applying both emphasized content in conjunction with 21st century skills, such as creativity, problem solving, and critical thinking (Tillman et al., 2015). In this example, the explicit inclusion of art within STEM activities assumes that students will be required to engage in producing something both original and worthwhile as related to the interdisciplinary context. The emphasis on producing sits in contrast to traditional STEM activities such as conducting a scripted chemistry experiment and writing an explanatory laboratory report. The following STEAM activity, depicted in Fig. 5.1, can be found at STEAM Education (2014), a blog dedicated to showcasing STEAM lessons. The teacher, Sarah Weaver, worked with fifth graders on a STEAM lesson that would help students understand the impact of plastic on the environment (S), use the internet and digital literacy skills to research and decide on a topic (T), require students to design and build something (E), teach students about

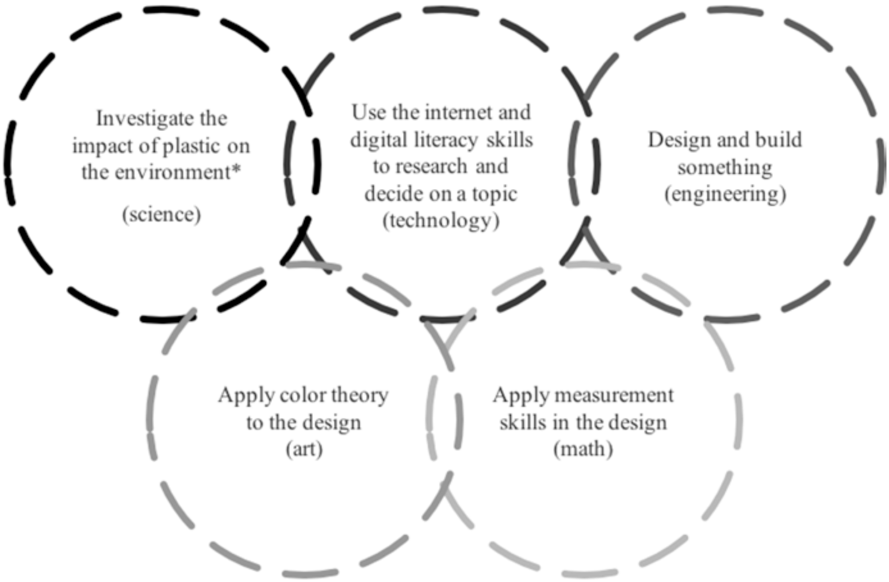

Fig. 5.1 STEAM lesson example

color theory (A), and provide an opportunity to practice applying measurement skills (M). The students ultimately decided to collect and paint bottle caps to create an artistic representation of a whale in the ocean at sunset. In contrast to the makerspace/PbBL approach, the STEAM framework did not necessarily require learners to acquire a new skill nor did the learners have to solve a problem. The STEAM lesson often takes the shape of PjBL and certainly fulfills the requirement of blending creativity skill development along with content.

3 Assessment

The deep connection between makerspaces and informal learning poses a challenge to schools attempting to blend this approach with formal learning. A secondary dilemma exists wherein educators and education leaders express a need to develop and assess 21st century skills like creativity and struggle to identify appropriate mechanisms (Deschryver & Yadav, 2015). Evaluating creativity and creative works happens innately as we observe and interact with the world around us, but creativity assessment in the classroom must move beyond the subjective (Mishra et al., 2013). Yet, evaluating creativity in the classroom eludes most common assessments. Generally speaking, the Torrence Tests of Creative Thinking (TTCT) are by far the most commonly used assessment of creativity (Plucker & Makel, 2010). However, these types of research measurements provide little practical use for classroom teachers (Kaufman et al., 2016). The purpose of the TTCT is to identify students who exhibit creative or gifted skills. When it comes to evaluating the creative process or products, Henriksen et al. (2015) noted that educators often view assessing creativity as subjective, lacking both definition and measurement techniques due to often open-ended structures with unpredictable outcomes. When evaluating a creative artifact, the teacher may be drawn to purely aesthetic qualities that are indeed personal and subjective. Thus he or she must look for other guidance for evaluation. Another challenge of creativity assessment rests in balanced feedback, between harsh and gentle, to learners and must not stifle growth and perseverance nor ignore practical standards (Beghetto & Kaufman, 2007; Kaufman et al., 2016). "Empty praise cheats students from receiving the kind of demanding feedback necessary for creative growth" (Kaufman et al., 2016, p. 146). Even the assessment guide from the Partnership for 21st Century Skills (2009) falls short in this endeavor by leaving out rubrics for assessing each of the identified skills.

To better address this lack of creative product assessment, Mishra et al. (2013) proposed three dimensions by which to measure creativity; novel, effective, and whole (NEW). Per the researchers, a novel creative product possesses unusual, radical, or influential characteristics. Similarly, effectiveness measures consider the product's value, usefulness, and appropriateness. Lastly, the product's organization, meaning, and aesthetic features contribute to evaluating the wholeness. In other words, is the product something new or different, is it comprised of unique characteristics from similar products, and is it complete and useful? The researchers have

Table 5.3 NEW rubric for classroom implementation, adapted from Henriksen et al. (2015)

Criteria	1	2	3	4	5
Novel	Completely lacking any form of unique characteristic and/or lacking content	Most components are standard or conventional with some uniqueness	Average product with a balance between conventional and novel characteristics	Mostly unique, but some conventional components	Strong qualities of novel characteristics
Effective	Confusing, limited, and/ or or ineffective in design or application	Design or application is mostly confusing or somewhat limited with some elements of effectiveness	Interesting design with some confusing or limitations in application	Thoughtful design with little confusion or limitations in application	Excellent application with no confusion or limitations
Whole	Little or no consideration to aesthetics or design practice and incomplete	Some aesthetic appeal, but lacking cohesion or design practice consideration or incomplete	Conventional or standard aesthetic appeal, complete, and obvious consideration to design practice	Some aesthetic appeal with some conventional or standard design and complete	Exceptional aesthetic appeal with rich sensory interest and complete

developed and tested a Likert-like rubric for each of the three dimensions, on a scale from 1 to 5 (Henriksen et al., 2015) that teachers may find useful when assessing creative products. Table 5.3 summarizes the NEW framework and how it might be used as a classroom rubric.

Examining this rubric and individual criterion closer, some educators may be able to understand and apply the concepts of effective and whole with relative ease. For example, assessing the artifacts from the aforementioned STEAM lesson would involve evaluating if the bottle cap artwork clearly depicts the intended scene, a whale a sunset, or if the representations could be confused with other creatures or contexts. Similarly, the teacher or other evaluators would be able to assess the artwork for completion; are any bottle caps unpainted, are any scenes of the artwork unfinished/unpainted, etc. In conjunction with the *whole* evaluation, the teacher can also assess aesthetic appeal based upon relevant parameters from the assignment; i.e., "does the final artwork follow color theory in applying complementary colors?" However, teachers may find more of a challenge in defining or capturing the *novel* criterion. The goal of the NEW framework is to reduce the likelihood of subjective evaluation, but unintended subjectivity may arise in this particular element simply due to the evaluator's experiences or lack thereof. In continuing the previous example, consider if the artwork had a visual quality similar to that of Robert Wyland, a famous American painter of whales. If the teacher is familiar with Wyland's work, he or she may score the artifact at a 3 or 4 in terms of novel creative output whereas a teacher unfamiliar with the artist may score the artifact at a 5. Keep in mind, however, that as work continues to develop in the area of assessing creative output, how researchers and practitioners define *novel* now may change over time.

Also warranting discussion, the Buck Institute for Education (BIE, n.d.) provides a number of rubrics related to creativity, collaboration, and critical thinking, but there are issues across the resources. The rubrics are grouped into grades K-2, 3–5, and 6–12 with options to view the latter two rubrics as either aligned or unaligned with the U.S. Common Core State Standards. Unfortunately, the rubrics distinguish between "below standard," "approaching standard," "at standard," and "above standard," and only provide specific guidelines for the first three categories. This incomplete approach to rubric implementation contributes to the subjective potential of evaluation previously noted. Additionally, the divided rubrics are only in name as the content is identical, including references to standards, and there is no information provided to help the instructor gauge how the rubrics were assembled. Interesting to note, however, the BIE rubrics include both the creative process and the creative artifact. There are four categories presented by BIE related to the creative process:

1. Launching the project (define the creative challenge)
2. Building knowledge, understanding, and skills (identify sources of information)
3. Developing and revising ideas and products (generate and select ideas)
4. Presenting products and answers to driving question (present work to users/target audience)

On one hand, BIE distinguishes between what could be assumed to be hierarchical skill development between the 3–5 and 6–12 rubrics by having slightly different criterion descriptions. However, the artistic instructor attempting to use such rubrics may find that the process criterion lean too far away from their traditional processes. See Table 5.4 for a comparison example. There is also a question of why the institute chose to write the K-2 and 3–5 rubrics from the viewpoint of a first-person self-assessment. Perhaps the intent was to transition into a more formal, business-like approach once the student reaches grade 6. However, in the absence of detail or justification, the question remains. Another question to consider rests in the wording of descriptions. What constitutes an "unusual way" of finding information, as noted in in the "at standard" description for "Building knowledge, understanding, and skills"?

Lastly, the product or artifact criteria and corresponding levels included in the BIE rubrics bear a striking resemblance to the NEW rubric discussed previously. Originality relates to novel, value relates to effective, and style relates to whole. The presence of these three similarly themed criteria provides insight into the direction of creativity assessment and how to capture the end product.

While research on the NEW framework is clearly under development and emerging, educators implementing rubrics (see Henriksen et al., 2015, pp. 476–478) might

Table 5.4 BIE rubric comparison for Building knowledge, understanding, and skills

Rubric level	3–5	6–12
Below standard	• I use only the usual sources of information (website, book, article)	• uses only typical sources of information (website, book, article) • does not offer new ideas during discussions
Approaching standard	• I find one or two sources of information that are unusual	• finds one or two sources of information that are not typical • offers new ideas during discussions, but stays within narrow perspectives
At standard	• I find unusual ways to get information	• in addition to typical sources, finds unusual ways or places to get information (adult expert, community member, business or organization, literature) • promotes divergent and creative perspectives during discussions

consider contacting the researchers continue the process of evaluating creative product measurement techniques. In particular, using the NEW rubric, or any other, to assess creative outputs from students might benefit from having multiple evaluators rather than just one, as is traditional in the classroom. Arguably, a single evaluation still leaves room for subjective evaluation arguments, and this is a weakness of the approach lacking further research-based applications. Teachers or administrators who seek to implement any of the suggested activities described earlier could also consider implementing the creativity rubric(s) alongside content evaluation rubrics to complete the classroom assessment process.

Maker activities, which often manifest as PjBL and PbBL, draw upon the strengths of informal and constructivism/constructionism. Thus, the assessments we use to evaluate the learning that occurs in this context cannot rely on standardized testing or traditional forms of assessment for formal learning. As maker education continues to grow in popularity in schools, these rubrics represent ways in which teachers can provide objective assessment of artifacts and the processes in which students engage.

4 Discussion

Despite the growing interest in creativity skill development, teachers struggle to effectively design classroom learning activities to foster this essential twenty-first century skill in conjunction with content instruction and assessment. The reasons for this struggle include a continued segregation of creativity from other disciplines as well as challenges with assessment. Many teachers continue to view creativity as solely artistic or aesthetic in nature (Deschryver & Yadav, 2015; Diakidoy & Phtiaka, 2002). However, creativity is as essential in science and math as it is in art or music (Caper, 1996; Root-Bernstein, 1996; Root-Bernstein & Root-Bernstein, 1999). Creative learning experiences through makerspaces, PbBl, and PjBL provide opportunities for teachers to challenge traditional roles in the classroom while fostering content knowledge and other twenty-first century learning skills like creativity and media literacy. Any preservice teacher currently in studies or inservice teachers with access to professional development might consider looking at some of the international, national, and regional or local design and/or science competitions, such as the Intel International Science and Engineering Fair. Similarly, teachers interested in learning more about maker education can look to organizations like the Nation of Makers, based in the United States, or Make Magazine, the host organization for the worldwide maker faires. Teachers who challenge students with activities like solving a local pollution problem or researching effects of a material on an ecosystem may find assessing creativity challenging, but work such as the NEW framework from Mishra et al. (2013) provides easy-to-implement guidance with a ready-made rubric. While the NEW framework addresses how to assess creative output, more research must be conducted to also identify ways to assess the creative process, perhaps drawing upon the criteria included by the Buck Institute. Any research going forward should critically evaluate, and challenge, existing and proposed rubrics, taking into consideration local/federal reporting requirements, subject area, and grade level. Additionally, case studies and action research methodologies may also help researchers better understand the effectiveness of makerspace, PBL, and other interdisciplinary approaches to blending content and skill development.

The implications of emerging research and practice related to creativity skill development play out in formal classrooms and the more than 700 makerspaces worldwide (see http://makerspace.com/ and http://hackerspaces.org). Federal U.S. initiatives such as the CTE Makeover Challenge from the USDOE (2016) or even China's executive meetings and policy changes to expand entrepreneurship and innovation (The State Council The People's Republic of China, 2015) illustrate the high-level emphasis for developing essential technical and twenty-first century learning skills. As other initiatives develop or as local educational organizations make the contentious decision to equally develop knowledge and skill in the classroom, suggestions for classroom instructional design, technology considerations, and assessment must be informed by the works presented here and those that continue to develop. Scholars researching in the areas of curriculum and instruction, instructional design, and instructional technology will continue to build off of these works, extending recommendations for practice and research into the twenty-second century and beyond.

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