Chapter 16
Creativity and the Urban Teacher: A STEM-Related Professional Development Program

Akesha Horton, Danah Henriksen, Punya Mishra, Christopher Seals, Kyle Shack, and Candace Marcotte

Abstract We examine the urban context of learning for the fellows in a partnership between Michigan State University (MSU) and Wipro Limited, a leading global information technology, consulting and business services company, which resulted in the Wipro Urban STEM Fellowship Program at Michigan State University (MSUrbanSTEM) program. This grant-funded fellowship provided full tuition scholarships and stipends for 124 highly motivated teachers in Chicago Public Schools (CPS) who demonstrated a passion for teaching STEM. The fellows were divided up into three cohorts. Each cohort participated in an innovative yearlong integrated learning experience to build STEM teachers' capacity to lead and inspire transformative, innovative practices in urban K-12 schools. In this chapter, the fellows' instructors explore how to support these teacher participants in their efforts to foster creativity in an era of intensified authority, control, and resistance. By engaging in creative pedagogies explicitly connected to disciplinary knowledge, the program aims to disrupt traditional ideologies around teaching. The mission of the MSUrbanSTEM program is to empower K-12 math and science teachers in CPS to create transformative, innovative, and multimodal instructional experiences through project-based and experiential learning experiences. Each educator participant was encouraged to engage in inquiry around how the ideas of wonder, improvisation, invention, and reflection connected with his or her subject-matter expertise. As reported by way of this case example of teacher creativity, these strategies supported the activities the teachers engaged in throughout the year. The fellowship itself provided a foundation for fellows to develop projects for reshaping aspects of their teaching practice.

A. Horton (✉)
Indiana University, Montgomery, AL, USA
e-mail: akmhorto@iu.edu

D. Henriksen · P. Mishra
Arizona State University, Tempe, AZ, USA

C. Seals · K. Shack · C. Marcotte
University of Illinois at Urbana-Champaign, East Lansing, MI, USA

C. A. Mullen (ed.), *Creativity Under Duress in Education?*, Creativity Theory and Action in Education 3, https://doi.org/10.1007/978-3-319-90272-2_16

16.1 Introduction

Schools and teachers in urban contexts are faced with increasing and varied challenges. These include budget cuts, low teacher retention rates, and the in-school impact of difficult outside of school experiences students and their families face, such as abuse, addiction, health and financial problems (Milner, 2012). Matsko and Hammerness (2013) observe that urban educators are charged with addressing "complicated, interrelated issues … including racial and ethnic heterogeneity, concentrations of poverty, and large, dense bureaucracies" (p. 128). Efforts to support and evaluate urban students in such contexts sometimes reinforce negative practices, such as low teacher expectations and avoidance by teachers and administrators of the intellectual risks that necessary for creativity in teaching and learning. Teaching and learning in urban contexts often focus on lower-order skills, such as memorization and test-preparation, rather than higher-order skills, such as conceptual understanding and creativity (e.g., Ketelhut, Nelson, Clarke, & Dede, 2010). The purpose of our chapter is to consider the importance of integrating higher-order skills like creativity in teacher's pedagogical practice and ways that teacher professional development can better support and nurture creativity.

We examine a case of teacher professional development in a program aimed at inspiring more innovative and creative teaching practices by urban teachers. In the MSU-Wipro Leadership Teaching Fellowship Program, experienced Chicago Public Schools (CPS) teachers were able to develop creative instructional experiences for their students that were transformative, innovative, and multimodal. We describe how these urban teachers engaged in creative practices and project-based and experiential learning experiences while participating in the program, and the manner in which these experiences were informed by the urban context in which they taught. Through this case example of teacher creativity, we look at how teacher professional development can influence urban teachers' practices and perspectives toward greater creativity in both their work and thinking.

16.2 Creativity in Urban Contexts

In times of budget cuts and standardized testing, urban educators face a situation where they are forced to make tough choices about what content to provide to students, as well as how to provide it. With limited time to cover the material, teachers may feel pressure to "teach to the test;" a test with outcomes that may be linked to teacher performance rating. "Creativity is perceived as a luxury in a setting that is trying to combat criticism of inadequate instructional structures as measured by student achievement on standardized tests" (Kaimal, Drescher, Fairbank, Gonzaga, & White, 2014, p. 3). In this challenging environment, teachers and students tend to avoid taking risks or trying new things in teaching and learning that do not have demonstrative connections to testing outcomes.

Henriksen and Mishra (2015) observe that risk-taking behavior has long been considered an integral component for creativity. Such risk-taking is strategic, in that when allowed to do so, teachers inform their teaching with what they know about pedagogy, content, and student learning by seeking out new and effective approaches to instruction and learning. Pegg (2010) explains that while creativity is valued in education, such explorations may not be rewarded in performance-driven environments, especially those heavily burdened with social or economic problems.

16.3 Examining Creativity in the MSUrbanSTEM Program

As authors, we are members of the MSUrbanSTEM instructional and research teams. Some of us were heavily involved in developing the curriculum and activities, supporting the teacher fellows intensively along their yearlong learning journey, offering feedback to them in order to positively push their practice forward while applying the fellows' feedback of the program for instructional and programmatic improvement. Some of our research team's coauthors had more limited interaction with these fellows, but they know the data and their experience at an interpersonal level. We have all served this project for the same reason: to support these teachers leaders in developing creative pedagogies imbued with a positive mindset and that offer meaningful learning experiences for their students. We also supported teachers in addressing administrative challenges that impacted their teaching practice. As follows, we provide context about the MSUrbanSTEM program, then share a brief review of the literature on creativity and teaching, followed by a discussion of the outcomes, data, and learnings derived from this experience.

Regarding context, the goal of the MSUrbanSTEM program was to support 124 K-12 math and science urban educators in CPS over 3 years (2014–2016). The teachers underwent an ongoing professional development experience for the 1-year fellowship period. The teachers were grouped into three cohorts. In the first cohort, there were 25 fellows. In the second cohort, there were 50 fellows and in the third cohort 49 fellows. All fellows completed their work (3 graduate level courses totaling 9 credits) through a hybrid model of online work and intense face-to-face meetings. The educators who applied for and were accepted into the fellowship were educational practitioners in CPS with direct impact on students. Program participants mostly included classroom teachers, with a few discipline-specific coaches and administrators at the building level.

An integral part of supporting these educators involved doing our best to understand the urban context in which they teach, tailoring our design of experiences to this reality. For our fellow participants, this teaching context is the large, densely populated cosmopolitan area of Chicago, a mass school system in the United States that has struggled financially to equitably meet the needs of its diverse populations. In their daily teaching roles, the fellows were charged with teaching students from a wide variety of racial and ethnic backgrounds. Some taught students who were multilingual, while others had students who had not yet learned English as a language. Despite these challenges, the MSUrbanSTEM teachers were interested in enhancing the ways in which they attempt to meet the needs of learners in their classrooms. They also wanted to learn more ways to cultivate a community of practice amongst colleagues to support STEM learning in their schools. These interests motivated them to apply for this program, in turn helping the instructional team design the best way to support these teachers around expanding creative teaching practice within their classrooms and schools.

16.4 Exploring the Creativity and Educational Literature

In the subsections that follow, we discuss educational theory, research and literature that support the importance of focusing on teacher creativity. We consider the gap between what existing creativity research offers, and what hands-on educational practice and teaching need. Further, we consider current scholarship with a more social orientation toward classrooms or a more pragmatic look at what creative teachers do, to consider themes that may be important for creative teaching in urban STEM contexts.

16.4.1 Gap Between Research and Practice in Creativity

Creativity is viewed increasingly as an important twenty-first century skill, receiving attention in the popular media and in educational policy (Bell, Limberg, Jacobson, & Super, 2014). Converting this interest in creativity into actual teaching practice is a different matter altogether, even though there exist current and even powerful examples of this integration. Teaching creatively or instantiating creativity in practice is complicated, partly due to the open-ended nature of the construct and the relative scarcity of practical research in this area (Hargreaves, 1997). Even outside of creativity, the overall disconnect between research and practice is a longstanding concern in education (Levine, 2007). The ivory tower of academia and thus professors' research has long been seen as disconnected from the everyday life of classrooms and teaching (Lovitts, 2001), while practitioners are often criticized for not employing the most effective research-based strategies (Perry, 2016). When it comes to creativity this challenge is significant, because creativity is already perceived as a subjective or vague concept and because practitioners may feel uncertain about how to instantiate it without guidance or clarity. This, of course, raises the question as to how much of the existing research on creativity is directly relevant to, or applicable for, educators.

Despite the wide body of important work done in the field of creativity research—a great deal of it is not grounded in K-12 education contexts or framed in ways that would be practical and thus useful to teachers. This is particularly the case for unique or challenging contexts, such as urban settings.

16.4.2 Research in Creativity

In this section, we briefly review work in the field to consider some alignments and misalignments between creativity research and teaching practice. We also suggest recent work in educational research that may be more directly relevant for teaching and learning considerations. Our attempt is to offer a frame for informing creative teaching practice and for setting the foundation for the teacher professional development work developed in this chapter.

The construct of creativity is an ancient one (Starko, 2013), but formal research on this concept picked up significant interest in the latter half of the twentieth century, sparked by Guilford's (1950) address to the *American Psychological Association* on the subject. Guilford's call to action led to a wide range of research studies, with branches and applications in many directions. Creativity scholarship has touched on (and built upon) research from neuroscience, economics, design, social justice, the arts, and more (Kaufman & Sternberg, 2010). Yet, despite the existence of diversity in creativity research, for much of recent history, the most highly touted academic research has been around the psychological aspects of individual creativity (Runco, 2014). The foundational core of the field stems from a cognitive or psychological perspective, often focused on the self; further, such research is often done through psychometric examination or testing more than application in social and classroom contexts (Plucker & Renzulli, 1999).

Psychological theories of creativity explain different cognitive processes underlying the creative process or aspects of cognitive style that might account for creative thinking (e.g., Cropley, 2000). A key area of creativity study in psychology through the late twentieth century focused on psychometric approaches—individualistic examinations of creative potential within the mind and construction of a battery of tests to measure individual creative potential and performance (Runco & Chand, 1995). Stemming from this, Davis and Gardner (1993) linked creativity with a theory of multiple intelligences, emphasizing the importance of creativity to the domain of education. They proposed that creative individuals have "inborn sensitivities" to specific kinds of information or ways of learning and operating.

To be sure, these dominant discourses in creativity research have been notable for advancing our understanding of individual human creative potential. However, this focus on individual creativity—or internal psychological states, capacities, and skills—is both limiting to, and separate from, the highly social, practical, and hands-on needs of most classroom teachers. There is not always a clear practical connection between common psychometric or psychological approaches in creativity and what teachers do in the classroom. Even beyond the specific creativity tests that dominate psychology, it can be hard for teachers to find much in most creativity research that directly speaks to their practice. Henriksen, Mishra, and Mehta (2015) reported that a review of existing creativity measures indicated that very few measures or instruments were practically applicable to education. Their independent analysis of all existing creativity measures listed in databases that catalogue psychological measures (such as in the PsychTests database or Mental Measurements

Yearbook—both key APA databases for psychological instruments), showed that only 3% of existing creativity measures addressed areas of possible relevance to teaching (and not all of these were relevant to working with children or youth). Many existing measure covered self-report of thinking styles, or individual psychological tests of creative thinking—but very few dealt with the kind of social or developmental needs that teachers and students in classrooms might experience.

Moreover, most educational research on creativity has focused on gifted and talented students, which is somewhat exclusionary and attends only to those seen as special or exceptionally talented. Such measures of creativity, such as the Torrance Test of Creative Thinking, the Guilford Alternative Uses Test, or other common psychometric tests of divergent thinking (i.e., the ability to come up with many divergent ideas) or psychological correlates of creativity, may also suggest researcher blindness to social and cultural factors that may complicate how creativity is defined, instantiated, taught, and measured (Karp, 2017). Focusing on just those students pre-identified as being gifted or talented is problematic. Teachers must work with and develop the opportunities of all students, not merely those with high scores on internal measures of creativity.

Moving beyond this specific focus on talent, we must acknowledge that teachers function/work/create within the social setting of a classroom. Classrooms tie together school culture, personal relationships, interactions among students and teachers, subject matter with the norms, roles, and tools of schooling. Much psychological creativity research has not connected to these realities, and often misses the broader forest for the trees.

In recent years, as social and constructivist theories of learning have emerged more clearly, researchers have aimed to bring creativity into the complex and practical social arena of teaching. For instance, Sawyer (2011a, b) speaks to the collaborative, constructivist, and social dynamics of creative teaching. He suggests that the commonly known values of constructivist and social theories of learning inherently align with good teaching and creative educational practice (Henriksen, Mishra, & the Deep-Play Research Group, 2017). Craft's (e.g., 2003, 2005) work considers practical dilemmas in implementing creativity in the classroom and inherent tensions and possibilities as well. Yet, little research suggests that strategies have been actively sought out for classrooms that respond to the practices of creative teachers who are successful.

Henriksen (2011) and Henriksen and Mishra (2015) have looked at how creativity emerges in effective teaching practice. Their research showed that a key factor in developing a mindset for creativity is in cultivating an openness for the new. The teachers they studied describe creativity not as a process or skill separate from other thought processes, but as a mindset that they actively aim to practice and strengthen in their own minds. This creative mindset revolves around a student-centered focus on problem solving for effective practice, a willingness to try new things, and a belief that creative thinking is accessible to everyone (not merely people deemed "artistic" or "special"). Key themes that arose from this study were real-world teaching and learning, *cross-curricular connections*, and taking intellectual risks—

with an overarching idea that we teach who we are, or that creative teachers integrate aspects of their own interests, personalities and preferences into their practice.

In the examples of creative lessons from each teacher across a range of contexts (Henriksen & Mishra, 2015), a common tendency was to create lessons with a focus on real-world learning. This was instantiated in different ways and with varying subject matter across subjects like math, science, language arts, or general elementary education contexts, but all of the teacher participants tried to root their lessons in a real-world or "authentic" basis or framework. This type of real-life teaching requires that teachers seek connections between the content they teach and activities or links with applications in actual settings.

The teachers in Henriksen and Mishra's (2015) study also focused on cross-curricular connections. In some cases, they gave examples of teaching school subject matter via the medium of the arts or music. They also used a variety of cross-curricular approaches in ways that made sense for their own interests and practice. This may mean, for example, teaching subjects like mathematics using advertising activities, or language arts using an idea from music theory. The goal of blending different areas of curriculum allowed for unique creative hooks or views of learning.

Finally, a key finding from the creativity paradigms of successful teachers is a willingness to take risks, as mentioned. Teaching with and for creativity does *not* denote careless or "risky" teaching, but rather a willingness to think "outside of the box" and take intellectual or teaching risks by trying out new ideas and approaches to lessons and classroom practices. The importance of intellectual risk taking is also a common finding of psychology research, which suggests that to be creative, one must take risks, allowing innovative approaches to emerge (Cropley, 2015).

An organizing idea behind these themes described above was that creative teachers use a variety of avocations and creative pursuits in their lives outside of school, which creatively affects their teaching practices. The idea that we teach who we are as described above, or that aspects of our own selves and lives can and should be woven into our teaching practice and presence with students. This concept can resonate not only in creativity research but also in the varied nature of teaching in practice—whether this involves STEM teaching, urban settings or any of the rewarding but inherently challenging spaces in which teachers find themselves.

16.5 Key Aspects of Our Instructional Strategy

The MSU-Wipro program was launched in summer give the year with an intensive face-to-face, 2-week session. As mentioned, this was followed by a yearlong blended experience (online for the most part with face-to-face whole-day Saturday meetings four times a year) where the teachers applied what they learned from the initial session to their classroom teaching and interactions with colleagues in their schools. STEM educators (N = 124) participated over 3 years. Teacher creativity was supported and enhanced through the teachers' development of their technological pedagogical and content knowledge (TPACK). The goal was to develop technology-rich contexts that allow for the creative interplay of technology, pedagogy, and content. The approach, which we have described elsewhere as deep-play (Koehler et al., 2011), fosters TPACK as well as the creative knowledge and skills needed for re-designing and repurposing technologies, tools, and techniques for effective instruction in contexts (in this case, the urban classroom).

Our model or approach emphasizes contextualized playfulness, creativity, and new ways of seeing at the intersections of content, pedagogy, and technology. Through experiences with new technologies, tools, and techniques, we hope that teachers came to understand that, because many technologies are not designed for classroom settings, they would need to creatively repurpose these to make them useful for pedagogical purposes.

For instance, within the context of learning about scientific misconceptions, the fellows created stop-motion videos that actually *enhanced* the misconceptions, and through that process reveal the fallacy that undergirds the misconception in the minds of learners. Another example is what we have called the Veja du activity. Déjà vu is the process by which something strange or unfamiliar becomes abruptly and surprisingly familiar. Veja du is the opposite. It is the seeing of a familiar situation with "fresh eyes," as if you had never seen it before. For example, our fellows would take pictures and create images of everyday objects in ways intended to hide their true nature and re-see them (e.g. seeing a chair from bottom up, a computer from an unfamiliar angle, or a fire hydrant at so close up as to simply see the color and texture). The act of creating and sharing these pictures led to important conversations about representation, seeing, perception, creativity and design—about how our perceptions of the world around us are key to creativity in any context. The idea behind this, in making the familiar strange, has been historically noted in in common practice as a useful tool toward creativity, as a way of re-seeing what is right in front of us (Summer & White, 1976; Mannay, 2010). This activity also highlights how the specific affordances of technology (in this case, the digital camera) may serve to help facilitate creative thinking or actions. This activity is used early in the semester in order to foreshadow the deep-play we expect during the semester. It requires students to see the world in new ways and also scaffolds the development of new skills (technical and aesthetic) with digital cameras that allow them to later repurpose the technology for new tasks. Later in the term, this activity is combined with an images activity which askes our fellows to see the world through their disciplinary lenses, to see the world as a physicist or mathematician might do so.

Other such examples of creative repurposing would be using Twitter as a medium of synthesis of ideas in a reading, with the 140 character limit acting as a significant constraint. We also do several creative micro-design activities included writing a short story in 55 words, finding letterforms in nature using digital cameras, using magic as a way of introducing mathematical ideas, creating time-reversed videos to understand the second law of thermodynamics, creating video synopsis of chapters in a book and so on. These tasks were usually constrained tightly in terms of resources and time provided. Our fellows found these tasks invigorating and challenging. Through these activities, we attempted to embody many of the social, collaborative and creative goals we espouse in this program. For instance, the assignment on writing a story in 55 words demonstrated how constraints (of medium) can actually encourage creativity, when most of our fellows believed that creativity necessarily required open-ended, time-consuming, unstructured activity.

16.5.1 Creative Pedagogies in Practice

The design of the MSUrbanSTEM program was developed out of our prior experience with the Master of Arts Program in Educational Technology (MAET) program at Michigan State University, Michigan, USA. Specifically, the MAET program uses a unique and rigorous approach towards instructional and professional development. The goal is to support and develop thoughtful, innovative, and creative practitioners who integrate content, technology, and pedagogy in creative ways. Some of the key tenets of the pedagogical approach here include Learning by Design, as next discussed.

16.5.2 Learning by Design

The instructional approach involved real world, hands-on engagement with tools, techniques and pedagogies and their relationship to core constructs in the STEM disciplines. Design as conceptualized in the program was a purposeful, collaborative approach that spotlighted developing creative solutions to problems of practice. With this, focus is maintained on powerful disciplinary ideas even while keeping state and national standards (such as Common Core standards) in mind. Thus, learning by design allows teachers to participate in in *deep* conversations about their practice; provides them opportunities to experiment and *play* with ideas, tools, and subject matter, and offers contexts to reflect on their learning.

16.5.3 Conceptual Integration Across Multiple Delivery Modes

The MSUrbanSTEM program was integrated conceptually and practically across two modes of delivery (face-to-face and online). The instructional team worked with the teachers across platforms, not just on imparting knowledge of the latest digital tools and technologies but rather aiming to help these fellows thoughtfully and creatively repurpose tools at their disposal for meeting student learning goals. The program's learning community extended well beyond the time spent in specific programs or courses. Fellows, across cohorts, became part of an affinity group (Gee & Hayes, 2012), mainly using social media (Twitter and a private Facebook group) that continues to be active even after they had graduated from the program.

16.5.4 Deep-Play at the Program's Heart

At the heart of our MSUrbanSTEM approach to professional development is what we have previously called *deep-play*. As Koehler et al. (2011) write:

> *By Deep-Play we mean an engagement with rich problems of pedagogy, technology and content and their inter-relationships. Deep-Play is creative, seeking to construct new ways of seeing the world, and new approaches to using technology, in order to develop creative pedagogical solutions.* By engaging in design with Deep Play, educators can see themselves not as passive users of technology, but rather as active designers of technology, who creatively repurpose tools, technologies, and artifacts to meet their own goals and desires (italics in original). (p. 154)

Deep-play as an instructional approach encouraged the participants to "play" with technology even while reflecting on deeper issues related to content and pedagogy and their integration. This element of the MSUrbanSTEM program (i.e., deep-play) encourages teachers to be creative in their pedagogy. The program attempt several key goals around this relative to our participating fellows to:

1. Inspire teachers to repurpose everyday items to use as teaching and learning tools in the classroom;
2. Help teachers create active classrooms for their students;
3. Teach with hands-on activities that allow the learner to use various senses and intelligence types;
4. Be reflective of their practices for the sake of always being a better teacher, and
5. Use artifacts and metaphors to demonstrate understanding and profound thought.

During the program, the instructional team emphasized how the act of making or creating can provide rich, transformative learning experiences. In order to help the fellows embrace this idea, we exposed them to readings and activities. These activities were designed intentionally to send the message that creativity is not a gift given to a select few, but a habit of thinking about and engaging with the world that can be learned. This process involves the thoughtful integration of creative pedagogical decisions instantiated in a range of projects, small and large, such as the examples provided above. What is common to all the activities designed and implemented by the instructional team is to nudge students to look at the tools they have in terms of their inherent constraints and affordances and through that to push them to think carefully and creatively about how to leverage them to meet their core student-learning goals.

16.6 Formative and Summative Assessments

In this section, we illustrate how strategies such as flexible grouping, team-building and collaborative work processes, use of formal and informal active learning spaces, improvisation, and strategic technology integration were all used to support creative risk-taking amongst the fellows. In the program, we take a rigorous, student-centered approach to explore how creativity is encouraged through the following tenets in our instructional practice: learning by design; demonstrating explicit connections between classroom practice, theories, and standards; multiple levels of conceptual integration across modes of delivery; innovative use of technology, and the development of learning communities.

In order for pedagogy to be classified as creative, it must meet three criteria: "…model a community of practice (COP), focus upon redefining pedagogy and provide an appropriate technology support infrastructure" (Cochrane, Antonczakb, Keeganc, & Narayanan, 2014, p. 4). The program's instructors integrated an array of formative and summative assessments that supported the community we built among our cohorts, as well as encouraged exploration as they examined technologies to support their teaching practice in an effort to give fellows constant practice in honing their creativity. While assessments are not a new concept to teachers, these have varying levels of value for student learning, depending on their context. Black (2015) states that many scholars and teachers "regard assessment as a peripheral component of pedagogy, one that is inescapable but which always threatens to undermine the most valued aim, that of developing the learning capacity of their students" (p. 163). Continuing, Black argues that, in practice, implementing innovative formative and summative assessments is often challenging for teachers for many reasons.

As though echoing Black, the program fellows expressed challenges to implementing different forms of assessments for several reasons. These included but were not limited to

- Scheduling a mandatory week of standardized testing into a packed curriculum with little notice.
- Difficulty getting buy-in from colleagues, administration, and parents
- Obtaining time and resources needed to create assessments, and
- Differentiating assessments based on the wide diverse learner characteristics they need to support.

During the ten face-to-face sessions that launched each of the three academic years for the fellows, the instructional team integrated a wide range of assessment practices for them to consider modeling in their classrooms.

16.6.1 Formative Assessments

We now describe a small sampling of the formative and summative assessments fellows completed to help support their instructional needs and enhance their ideas around creative pedagogies. During the face-to-face sessions of the course, fellows, on average were asked to complete three to five formative assessments each day. One of the most challenging yet popular forms of formative assessments were Quickfire Challenges Wolf (2009). In a Quickfire Challenge, participants complete a challenging, authentic task within a tight time frame that combines content and technology. The assignment is tiered so that they can customize the activity based on their comfort level with technology. Quickfires provide a safe and collaborative way to fail and iterate (Horton, Mehta, & Shack, 2017, p. 247).

Within each cohort, fellows self-selected themselves into groups of five that were diverse in level of technology skill, and grade and subject level taught. Each group worked together to develop the products required from the Quickfire challenge, such as videos, digital posters, and games. Initially, the goal for each group was to complete the challenge in a timely manner. As the group collectively became more comfortable with the format of the assignment and their membership, the fellows were able to spend more time taking risks that could involve enhancing their product. Thus, we aimed to give them opportunities for exploring learning and pedagogical work that required the critical risk-taking aspect of creative teaching that Henriksen and Mishra (2015) note is so important. Along those same lines, the focus on authenticity brings the element of real-world relevance to the task, as we next describe.

16.6.2 Video Story Problems: Deciphering the Disciplines in Real World Contexts

In the video story problem, teachers are given 30 min to create a video that communicates a story problem with real-world application. The goal of this exercise is to help teachers practice transiting from teaching a subject area to fostering the disciplined minds of their students (Mansilla & Gardner, 2008). The activity requires teachers to consider a real-world application for the skills they are already teaching in their class, and create a video that illustrates the problem in some context students would see in their actual life. Teachers engage with the real-world component of creative teaching as they capitalize on their students' interests and lives to incorporate those elements into the story problem. Thus, they increase the connection between their students' world and the subject area in which they teach.

Each group of fellows brainstormed ideas for the product and then created a video based on their ideas in the time allotted. If they had more time, they were encouraged to make the Quickfire "extra-spicy" by adding technological and production-value enhancements to their video or creating an appendix to enrich the content of their video. Teachers were able to create videos that encouraged students to apply their knowledge of math, science, and engineering to determine the solutions to the proposed problems they found around the city. The fellows found and proposed questions like how much soil does it take to fill a cylindrical cement planter, how much water was dispensed from a bottle-filling drinking fountain, what was the speed of our walk to lunch, how do we classify materials based on observable properties, and how much money does the parking meters generate?

We found that two different groups captured a video of the same building front. Due to a difference in the ages of learners that they worked with, what the teachers saw in the building's structure was different. The teachers of earlier grade levels asked students how they could count the total number of windows on one side quickly. The other group of fellows taught at the high school level and they discussed the size of buildings in the city in general in terms of proportions and scale in relation to other buildings around the world. They asked their students to calculate the number of red bricks it takes to complete this window-filled front of the building. This example highlights what we saw emerge from these videos – how our teachers see STEM in the city is focused on the knowledge and skills of their learners.

16.6.3 Breaking the Laws: Confronting Misconceptions Through Video Creation

The Breaking the Laws activity is intended to directly confront assumptions or conventions and engage risk-taking by viewing existing content differently. Prior to this activity the class engages in a conversation about barriers to learning, using Lee Shulman's research on the "epidemiology of mislearning" as the anchor text for the conversation. One of the major points of emphasis of this discussion is the disruptive role misconceptions play in learning. Shulman explains that misconceptions are one of the most disruptive barriers to learning because unlike simply forgetting information, a misconception can often result in a person confident that they understand something, when they truly do not (Shulman, 1999). As a part of the reading and discussion, teachers confront the idea that science is often not taught in a way that requires students to confront paradoxes and conflict brought on by their own preconceived notions. In an effort to help teachers conceptualize this issue and see its effect on their students' understanding, teachers create a stop motion video that purposefully breaks the law of physics, thereby perpetuating a misconception. An "extra-spicy" version of this assignment would have fellows create a second video that responds to the misconception illustrated in their first video, as an opportunity to extend the thinking and take it farther into real-world teaching.

Through the exercise, the fellows developed their video creation and design skills and utilized this medium to help them explore misconceptions that their own students may be holding onto that prevent them from reaching deeper levels of understanding. Thus, they again were called on to bring their attention to issues and ideas that their own students confront in real-world misconceptions, and to help move them to viewing things from a completely different perspective to promote understanding.

The primary purpose of this assignment was to force teachers to delve into the "why" of their students' misconceptions. For example, one group of teachers demonstrated the common student misconception that larger objects fall faster than smaller objects. Other groups created stop motion videos that covered topics like friction-less environments, force and motion, recreating the perception and reality of Ben Franklin's interaction with lightning, and the sun's path of travel. By forcing the fellows to conceptualize their student's misconceptions as narrative videos, teachers would then be better equipped to address these misconceptions in the classroom.

This activity's secondary purpose was to arm teachers with an assessment strategy that could creatively assess a student's understanding of the content. To create a video that successfully highlights a misconception, a student would first have to possess a deep understanding of the content. Through this activity, teachers engaged with a common and disruptive barrier to student understanding, while simultaneously sharpening their creative assessment skills.

16.6.4 Summative Assessments

Through the fellowship, teachers also completed summative assessments. These items included the ImagineIT project, an independent project that allowed fellows to address a pervasive STEM-related question in their teaching or leadership capabilities. Also, within each cohort, fellows formed subgroups called Deep Play Groups. In these interdisciplinary groups, fellows were asked to explore teaching tools or strategies in which they had a collective interest, and share their findings through various activities, including creating interactive professional development opportunities for their colleagues. Further, each cohort of fellows contributed to at least two published anthologies related to their experiences teaching in STEM. These books share reflections from our teaching fellows about what teaching means to them, differentiated lesson plans and other resources related to teaching STEM in the urban K-12 context.

16.6.5 ImagineIT

The ImagineIT assignment was one of 2-yearlong activities in which the fellows participated. It was constructed as a series of multi-staged projects that challenged them to identify and address a problem that their classroom, school, and/or teaching community faces related to STEM and technology. The goal was not to simply think about how to integrate technology into a STEM course. Instead, the objective of this project was for the teachers to identify a real-world problem that would allow them to take a radical action in their teaching context that they believed would be both beneficial and transformative to their practice.

We asked teachers to *imagine* an aspect of their STEM content that involved some pedagogical problem that they wished to address. For example, some of the challenges teachers named and chose to address through this project included how to make students see that science and math were implicit parts of their own lives and how to get parents more connected to STEM so students, parents, and teachers can create a STEM environment in their school community. Based on these goals, fellows created videos that allowed them to think about their big ideas from different perspectives and new ones, as well as to communicate their big ideas to target audiences (i.e., colleagues, administrators, students, and parents). We have noted how real world and cross-disciplinary teaching and intellectual risk taking or trying new things is essential to creative teaching, so in many ways this assignment wove together several of these concepts.

During the fall semester of the academic year for each cohort, fellows were charged with developing and facilitating two focus groups (one with their colleagues and one with their students) so fellows could brainstorm with each group and receive feedback about their planned intervention. A few interventions that fellows tried resulted in professional innovations in their practice, such as creating a school garden for teaching biological and nutritional concepts and developing a makerspace that included circuitry and coding tools, as well as a 3-D printer for students to explore STEM concepts. At each step, fellows were asked to reflect on the process and make decisions about how to proceed as informed by the feedback they received from instructors or from insights the readings provided. In the spring semester, the fellows put their ideas into action by implementing them in their teaching and then reflecting and providing written reports on results.

16.6.6 Deep Play Groups

As mentioned, Koehler et al. (2011) describe deep play as engagement with rich problems of pedagogy, technology, and content and their inter-relationships. Deep-play is a creative process for seeking to construct new ways of seeing the world and using technology to develop creative pedagogical approaches and solutions to disciplinary and or administrative challenges that impact their teaching practice. The cohort members had a wide range of interests for which they wanted to learn more. It is difficult, if not impossible, for us as instructors to meet each and every one of these interests and needs. The Deep Play groups were a way for fellows to interact around of topics of shared interest as they worked to explore and solve a problem in a risk-free, playful manner. In other words, these groups were interdisciplinary teams within each cohort, which focused on developing a better understanding of a specific topic related to teaching and learning in the STEM disciplines.

Teams of five were created based on mutual interest in their topics. The topics they chose to explore included 3-D printing in the classroom, gamification, genius hour, and project-based learning in the classroom. Group members then undertook a series of activities that allowed for a deep-dive exploration into the topic with their colleagues. One of these activities involved a book review in which each team hosted a webcast to review books related to their topic and share the ways (if any) the book connected to their ImagineIT project or teaching context. This group also planned an interactive professional development activity around this topic that could be implemented in their schools. Further, these teachers curated content that was connected to their topic and distributed this information through social media.

16.6.7 Book Publications

Each year, fellows published books exploring their teaching practice. During the third cohort, the fellows created two books within the summer. The first was *A Teacher's Quick and Dirty Guide to Cosmos*, which offers STEM teachers a new lens for evaluating the original classic by Carl Sagan. By the end of this semester, they also created *Amazing STEM*, which highlights master lesson each teacher developed and implemented, and then enacted for their cohort peers. Their final publication titled *This I Believe* reveals the teachers reflecting on their experience in the program and sharing revisions to their ideas about teaching and learning over time.

16.6.8 Bringing It All Together

Our overall aim for these assignments was to immerse these teachers in their own creativity by offering opportunities to take risks and try new things, to engage with digital media in news ways, and to create, play, and build learning experiences for their cohort. All of these experiences and challenges were grounded in real-world, interdisciplinary approaches to STEM. By creating a philosophy based in Dewian principles that also spoke to creative engagement as central to the STEM teaching and learning experiences of this large group of fellows, we aimed to promote learning in new ways that would carry over from their new mindset and beliefs into their teaching practice.

16.7 Findings

To describe these fellows' creative learning outcomes, we provide demographic data, data collection procedures, measurement information, and some key findings from our ongoing research with the MSUrbanSTEM project. We also provide some implications of our research findings on broader factors such as teacher efficacy and student learning and achievement. This section reflects our effort to form a picture of the development of creative mindsets and practices for this particular group of urban STEM teachers.

16.7.1 Participants

The study data include the responses of 124 STEM teachers in a large urban school district who were enrolled in three separate cohorts (years) of the MSUrbanSTEM program (25 teachers were part of the year 1 cohort, 49 in year 2, and 50 in year 3). These teachers were accepted into this program after being selected based on their essay responses, letters of recommendation, leadership, and past teaching experience.

In terms of demographics, 81 (65%) of the teachers were female and 43 (35%) were male. Also, 56 (45%) identified as White, 30 (24%) African American, 16 (13%) Hispanic/Latino, 12 (10%) Asian, and 9 (7%) as multi-ethnic. While 59 (47%) taught at the middle school level, 37 (30%) taught high school and 11 (9%) taught elementary; additionally, 13 (11%) taught at the elementary and middle school levels, with 4 (3%) at middle and high school levels. Finally, 56 (45%) taught science, 55 (44%) taught math, 13 (11%) taught identified other subjects (engineering, technology, and combinations). Among them was a STEM program coordinator, assistant principal, and instructor of teachers.

16.7.2 Examining Changes in Beliefs About Creativity and TPACK

In order to assess if the participating MSUrbanSTEM teachers showed any changes in their skills or creative beliefs as STEM educators, we asked them to complete the Teacher Creativity Scale (TCS) and the Technological Pedagogical Content Knowledge (TPACK) surveys, which are explained further in this section. Data collection consisted of several procedural steps. The survey measures were administered to participants at three time points: prior to the first meeting of the year (July), 6 months later (December), and at the end of the year (May).

16.7.2.1 Looking at Changes in Beliefs about Creativity

The TCS is a ten item, self-report survey that measures teachers' beliefs about their ability to be flexible and creative in their classroom practices. Survey questions are answered on a five-point Likert scale from strongly disagree to strongly agree. MSUrbanSTEM team members created the teacher creativity scale in 2015 (during the implementation of the first cohort to assess if teachers' creative approach to teaching and thinking was impacted by program participation. The items in the scale speak to elements that indicate creativity like risk taking behavior and ability to find alternate paths to reach one's goal (Henriksen & Mishra, 2015; Peg, 2010).

The TCS consists of two subscales: creative resilience (CR) and teacher creativity (TC), which is in Table 16.1. An exploratory factor analysis was conducted in

Table 16.1 TCS [Teacher Creativity Scale] (Seals, Mishra, Henricksen, & Mehta, 2015)

#	Questions/item	Subscale
1	I am a creative person	–
2	I can come up with a lot of ideas when faced with a problem	CR
3	I am open to new ideas and experiences	CR
4	I see failure as a serious setback (reverse coded)	CR
5	I am a creative teacher	TC
6	Teaching creatively is easy for me	TC
7	I am extremely willing to try new things in my classroom	TC
8	I am good at imagining new ideas to engage my students	TC
9	I feel comfortable teaching my subject matter from multiple angles	TC
10	I am extremely comfortable with deviating from a prepared teaching plan	TC

Items 2 and 3 were omitted due to poor factor loadings and reliability
CR creative resilience, and *TC* teacher creativity

order to validate the relationship among the items. Reliability measures of the TCS were good (α = 0.783). Six of the items (items 5–10) loaded heavily onto construct one with a good reliability (α = 0.745. Since the scale was created after the launch of cohort 1, creativity data could only be collected for cohorts two and three (n = 99).

For this chapter, we used the survey responses to conduct a one-way repeated measures ANOVA to test the null hypothesis that there is no change in creativity over the 1-year period of participating in the MSUrbanSTEM project (N = 70). Findings show that there was significant growth in creativity from July to May $F(2, 68) = 50.78$, $p < .001$. Post hoc results for creativity over time indicate a significant difference among all three points: time one 95% CI [2.90, 3.46], time two [3.74, 4.06] and time three [3.94, 4.22]. Table 16.2 has the average scores across the three time points, showing how teachers grew in TCS and TC across the three time points. Moreover, growth also proved significant in teaching creativity over time $F(2, 68) = 42.81$, $p < .001$. This indicates that the teachers' approach to their pedagogy and content may have changed due to their involvement. Specifically, participating teacher fellows in the MSUrbanSTEM project increased their self-perception as creative teacher educators.

16.7.2.2 Examining Changes in TPACK

The TPACK survey seeks to measures the ability of teachers to integrate successfully content, pedagogy, and technology in their teaching (Mishra & Koehler, 2006). Teacher TPACK is measured by way of a 47-item self-report survey; questions are answered on a five-point Likert scale from strongly disagree to strongly agree.

Table 16.2 Means from creativity and TPACK survey responses

			Cohorts by year		
			1	2	3
			Mean	Mean	Mean
TPACK	Time	July	3.91	3.82	3.77
		Dec.	4.36	4.09	4.18
		May	4.49	4.31	4.33
TCS	Time	July		1.65	3.70
		Dec.		3.00	3.89
		May		3.03	4.05
TC	Time	July		1.46	3.83
		Dec.		3.98	4.04
		May		4.17	4.20

Average responses over 1 year for three cohorts showing growth in creativity and TPACK during teaching fellows' year of participation within the MSUrbanSTEM program (cohort 1 did not complete the Creativity survey). TCS includes the mean of all ten items from the teacher creativity scale, while TC includes the mean of items 5–10

Reliability measure of the TPACK was strong ($\alpha = .946$). On the survey, items making up the TPACK scale were clustered together by these constructs: technological knowledge (TK, 7 items, $\alpha = 9.33$), content knowledge (CK, 12 items, $\alpha = 8.57$), pedagogical knowledge (PK, 7 items, $\alpha = 8.84$), pedagogical content knowledge (PCK, 4 items, $\alpha = 6.63$), technological content knowledge (TCK, 4 items, $\alpha = 7.94$), technological pedagogical knowledge (TPK, 5 items, $\alpha = 8.02$), and technological pedagogical content knowledge (TPCK, 8 items, $\alpha = 8.82$). TPACK data were collected from teachers ($n = 124$) in all three cohorts.

We conducted a one-way repeated measures ANOVA to evaluate the null hypothesis that there was no change in their perception of TPACK over time ($N = 91$). Findings show that there is growth in TPACK over their year of involvement in the MSUrbanSTEM program (July to May) $F(2, 89) = 62.81$, $p < .001$. Post hoc results for TPACK over time show a significant difference among all three points: time one 95% CI [3.71, 3.90], time two [4.14, 4.32] and time three [4.28, 4.48]. This indicates that the teachers' approach to their pedagogy and content changed due to their program participation.

16.7.3 Summary of Findings

Given these changes in teacher self-beliefs, the teachers' approach to their classroom practices has become more open minded and flexible about trying novel and different methods to deliver class content. Further, the growth in TPACK indicates that confidence levels had increased, along with feeling comfortable with one's knowledge of STEM content and ability to integrate successfully technology into one's pedagogical practices. This type of thinking requires teachers to be creative so that classroom technology has purpose and they can innovatively integrate technological devices into their activities. The program goal was to support teachers in this direction, giving them opportunities to use technology innovatively to create multimodal learning environments for their students.

All forms of teacher knowledge are involved in student learning and student evaluation (Mishra & Koehler, 2006), and the quality and variety of teacher practices can influence student achievement (Rockoff, 2004). Moreover, general teacher self-perception of competence is correlated to student achievement, especially in math and science (Muijs & Reynolds, 2002), suggesting that an efficacy-enhancing development program may directly impact student achievement.

16.8 Conclusions

Urban settings often present a complex and challenging environment for teaching, as teachers face contextual and systemic pressures that include the socio-economics of poverty (Milner, 2012). Given all such challenges, urban teachers in struggling contexts need more support and professional development aimed at guiding students and supporting their learning. Unfortunately, in such settings teaching and learning often slides toward lower-order skills and rote learning. Yet, it is the higher-order skills like creativity that could aid student success in academics and in life. In this chapter, we have considered the importance of bolstering creativity for teachers and students in these contexts, with a specific focus on STEM disciplines as areas that are often not seen as creative, but which are ripe with opportunities to teach and learn in both novel and effective ways.

The case of teacher professional development that we have presented through the MSUrbanSTEM program with CPS aimed at inspiring more innovation and creativity for urban teachers. Through the types of learning experiences crafted for these cohorts of teaching fellow, we have aimed to build their capacities to engage students creatively in STEM learning with project-based and experiential learning experiences that are connected to the real-world and informed by the urban context. In seeking to understand what the impact was upon such teachers, we investigated the perceptions that each cohort member had of his or her own creative teaching abilities as well as understanding of TPACK. Based on our findings, it was clear that each cohort of MSUrbanSTEM teachers saw significant growth for both of these constructs. Importantly, their perceptions of their own creative abilities as teachers and their TPACK, based on a year's involvement in this professional development program, can be said to have transformed.

While we have noted that some existing creativity research and scholarship has been somewhat distanced from classroom or teaching practices, there are still some important connections to be made. For example, a core component of creativity is having an openness and orientation to the new and engaging in intellectual risk taking (Glover & Sautter, 1977). There is a natural degree of resistance to uncertainty, novelty, and risk-taking for many people, particularly in challenging situations. But these are also habits of mind that can be developed through opportunities to change behaviors and practices that promote such a mindset (Costa & Kallick, 2009). Further, we have noted how some research (e.g., Henriksen & Mishra, 2015) illustrates how creative teachers support their practice through real-world connections, cross-disciplinary teaching, and intellectual risk taking. Through the kinds of professional development opportunities that we have described from the MSUrbanSTEM program, we aimed to enhance as well as expand such creative practices and beliefs in these teachers. The analysis of data we have reported demonstrates positive and promising findings. So, as we look ahead to the future of creative teaching in challenging settings, we hope that the pedagogies and approaches we described through a long-term program may be helpful for further creative professional development for teachers of STEM and other areas.

References

Bell, H., Limberg, D., Jacobson, L., & Super, J. T. (2014). Enhancing self-awareness through creative experiential-learning play-based activities. *Journal of Creativity in Mental Health, 9*(3), 399–414.

Black, P. (2015). Formative assessment—an optimistic but incomplete vision. *Assessment in Education: Principles, Policy & Practice, 22*(1), 161–177.

Cochranea, T., Antonczakb, L., Keeganc, H., & Narayana, V. (2014). Riding the wave of BYOD: Developing a framework for creative pedagogies. *Research in Learning Technology, 22*, 133–146. https://doi.org/10.3402/rlt.v22.24637

Costa, A. L., & Kallick, B. (2009). *Habits of mind across the curriculum: Practical and creative strategies for teachers*. Alexandria, VA: Association of Curriculum and Development.

Craft, A. (2003). *Creativity across the primary curriculum: Framing and developing practice*. New York, NY: Routledge.

Craft, A. (2005). *Creativity in schools: Tensions and dilemmas*. London, UK: Psychology Press.

Cropley, A. J. (2000). Defining and measuring creativity: Are creativity tests worth using? *Roeper Review, 23*(2), 72–79.

Cropley, D. H. (2015). Promoting creativity and innovation in engineering education. *Psychology of Aesthetics, Creativity, and the Arts, 9*(2), 161–171.

Davis, J., & Gardner, H. (1993). The arts and early childhood education: A cognitive developmental portrait of the young child as artist. In B. Spodek (Ed.), *Handbook of research on the education of young children* (pp. 191–206). New York, NY: Macmillan.

Gee, J. P., & Hayes, E. (2012). Nurturing affinity spaces and game-based learning. In *Games, learning, and society: Learning and meaning in the digital age* (pp. 129–153). New York: Cambridge University Press. https://doi.org/10.1017/CBO9781139031127.015

Guilford, J. P. (1950). Creativity. *American Psychologist, 5*, 444–454.

Glover, J. A., & Sautter, F. (1977). Relation of four components of creativity to risk-taking preferences. *Psychological Reports, 41*(1), 227–230.

Hargreaves, A. (1997). *Rethinking educational change with heart and mind*. Alexandria, VA: Association of Curriculum and Development.

Henriksen, D. (2011). We teach who we are: Creativity and trans-disciplinary thinking in the practices of accomplished teachers. Unpublished doctoral dissertation, East Lansing MI. Michigan State University. Retrieved from ProQuest.

Henriksen, D., & Mishra, P. (2015). We teach who we are: Creativity in the lives and practices of accomplished teachers. *Teachers College Record, 117*(7), 1–46.

Henriksen, D., Mishra, P., & Mehta, R. (2015). Novel, effective, whole: Toward a NEW framework for evaluations of creative products. *Journal of Technology and Teacher Education, 23*(3), 455–478.

Henriksen, D., Mishra, P., & Deep-Play Research Group. (2017). Between structure and improvisation: a conversation on creativity as a social and collaborative behavior with Dr. Keith Sawyer. *TechTrends, 61*(1), 13–18.

Horton, A., Shack, K., & Mehta, R. (2017). Curriculum and practice of an innovative teacher professional development program. *Journal of Computers in Mathematics and Science Teaching, 36*(3), 237–254.

Kaimal, G., Drescher, J., Fairbank, H., Gonzaga, A., & White, G. P. (2014). Inspiring creativity in urban school leaders: Lessons from the performing arts. *International Journal of Education & the Arts, 15*(4), 1–22. Retrieved from http://www.ijea.org/v15n4/

Karp, A. (2017). Mathematically gifted education: Some political questions. In R. Leiken & B. Sriraman (Eds.), *Creativity and giftedness: Interdisciplinary perspectives from mathematics education* (pp. 239–255). Amsterdam, Netherlands: Springer.

Kaufman, J. C., & Sternberg, R. J. (Eds.). (2010). *The Cambridge handbook of creativity*. Cambridge, UK: Cambridge University Press.

Ketelhut, D. J., Nelson, B. C., Clarke, J., & Dede, C. (2010). A multi-user virtual environment for building and assessing higher order inquiry skills in science. *British Journal of Educational Technology, 41*(1), 56–68.

Koehler, M. J., Mishra, P., Bouck, E. C., DeSchryver, M., Kereluik, K., Shin, T. S., & Wolf, L. G. (2011). Deep-play: Developing TPACK for 21st century teachers. *International Journal of Learning Technology, 6*(2), 146–163.

Levine, A. (2007). *Educating researchers*. New York, NY: The Education School Project.

Lovitts, B. E. (2001). *Leaving the ivory tower: The causes and consequences of departure from doctoral study*. Lanham, MD: Rowman & Littlefield.

Mannay, D. (2010). Making the familiar strange: Can visual research methods render the familiar setting more perceptible? *Qualitative Research, 10*(1), 91–111.

Matsko, K. K., & Hammerness, K. (2013). Unpacking the "urban" in urban teacher education: Making a case for context-specific preparation. *Journal of Teacher Education, 65*(2), 128–144.

Milner, H. R., IV. (2012). But what is urban education? *Urban Education, 47*(3), 556–561.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A new framework for teacher knowledge. *Teachers College Record, 108*(6), 1017–1054.

Muijs, D., & Reynolds, D. (2002). Teachers' beliefs and behaviors: What really matters? *Journal of Classroom Interaction, 37*, 3–15.

Pegg, A. E. (2010). Learning to lead the risk-conscious organization: An empirical study of five English primary school leaders. *International Journal of Leadership in Education, 13*, 121–139.

Perry, J. A. (Ed.). (2016). *The EdD and the scholarly practitioner*. Charlotte, NC: Information Age Publishing.

Plucker, J. A., & Renzulli, J. S. (1999). Psychometric approaches to the study of human creativity. In R. E. Sternberg (Ed.), *Handbook of creativity* (pp. 35–61). Cambridge, UK: Cambridge University Press.

Rockoff, J. E. (2004). The impact of individual teachers on student achievement: Evidence from panel data. *American Economic Review, 94*(2), 247–252.

Runco, M. A. (2014). *Creativity: Theories and themes: Research, development, and practice*. Amsterdam, Netherlands: Elsevier.

Runco, M. A., & Chand, I. (1995). Cognition and creativity. *Educational Psychology Review, 7*(3), 243–267.

Sawyer, R. K. (Ed.). (2011a). *Structure and improvisation in creative teaching*. Cambridge, UK: Cambridge University Press.

Sawyer, R. K. (2011b). *Explaining creativity: The science of human innovation*. Oxford, UK: Oxford University Press.

Seals, C., Mishra, P., Henricksen, D., Mehta, R. (2015). Teacher creativity scale. Unpublished manuscript.

Shulman, L. S. (1999). Taking learning seriously. *Change: The Magazine of Higher Learning, 31*(4), 10–17.

Starko, A. J. (2013). *Creativity in the classroom: Schools of curious delight*. New York, NY: Routledge.

Summers, I., & White, D. E. (1976). Creativity techniques: Toward improvement of the decision process. *Academy of Management Review, 1*(2), 99–108.

Wolf, L. G. (2009). *Quickfires explained.* Retrieved from http://www.leighgraveswolf.com/2009/08/19/quickfires-explained/.