

Novel, Effective, Whole: Toward a NEW Framework for Evaluations of Creative Products

DANAH HENRIKSEN
Arizona State University, USA
danah.henriksen@asu.edu

PUNYA MISHRA
Michigan State University, USA
punya@msu.edu

ROHIT MEHTA
Michigan State University, USA
mehtaro3@msu.edu

Creativity is increasingly viewed as an important 21st century skill that should be taught in schools. This emphasis on creativity is often reflected by having students engage in open-ended, project based activities and assignments. A key challenge faced by educators is how such assignments are to be evaluated. An in-depth review of existing tests of creativity indicates a relative lack of instruments or rubrics for evaluating creative artifacts. We address this gap by a two-step process. First, we provide a definition of creativity based on current research and scholarship as being something that is NEW, i.e. novel, effective, and whole. Next, we utilize this definition to develop a rubric that seeks to evaluate creative artifacts along these three dimensions. We also provide examples of how this rubric has been used to evaluate student created artifacts in a master's level seminar devoted to creativity in teaching and learning. We provide not just the rubric but also examples of projects that score low to high along these

three dimensions. We argue that this line of work, though in its initial stages, has much to offer educators as they seek to evaluate student generated creative artifacts. We end with suggestions for future research in this area as well as its implications for teacher education and teacher professional development.

INTRODUCTION

How do we measure creativity? This may be one of the most significant challenges faced by educators who seek to incorporate creative, open-ended project based assignments with their students. A part of the problem is that creativity is often seen as subjective in nature—and immune to definition and measurement. Creative projects also are open-ended and unpredictable in nature, and thus do not seem amenable to being assessed through pre-determined rubrics and assessment frameworks. In this paper, we address these issues of definition and assessment, as well as the complex issues related to evaluating creative artifacts. In brief, we demonstrate a need for such assessments based on a survey of existing tests of creativity, provide a definition of creativity based on current research and in turn use this definition to develop a flexible approach to evaluate creative artifacts (with the caveat that this is work in progress and should be seen as such).

The structure of this paper broadly follows the outline presented above. We begin with an introduction to the need for creativity in today's educational system and the challenges in defining and measuring it. Our review of assessment tools traditionally used to measure creativity indicates that most of these instruments have focused more on measuring individual psychological characteristics, and less on tools related to evaluating creative artifacts. Developing an instrument for measuring creativity in products developed by students requires a shared, and widely applicable, definition of creativity. We provide such a definition of creativity, based on current research and scholarship on the factors that constitute the essential elements of a creative product. We describe how we used this definition to develop a rubric to evaluate creative artifacts, providing data from multi-year research project in which this rubric was utilized to evaluate artifacts created by teachers in a graduate level course on creativity in teaching and learning. We describe the graduate course context, as well as the artifacts created by students, and methodology used to evaluate these products. Our results indicate that this instrument/rubric shows promise, though it is still in an early stage, and there remains much work to be done. We conclude with implications for

teacher education and teacher professional development as well as suggestions for future research.

A CONTEXT FOR CREATIVITY IN EDUCATION

We live in a rapidly changing world. These changes are driven by a variety of forces including expanding knowledge bases, globalization and the rapid evolution of technology (Zhao, 2012). In this competitive and interdependent climate, society faces a variety of political, social, scientific, technological, health, and environmental challenges that demand creativity and an innovative mindset (Robinson, 2011). At a broader global level, creative thinkers are valued and venerated for their ability to solve problems and develop solutions. Companies such as Apple and Google have thrived through their attention to creativity and innovation. In the fields of science and mathematics, creativity has been highly correlated to professional accomplishment and innovation (Root-Bernstein, 1996). In subject areas that include design, writing, the arts, music and more, creativity has always been, and will continue to be, a driving force for work that is valued by society. Thus it is clear that creative thinking is an essential trait across a range of fields and disciplines. While creativity may not have received the level of attention it deserves in educational contexts, there is a strong and encouraging drumbeat in research, scholarship, and popular wisdom (and even the stirrings in policy shifts), calling for a greater emphasis on creative thinking in curricula and educational practice.

Thus, the topic of creativity has increasingly come to the forefront of educational discourse (Sawyer, 2011). For instance, the *Partnership for 21st Century Skills* (<http://www.p21.org>) argues that all learners require 21st century knowledge and skills to succeed as effective citizens, workers, and leaders in the future. These skills and competencies are defined in different ways, but they share some common themes. There is an emphasis on higher order cognitive processes such as creativity and problem solving, over traditional rote learning that has been privileged by conventional or high-stakes, standardized approaches (Giroux & Schmidt, 2004). As we look forward to modes of thinking and learning that are productive for progress, we see that adaptability, creativity, curiosity, and imagination are increasingly seen as being critical for student learning (Cropley, 2006). It is no surprise that a review of the literature on 21st century learning (Kereluik, Mishra, Fahnoe, & Terry, 2013) identified creativity as being a key competency considered essential to learning.

This emphasis on creativity in education is not without its challenges. Along with this shift toward increased creativity in the classroom comes a need for student project work and class assignments that emphasize creativity. While standardized testing and “teaching to the test” methods are suited to more straightforward transmission-style approaches, teaching for creativity calls for open-ended projects and assignments, with increased focus on critical thinking, and real world problem solving. Real world problems are not solved with discrete and decontextualized facts (as multiple choice testing approaches underscore), but require sensitivity to context and an ability to see the problem from multiple points of view (Lilly & Bramwell-Rejskind, 2004).

In this context, a pressing and practical problem for educators is that of defining creativity in a manner that is both accessible and useful to evaluating creative work done by students. This is consistent with an ongoing concern within the field of psychology and creativity research about how to define creativity (Baker, Rudd, & Pomeroy, 2001; Friedel & Rudd, 2005; Marksberry, 1963; Sternberg, 1999). Creativity has often, at least in the common discourse, been seen as an ill-defined construct that is difficult to assess (Plucker, Beghetto, & Dow, 2004). With more open-ended and project-based learning starting to become a focus in education, there is a strong need for the field to develop measures to evaluate and assess creative artifacts. Similarly teachers need approaches that are flexible, yet go beyond complete subjectivity, for dealing with creative student projects.

EXISTING INSTRUMENTS TO MEASURE CREATIVITY IN EDUCATION

There has been a great deal of research on creativity in the past few decades—leading to the development of many different instruments to measure creativity. In order to better understand the available instruments, and to identify those that could be used to evaluate creative artifacts, we conducted a thorough review of the existing instruments for measuring creativity and categorized them with respect to their use in educational contexts. Our classification of these instruments is based on Hocevar and Bachelor’s (1989), and Clapham’s (2011) prior work on categorizing creativity measurements. They classify the instruments into 9 types or categories. These are:

- Divergent thinking tests
- Attitude and interest inventories
- Biographical inventories
- Personality inventories

- Ratings by peers, teachers, or supervisors
- Ratings of eminence
- Judgments of products
- Self-reported creative activities
- Environmental climate inventories

To find existing measures of creativity, we started with one particular coherent body of creativity measures, the American Psychological Association's (APA) PsycTESTS® database. We began by using ProQuest as a search engine to go through PsycTESTS® using keywords 'Creativ*:' or 'Creativity OR Creative.' Using either of these options generated 220 results (in 2014)—i.e. there were 220 tests of creativity (of different types or categories) noted or validated by the APA.

We exported the data from these results into a spreadsheet that included basic information about the measures like title, abstract, year, publisher, author, purpose, etc. Before we started with the process of categorization, we discussed some common attributes, over-arching categories, or recurring themes in these measures that we could identify and use in the coding process. In addition to the title, purpose, abstract, and additional information that the PsycTESTS® search exported, we also created additional parameters based on our analysis of the measures. These were:

- **Domain specificity:** To see whether these measures were Domain Specific or Domain Neutral. If they were domain specific, we noted the particular domain this test targeted.
- **Type of creativity measure:** These were based on the 9 categories delineated by Hocevar and Bachelor (1989) and (Clapham, 2011).
- **Research methodology:** The research methodology followed in developing the instrument.
- **Data format:** The format used to collect data, e.g. survey, task-assignments, open-ended questions, etc.
- **Target population:** K-12 students, population at large, business school students, artists, etc..
- **Stage of creativity process that was addressed:** Examples of this parameter include individual-behavior (i.e., focusing on creative behavior among individuals), individual-process, group-process, product, etc.

One of the researchers (the third author) then read through the title, abstract, and the purpose of each study to determine whether the measure was actually a measure of creativity or just populated as a result of using the keywords Creativity and/or Creative. Out of 220 measures, we found that

only 85 of them were actually related to measuring creativity. The researcher then began to categorize them based on Hocevar & Bachelor's (1989) types of measures as well as some other additional dimensions as mentioned above. Once the first round of coding was complete, two other researchers went over the first coding to agree or disagree on the first round of coding. After the second and third round by the other additional two researchers, all three researchers met again to come to a common final coding list for all measures.

Overview of Creativity Measures Findings

Though the result of these categorizations can be interpreted in different ways, in this paper we focus on a couple of key findings that are relevant to the value of measuring creativity in educational settings. Briefly, our analysis shows that almost half of the instruments (41 out of the 85, approximately 48%) focused on adults and just under a fifth (16 of the 85, approximately 19%) targeted students in the K-12 age group. In addition, analysis of the types of measures showed that just 4 measures focused on evaluating a creative product (with self-reports leading with 29, followed by personality inventories with 13 and finally, attitude and interest inventory which had 11).

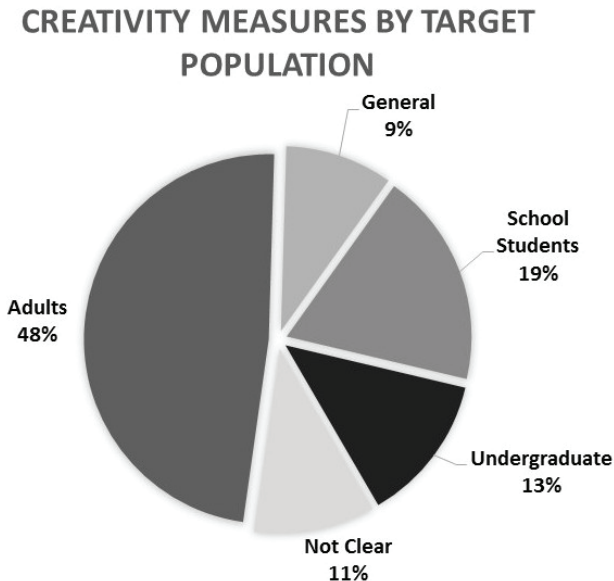


Figure 1. Creativity Measures Categorized by Target Population.

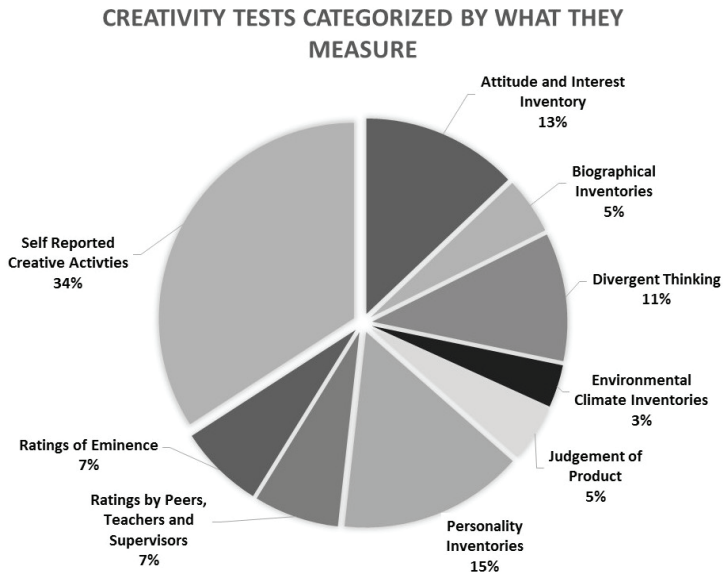


Figure 2. Creativity tests categorized by what they measure.

We argue that these two findings—specifically the lack of instruments focusing on the evaluation of creative products—have serious consequences for educators. As we noted in an earlier study:

Our emphasis on the end product of the creative process is driven by two reasons. The first is that the process of creativity is often invisible to the outsider. What we have, at the end of the day, is what the creative process produces. And *that* is what we seek to evaluate. The second reason involves our focus on actual classroom contexts where educators have to evaluate and pass judgment on student work. Though we value the importance of process, as educators we have to develop better measures and rubrics to speak coherently and systematically about the creative products that students develop. An increased emphasis on open-ended assignments and project based learning makes this task even more important. By putting the spotlight on creative production, we are focusing on work that has tangible validity in a classroom context. (Mishra, Henriksen & the Deep-Play Research Group, 2013, p. 11-12).

Clearly there is a *need* for better assessments of creative artifacts—which is the focus of the rest of the paper. But to address that need and create a rubric or assessment frame, requires a better definition of what we mean by creativity in the first place.

A PROBLEM OF DEFINITION

Despite the historical basis and recent increased research interest in creativity, theorists and researchers alike have found the concept difficult to clearly define (Baker et al., 2001; Friedel & Rudd, 2005; Marksberry, 1963; Sternberg, 1999). In a study of more than 90 articles from top peer-reviewed journals on the topic of creativity, Plucker, Beghetto, & Dow (2004) found that only 38% of these articles offered a clear definition of the term *creativity*. Koehler and Mishra (2008) have emphasized the problem of lack of a common definition for creativity and the difficulty of building one. They note that for education to focus on creativity there must be a “more rigorous articulation of it” (p. 11).

At a general level, creativity can be described as the production of useful solutions to problems, or novel and interesting ideas across domains, and/or the creation of products or artifacts that are useful or valued (Amabile, 1988; Amabile, Conti, Coon, Lazenby, & Herron, 1996; Oldham & Cummings, 1996; Zhou & George, 2001). A novel idea with no potential value to others is not something that can be considered creative (Fox, J., & Fox, R., 2000; Cropley, 2001). The goal of creative performance is to solve problems, create innovative ways of thinking or doing, or to add to knowledge in an area (Guilford, 1950).

Many definitions assert at least the two common factors of *novelty* and *effectiveness* in defining creativity. Creative work is novel in that it brings something into the world that did not exist before (at least in that particular instantiation). But novelty alone does not offer creativity—it must be joined to purpose or usefulness. Since novelty alone is not creative (Cropley, 2003) it must also have value or be effective towards a purpose (Amabile et al., 1996; Oldham & Cummings, 1996; Zhou & George, 2001).

Several authors (Besemer, 1998; Besemer & O’Quin, 1999; Sternberg & O’Hara, 1999) have suggested that these attributes of novelty and effectiveness are important but not sufficient. Sternberg and O’Hara suggest “task appropriateness” is also essential, while Besemer (1998) emphasizes the presence of “style”. Creative products (ideas, artifacts, etc.) are sensitive to context, and must be valued within the domain in which they were created. For instance, a creatively constructed mathematical proof, or beautiful piece of artwork, will be fundamentally different from each other. Furthermore they be different from creative acts in other disciplines (Mishra, Henriksen, & the Deep-Play Research Group, 2013). As such, a comprehensive definition of creativity will also account for contextual aspects - the *style* of the product, as it were. In a similar vein, Koehler & Mishra (2008) note

that, “Creative solutions often go beyond mere novelty and functionality to include a strong aesthetic quality. Creative products and solutions are deeply bound to the context within which they occur; they are integrated, organic and whole” (p. 11). Thus, they suggest “wholeness” (the aesthetic dimensions, situated in a specific context) as the third factor.

In this way, creative ideas are not just novel and effective, but they have a certain aesthetic sensibility—the *whole*—which is connected to and evaluated within a context or paradigm. So, creative solutions are *novel*, *effective* and *whole* spawning a definitional acronym for creativity, NEW. The following table helps to better give a sense of the definitional range of these components.

Table 1

From Mishra & Koehler, 2008 (adapted from Besemer & O’Quin, 1999)

| | |
|--|---|
| Creative solutions are... | |
| OR Creativity is a goal driven process of developing solutions that are... | |
| Novel | Fresh, unusual, unique, surprising, startling, astonishing, astounding, germinal, trendsetting, radical, revolutionary, influential, pioneering |
| Effective | Valuable, important, significant, essential, necessary, logical, sensible, relevant, appropriate, adequate, functional, operable, useful, user-friendly |
| Whole | Organic, ordered, style, arranged, organized, formed, complete, elegant, graceful, charming, attractive, refined, complex, intricate, ornate, interesting, understandable, meaningful, clear, self-explanatory, well crafted, skillful, well made, meticulous |

We believe, that with these three elements of novelty, effectiveness and wholeness in place, we can assert that we have a definition of creativity that captures its essential elements across varied contexts. Based on this definition, we developed an instrument to assess creative artifacts for their novelty, effectiveness, and wholeness, in order to provide a systematic way to evaluate creative products.

FROM NEW DEFINITION TO A NEW ASSESSMENT

Having a definition provides us with guidelines for developing an assessment rubric (along the three key dimensions of novel, effective and whole) for measuring creative artifacts. The rubric gives qualitative definitions at each score point and provides examples (or anchor artifacts) to give

a scorer an estimated range of products that may be expected at each point. We then implemented this to evaluate creative artifacts created by students in a graduate level course on creativity.

The course, *Creativity in Teaching and Learning*, was developed by the second author, and has been taught at least once a year since 2008. This is a fully online course designed for practicing teachers and educators. The foundation of this course is the idea of transdisciplinary creativity—specifically framed within the 7 transdisciplinary skills identified in Mishra, Koehler and Henriksen (2011) and Root-Bernstein & Root-Bernstein (1999). Transdisciplinary creativity involves 7 meta-level cognitive creative skills common to successful creative thinkers across domains (Perceiving, Patterning, Abstracting, Embodied Thinking, Modeling, Play, and Synthesis). An emphasis on this form of knowledge (transdisciplinary knowledge) allows learners to both be immersed in disciplinary practices, and yet also go beyond them (what we have elsewhere called (in)disciplined learning) (Mishra & Henriksen, 2012). Thus, transdisciplinary approaches eschew traditional distinctions between art and science, applied and pure knowledge and in fact seek to find commonalities between strategies and habits of thought used by creative individuals in any discipline.

The course was organized into 8 modules (an introductory module followed by 7 modules, one for each transdisciplinary skill). In each of these modules, students engaged in reading chapters from *Sparks of Genius* (Root-Bernstein & Root-Bernstein, 1999) and completed a range of projects based on the readings. Specifically each of the modules had students apply a different transdisciplinary skill to their topic of interest in teaching and learning. The topics that students focus on vary greatly—cutting across arts, science, mathematics, history, technology and so on. This range in topics means the same key concepts are explored in different ways throughout the semester—pushing the participants to *re-see* the same content through the 7 different cognitive tools. These open-ended assignments push students to think creatively about their teaching, and come up with solutions (lesson plans, classroom ideas, and more) that are often relatively novel in their implementation. Given the range of topics of interest to students, the open-ended nature of the assignments, and the freedom to represent their ideas, it is not surprising that the projects vary greatly not only in terms of what is constructed but also the quality of the final work. This diversity offers significant challenges to the instructors who have to offer feedback and grades to the participants on the work they complete for the course. It also makes the course an ideal context for considering the assessment of creative work. (Readers seeking a more detailed description of the course can find it in Mishra, Henriksen, & Mehta, in press).

DEVELOPING A MEASURE FOR USE IN CONTEXT

Over the past few years we have worked on developing an assessment rubric, based on the Novel, Effective & Whole framework. This evaluation system was developed by the first author and a graduate student, who independently familiarized themselves with each project in the data set. The initial data set included over 350 different student-generated artifacts (class projects), from three iterations of the *Creativity in Teaching and Learning* graduate seminar.

The researchers developed a written rubric, in Likert scale format, with definitions at each scale point (See Appendix A). Projects or artifacts can receive a score between 1 and 5 along each of these three dimensions. The rubric provides not only definitions at each score point, but also some examples (or *anchor projects*) for each score to provide a sense of what may be expected at each point. Since depictions of creativity vary from project to project (despite the common definition), it is important to establish some guidelines for the scoring within the context of projects/assignments or a course. This was done by selecting some anchor projects as agreed-on depictions of creativity for that project. The score-point definitions are relatively succinct, and they are meant to help any coder or scorer by giving a verbal description of the scoring (along with the visual description offered by chosen anchor examples). For example, a score of 1 for novelty would offer (as described in the rubric): “Lack of anything unique or novel, and lack of content or substance to even offer opportunities for novelty.” While a score of 5 for novelty would offer: “Strong qualities of uniqueness, in ways that could be exciting or interesting to learners—is very novel or different from other examples in the data set and shows a relatively novel approach to teaching of subject matter.”

After the researchers developed a holistic sense of the data, each conducted a preliminary coding of a subset of the projects. This preliminary coding was supported by many back-and-forth discussions between the researchers, to develop a shared and consistent understanding of what each score point - between 1 and 5 along each of the three NEW dimensions - would mean. After reaching a consensus on scoring guidelines, we performed an inter-rater reliability test by having the two coders independently code 10% of the projects. This reliability score was .87, or 87% agreement between the coders.

In the next section we give examples of how this coding process worked in actual practice by providing descriptions of student work from across multiple disciplines.

APPLYING THE ASSESSMENT TO STUDENT ARTIFACTS

The fact that the contextual nature of creativity is a core component of our definition (the Whole in Novel, Effective, Whole) means that evaluators require a certain flexibility and sensitivity in the scoring of open-ended products. The artifacts created by student participants in the course varied widely as they were created by different teachers, for different audiences, grade levels, and subjects. Keeping this in mind, the definitions in our rubric aim to set clear standards of quality yet remain flexible in interpretation.

Since the students in this course are (for the most part) teachers, they construct artifacts that are lessons or activities they can use with their own students to teach something in their curricula. Scoring these projects, required the use of aforementioned anchor projects (examples of varied projects at each score point) to exemplify a range, and set a standard, of what different projects might receive as a score. This helped with consistency between scorers (during the first round of scoring outlined in this piece, and then going forward into the future), to go beyond the definitions and descriptions of different score points in the rubric.

It is impossible to give full details of the written lesson plans or student work in the context of this article or to fully exemplify the range of contexts, lessons, and examples created by the students. Rather, the following is meant to give a sense of what an excellent project (NEW scores of 5s or 4s), an average project (scores of 2s or 3s), and a lesser project (scores of 1s) might look like. Some of these examples have also been cited in different contexts, as we have covered this concept of transdisciplinary creativity in teaching in other publications (Henriksen, Cain, Mishra & the Deep-Play Research Group, 2014; Henriksen, Fahnoe, Mishra, & the Deep-Play Research Group, 2014; Henriksen, Good, Mishra & the Deep-Play Research Group, 2015). We begin with examples of projects with *low* and *average* scores. We do this in order to highlight several project examples that demonstrate the type of richness needed for a *high* score of 4 or 5 (a more creative project, in this context).

Low Scores—What does a 1 look like?

Assigning the lowest score of 1 to a project was uncommon. Average creativity was more common to see; provided a student makes a fair effort, there is usually some kind of moderate degree of quality or effectiveness. This is rather intuitive (given the definitions of scores in the rubric), which defines a 1 as something that is completely lacking. Particularly in the context of open-ended student work, the denotation of project work that is *truly*

lacking, is something that usually only occurs when a student fails to incorporate enough effort to show a moderate degree of content and/or organization. In other words, a project that shows minimal effort will fail to have any content to be potentially effective (even minimally/moderately), and therefore tends not to reveal any novelty or aesthetic quality. Hence, it will lack the three dimensions of Novel, Effective, and Whole.

Most of the graduate level students that we observed in this course, incorporated at least some level of substance—taking them beyond the most minimal score of 1. While from this point there is variability between the average and above average projects, the below average work tended to share the same *lack* (of substance or content). We provide one example of what this looked like.

In this particular example of work, the student did not define a topic—which is perhaps one of the root causes of a low score, stemming from the fact that this student then had no boundaries to ground his work or establish disciplinary foundations for creativity. For example, his Perceiving project consisted of the following:

“My ability to teach creatively is impacted in these ways:

- **Observation:** I use observation in the classroom to pay attention to comments that made, body language, the level of interaction. All of these things give me information as an instructor to adjust the message that I am sending so that I can communicate more effectively. In the future, I plan to use the Observation tool as a method of engaging the class participants and encouraging discussion.
- **Imaging:** After reading the chapter, I identified with the feeling of frustration shared among highly visual people...What I got from this book that I think would help me, is understanding that everyone doesn't process problems visually...this skill can be used to help other think creatively by using strong pictures help illustrate learning points in the classroom. Since many people are visual thinkers, pictures would them understand.”

There are several indicators here of a project that is lacking in the elements of Novel, Effective and Whole. First, the project does not introduce anything new. The student repeats the concepts that define perceiving (observing and imaging). He states that he can use them in the classroom, but gives no real explanation, details or examples that enrich and define the case. So with a lack of detail or content to ground this project, it is not particularly effective. Common and general statements about “using strong pic-

tures help illustrate learning points in the classroom”, could be constructed without evidence of much thought or reflection of the ideas. Such general statements have no deep, specific or careful implementation of learning in context to ground them in either novelty or effectiveness for classroom learning. This contrasts starkly with the way these ideas emerged in high scoring projects (as described in greater detail below). As such, it becomes clear that there can also be no element of whole or aesthetics tied to context.

While the student did make an attempt to connect to the transdisciplinary skill of perceiving at a more general and surface level, the fact that the work never went deeper than this meant that the facets of NEW could not emerge.

This was one of the common conditions of low scoring work that received a 1 based on our rubric. Little effort to provide substance hampers quality and effectiveness, meaning that the work can never show novelty in context. While the elements of Novel, Effective and Whole each have their own meanings and distinctness, they often tie in together and affect each other to contribute to creative work in a holistic manner. In our coursework case examples these three factors, while they diverge at times, often work not as distinct entities, but in an interplay for creativity to emerge.

Average Scores—What does a 2 or 3 look like?

Play, with English as Second Language learning. In this example of an average scoring project, the student presents an example of play as a transdisciplinary creative skill, in her own subject of teaching English as Second Language (ESL). In contrast to the first example, this student has provided context for creativity to emerge. Her play example for ESL is summarized in her following description of her work:

According to Sparks of Genius module 7 webpage, we call it ‘deep play’—experimenting freely with an activity, whether it is growing cultures of bacteria in such a way that they create an image, or inventing a new language that has its own logic. I loved this link about ESL games: <http://teachingenglishgames.blogspot.com/2008/03/teaching-weather-and-seasons.html>

Which hit me about these games is that they took a different approach on how to teach ESL students. I teach in a very populated Chaldean area where many of my students lack the vocabulary needed in order to be successful at their grade level... With games like these, they are able to form their own connections without forcing abrupt vocabulary on them. Yes, I agree that these may not be ‘deep play’ for the average American student, but for our

primarily diverse population, this is exactly what they need:
<http://www.teachingenglishgames.com/games/blanketgame.htm>
<http://www.teachingenglishgames.com/games/relayrace.htm>

The student goes beyond the bare minimum of submission seen in the 1 score example, by essentially noting that games are something she can use to infuse specific skills and creativity into her students' learning (and providing some games she found online). But she does not fully develop her ideas in a way that provides novelty or quality. One can argue that she makes a fair point about this being what her students need, but when considering how to evaluate its creativity, we see that nothing new is created in a lesson form (as in the 4 and 5 point scoring examples that follow), and nothing elaborated upon in order to give creative spark, in-depth thought, or quality. The student gives context and examples, but doesn't add anything new or expand her ideas in a way that would be effective and whole. So, it is a fair attempt (offering more than the 1 example), but as is evident from the "high" scores in the next section, it does not rise to more advanced levels of creativity.

High Scores—What does a 4 or a 5 look like?

Below are a few examples of what scorers considered to be work that scored high for creativity (garnering top scores in NEW components).

Patterning, and Shakespeare. One of our students was a high school English teacher in an urban school. This teacher was struggling to get her students to understand and engage with content from the works of Shakespeare. Given that their struggles seemed to come from the unfamiliar language and complex patterns of speech, this teacher built one of her lessons around the skill of Patterning. Her lesson began by having students stand up and "walk out" the beat of the Iambic Pentameter. The goal was to make the rhythm and patterns into a "full body" experience in ways that would be more familiar and felt (making the patterns more relatable and recognizable). As she put it, "once they learn the pattern, the content can be discussed." This first part of the lesson was deemed a valuable approach to recognizing patterns, which then transitioned into creating patterns. After students had a sense of how to see patterns, the teacher had them comb through the text of Hamlet to highlight words and phrases that had a strong emotional connotation—for example any lines that brought negative thoughts or feelings, or a sense that "something evil is going on." Students then used this set of words and phrases drawn from the poem to build a new pattern. The resulting jumble of strong thematic and negative words and phrases,

were isolated to create something new (a “found” poem). The teacher reflected that:

“While a given passage may seem to have an ominous tone to some, it may seem like a random jumble of words to other students. But once the pattern is discovered and understood, the loathsome nature of what has occurred in the play will begin to come alive, and the evil of what has occurred can be fully realized.”

This lesson was considered an excellent creative instantiation of patterning skills because it took a unique approach, deviating from standard textbook, transmission, or discussion models of learning, to foster more effective student learning and engagement with content.

Embodied thinking, and mathematical number lines. The next high scoring example of creativity came from an elementary teacher who wanted to help her students conceptualize a sense of numbers. This teacher had noticed how her students sometimes struggled to understand how numbers are altered by addition and subtraction, and especially how negative numbers are conceptualized. She created a lesson to have her students move along chalk-drawn number lines to perform the processes of addition and subtraction. She designed this activity to focus around the skill of Embodied Thinking—in having students gain a physically felt sense of the greater movement for larger changes in number. Some examples of this are shown below.



Image 1. Kinesthetic explorations of the number line.

She extended this concept to the use of stairs, so that students could add and subtract within a familiar context. The students would be able to see how the numbers on each stair change as they move up and down—the zero number being at the top of the landing and negative numbers progressing down the stairs. This example is shown in the Image 2 below.



Image 2. Using a staircase to explain the idea of negative numbers.

The students not only perceive the continuum of number scales, they also physically experience this as a part of mathematical operations. Familiar movements of jumping, running, or walking are linked to a math concept in the classroom. This teacher's assignment was considered a high scoring example for Novelty, Effectiveness and Wholeness, based on the fact that it was relatively novel within the context of classroom learning, taking the skill of embodied thinking and applying it in a slightly different way to the construct of the number line. Her presentation of this number line lesson was also interesting for showing how to use an everyday object to demystify the concept of positive and negative numbers, again through the use of movement.

Abstraction and heat transfer. In another example that also received high scores for Novel, Effective, and Whole, a teacher developed a science lesson built around the concept of Abstraction. In order to teach the concept of heat transfer, she had students create a poem that in its words and typo-

graphical layout could draw out and demonstrate some of the key characteristics of the science underlying heat transfer. The idea is that they would learn to create abstractions of those concepts that can feel intangible, and represent them more concretely in a poem. She gave an example of a poem that exemplified the core ideas of heat transfer, in the following example:

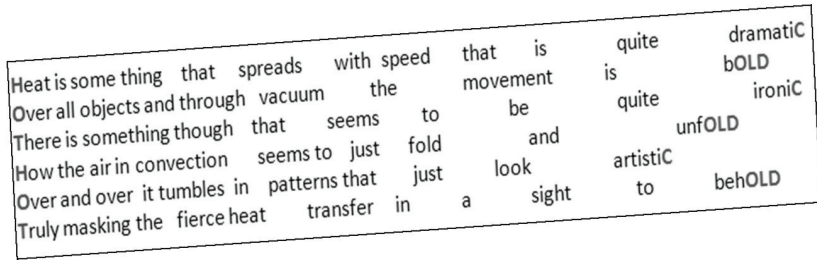


Image 3. Concrete poem to represent ideas of heat transfer.

This teacher described how the visual analogy (a core aspect of abstraction) helped to pull out the essence of the idea, and then developed it into something new that represented the ideas nicely. She noted that:

“Heat transfer can be the shape of the air movement and the different directions in it. I made an analogy between the invisible directions of air movement and visible letter spreading (which is happening between two different temperatures.) As a result, the shape and the color of the poetry provide us with an image to reveal an aspect of the invisible phenomena of heat transfer” (Abstraction assignment reflection).

This lesson and example was a strong scorer along the lines of Novelty, Effectiveness, and Wholeness for multiple reasons—most notably the way that it illustrated each of these as constructs. The idea was again something novel (relatively so in the context of the classroom—where this would vary from traditional types of teaching of science). It was also effective in giving a rich presentation of the science content and of the idea of Abstraction. The resulting poem constructs an analogy along not only the lines of word selections but also the layout and stylistic choices—connecting these thoughtfully to scientific ideas (a great example of the integration of form, function and meaning). The poem also functions on the level of being a complex acrostic—in that the first letter of each line repeats the word *HOT*, and the last letters spell out the word *COLD* (further represented aesthetically by red and blue colors).

IMPLICATIONS & CONCLUSION

The examples given above, ranging across different levels of creativity, help to give a sense of the reality of the work behind our use of a creativity assessment tool. But the broader theme of this article is not about the different ways these teachers engaged in their own creative work. It is about the process of developing a means to measure them. The anchor projects we showed are fairly representative of the levels of quality at different score points. Our rubric was relatively effective (in our estimation and in the consistency between scorers) in picking out and defining creativity within the bounds of this course and these projects. We believe this lies in the fact that we aimed our rubric at fitting with the very nature of creativity and creative work—both specific about quality, but flexible in interpretation and sensitive to context.

As creativity becomes an important part of what we expect students and teachers to engage in and develop in K-12 classrooms we will see more open-ended, real-world projects. In such contexts there is an increased need for assessments that are both general and broad enough to work across contexts, and yet contextualized to the local and the personal. In this paper we discuss several important points related to the assessment of creative products, specifically the lack of such instruments in the PsychTests database. Second, we offer a definition of creativity (Novel, Effective and Whole or NEW) based on the current scholarship in the field. Third, we use this definition to develop a rubric that can be used across multiple contexts to evaluate creative student work. Finally, we provide examples from one round of application of this rubric to the products created by students in a graduate seminar—to give a sense of the way that such rubrics should work. In other words, if this rubric were to be applied to a different project or circumstance, the definitions could stay in place, while the local/personal elements, the *anchor* examples, could be chosen and determined by project directors. Our preliminary finding is that while this rubric requires a significant amount of training and practice, it is useful in evaluating student work across the three dimensions of being novel, effective, and whole.

Clearly this is work in progress but we believe that this is an important first step in the process of developing robust assessment frameworks for assessing student creativity. In our own work, we have moved from seeing the course on creativity as a test bed to applying the rubric to assessing student work. We have attempted to make this process transparent—i.e. provided students with the rubric in advance so that they know how they are being evaluated, and can be aware of how this framework will be incorporated into their feedback. We believe that the results of this implementation have proven to be useful for both students and instructors.

We see value in this work beyond the graduate seminar in which it has been tested thus far. At the very least it demonstrates that a consistent scale/rubric can be developed for evaluating creative artifacts designed by students. We believe that this line of work can have significant impact on how we think about teacher education and teacher professional development. As teachers increasingly use open-ended projects and emphasize the development of creativity in their students, they will need to be trained to use this rubric to evaluate student work. Clearly this is the next step of the process and one that we hope to engage in for a further, and much needed, exploration of evaluations of creative products in education.

References

- Amabile, T. M. (1988). A model of creativity and innovation in organizations. *Research in organizational behavior*, *10*(1), 123-167.
- Amabile, T. M., Conti, R., Coon, H., Lazenby, J., & Herron, M. (1996). Assessing the work environment for creativity. *Academy of management journal*, *39*(5), 1154-1184.
- Baker, M., Rudd, R., & Pomeroy, C. (2001). Relationships between critical and creative thinking. *Journal of Southern Agricultural Education*, *51*(1), 173-188.
- Besemer, S. P. (1998). Creative product analysis matrix: Testing the model structure and a comparison among products--Three novel chairs. *Creativity Research Journal*, *11*(4), 333-346.
- Besemer, S. P., & O'Quin, K. (1999). Confirming the three-factor creative product analysis matrix model in an American sample. *Creativity Research Journal*, *12*(4), 287-296.
- Clapham, M. M. (2011). Testing/Measurement/Assessment. In M. A. Runco & S. R. Pritzker (Eds.), *Encyclopedia of Creativity (Second Edition)* (pp. 458-464). San Diego: Academic Press.
- Cropley, A. J. (2001). *Creativity in education & learning: A guide for teachers and educators*. Psychology Press.
- Cropley, A. J. (2003). *Creativity in education & learning*. Bodmin, Cornwall: Routledge Falmer.
- Cropley, A. J. (2006). In praise of convergent thinking. *Creativity research journal*, *18*(3), 391-404.
- Fox, J. M., & Fox, R. L. (2010). *Exploring the nature of creativity*. Kendall/Hunt Pub..
- Friedel, C., & Rudd, R. (2005). Creative thinking and learning styles in undergraduate agriculture students. *National AAAE Research Conference*, (pp. 199-211).
- Guilford, J.P. (1950) Creativity. *American Psychologist* *14*, 469-479

- Giroux, H. A., & Schmidt, M. (2004). Closing the achievement gap: A metaphor for children left behind. *Journal of Educational Change*, 5(3), 213-228.
- Henriksen, D., Cain, W., & Mishra, P. (2014). Making sense of what you see: Patterning as a transdisciplinary habit of mind. *TechTrends*, 58(5), 3.
- Henriksen, D., Fahnoe, C., & Mishra, P. (2014). Rethinking Technology & Creativity in the 21st Century: Abstracting as a transdisciplinary habit of mind. *TechTrends*, 58(6), 3.
- Henriksen, D., Good, J., & Mishra, P. (2015). Rethinking Technology & Creativity in the 21st Century: Embodied thinking as a transdisciplinary habit of mind. *TechTrends*, 59(1), 7.
- Hocevar, D., & Bachelor, P. (1989). A taxonomy and critique of measurements used in the study of creativity. In *Handbook of creativity* (pp. 53-75). Springer US.
- Kereluik, K., Mishra, P., Fahnoe, C., & Terry, L. (2013). What knowledge is of most worth: Teacher knowledge for 21st century learning. *Journal of Digital Learning in Teacher Education*, 29(4), 127-140.
- Koehler, M. J., & Mishra, P. (2008). Introducing TPCK. *Handbook of Technological Pedagogical Content Knowledge (TPCK) for Educators*, 3-29.
- Lilly, F. R., & Bramwell-Rejskind, G. (2004). The dynamics of creative teaching. *The Journal of Creative Behavior*, 38(2), 102-124.
- Marksberry, M. L. (1963). *Foundations of creativity*. New York: Harper & Row.
- Mishra, P., & Henriksen, D. (2012). Rethinking Technology & Creativity in the 21st Century: On Being In-Disciplined. *TechTrends*, 56(6), 18-21.
- Mishra, P., Henriksen, D., & the Deep-Play Research Group (2013). A NEW approach to defining and measuring creativity. *TechTrends* 57(5), p. 5-13.
- Mishra, P., Henriksen, D., & Mehta, R. (in press). Creativity, Digitality, and Teacher Professional Development: Unifying Theory, Research and Practice. In M. Niess and H. Willow-Giles (Eds.), *Handbook of Research on Teacher Education in the Digital Age*.
- Mishra, P., Koehler, M. J., & Henriksen, D. (2011). The seven transdisciplinary habits of mind: Extending the TPACK framework towards 21st century learning. *Educational Technology*, 51(2), 22-28.
- Oldham, G. R., & Cummings, A. (1996). Employee creativity: Personal and contextual factors at work. *Academy of management journal*, 39(3), 607-634.
- Plucker, J.A., Beghetto, R.A., & Dow, G.T. (2004). Why isn't creativity more important to educational psychologists? Potentials, pitfalls, and future directions in creativity research. *Educational Psychologist*, 39(2), 83-96.
- Robinson, K. (2011). *Out of our minds: Learning to be creative*. John Wiley & Sons.
- Root-Bernstein, R.S. (1996). The sciences and arts share a common creative aesthetic. In: A. I. Tauber (Ed.), *The elusive synthesis: Aesthetics and science* (pp. 49-82). Netherlands: Kluwer.
- Root-Bernstein, R.S., & Bernstein, M. (1999). *Sparks of genius: The thirteen thinking tools of the world's most creative people*. New York: Houghton Mifflin.

- Sawyer, R. K. (2011). *Explaining creativity: The science of human innovation*. Oxford University Press.
- Sternberg, R. (1999). *Handbook of creativity*. (R. Sternberg, Ed.). New York: Cambridge University Press.
- Sternberg, R. J., & O'Hara, L. A. (1999). Creativity and intelligence. *Handbook of Creativity*, 13, 251-271.
- Zhao, Y. (2012). *World class learners: Educating creative and entrepreneurial students*. Corwin Press.
- Zhou, J., & George, J. (2001). When job dissatisfaction leads to creativity: Encouraging the expression of voice. *Academy of Management Journal*, 44(4) 682-696.

Acknowledgements

The authors would like to thank Laura Terry for helping with the coding of student artifacts, Sarah Keenan and Carmen Richardson for helping with categorizing and coding the tests of creativity. We would also like to thank Jill Morningstar, education librarian at Michigan State University Libraries, for going above and beyond her duties to help us identify and use the PsycTESTS® database. Finally we would like to thank William Cain, Chris Fahnoe, Jon Good, Sarah Keenan, Carmen Richardson, and Colin Terry (other members of the Deep-Play Research Group) for their help at every stage of this process. Please address all communication to Danah Henriksen: danah.henriksen@asu.edu.

APPENDIX A

Coding Rubric for 818 Research—Novel, Effective, Whole

Novel

- 1—Complete lack of anything unique or novel, and/or a lack of content and substance to offer opportunities for novelty.
- 2—Fairly lacking in unique, fresh or novel qualities. Most elements are quite standard and unconventional.
- 3—Relatively standard approach to the teaching of the subject matter. While there may be a few unique qualities, it does not necessarily stand out among other CEP 818 projects. Average.
- 4—Some qualities of uniqueness, and relatively interesting to learners. While aspects may bear certain similarities to standard teaching approaches to the subject matter, it also contains some interesting, fresh or novel qualities.

5—Strong qualities of uniqueness, and exciting or interesting to learners. Is very novel or different from other examples in the course, and thereby a very novel approach to teaching of subject matter (in relative terms to other CEP 818 projects).

Effective

1—Complete lack of effectiveness, and lack of content or substance to even offer opportunities for effective teaching. A confusing approach, or highly limited presentation of subject matter that may lead to misconceptions or confusion for learners.

2—Fairly ineffective approach to or presentation of subject matter for teaching. May have elements that are somewhat boring, confusing, dry, light on content, or do not sufficiently communicate the subject matter clearly to learners.

3—Somewhat effective approach to teaching subject matter, in that some elements of the approach to or presentation of content work well to communicate the ideas clearly in interesting ways. However there remain some flaws or areas that lack, or that appear to teach the content less successfully.

Average

4—Effective approach to teaching the subject matter. Clear, thoughtful and interesting approach to teaching the content successfully. Little room for misconceptions or confusion—a coherent approach that appears to lead to solid understanding.

5—Excellent and highly effective approach to teaching the subject matter. Makes the subject matter clear and comprehensible to most learners and presents it in interesting and engaging ways that make the subject come alive.

Whole

1—Little or no aesthetic qualities. Poor, or complete lack of, production values, and indicates little or no thought to the design of the learning experience.

2—Few aesthetic qualities, showing weakness in aesthetic appeal or production values. Clear flaws or minimal thought given to the design of the learning experience.

3—Some aesthetic qualities, but also somewhat conventional or standard aesthetic appeal. Some thought to the design of the learning experience is evident, though overall the production values and aesthetic appeal are fairly average. Reasonably well done, but lacking in any “stand out” appeal.

4—Good aesthetic qualities, and sharp or polished production values. Approach provides some sensory interest (visual, auditory, etc.) for students, with clear thought to the design of the learning experience. The aesthetics qualities help make the learning experience interesting and thought-provoking to learners.

5—Excellent or exceptional aesthetic qualities. Flawless or near-perfect production values. Approach provides rich sensory interest (visual, auditory, etc.) for learners, and all aspects of the design of the learning experience are well thought-out to provide aesthetically cohesive, or “whole” learning that is exciting, thoughtful and stimulating to learners.