Measuring What Matters: Assessing Creativity, Critical Thinking, and the Design Process

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FEATURE

Measuring What Matters

Assessing Creativity, Critical Thinking, and the Design Process

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Abstract: The field of gifted education has a rich history of proposing and implementing innovative pedagogical practices to develop students' creative and critical thinking, yet less attention has been given to the assessment of these learning experiences. If creative and critical thinking are both inherently important in developing global problem solvers and further represent the goals of gifted curriculum, then classroom assessments must be designed to measure student development of these process skills. Many assessment rubrics emphasize the end product or superficially address process skills. This article provides sample rubrics to assess creative and critical thinking skills independently. Then, we consider anchoring larger projects' assessment within the Design Thinking Model (DTM), which embeds creative and critical thinking skills into the design process. Teachers may tailor these rubrics to assist in measuring the essential, yet complex, cognitive processes, and clearly convey to students the characteristics and practices of a good thinker and designer.

Keywords: Design Thinking Model, creativity, critical thinking, gifted, assessment

Imagine a physics class embarking on an exciting project, one that many science teachers have assigned over the years (Jumper, 2012). The challenge requires students to build a car using a mousetrap. Students work for days developing and honing their cars, and then on the final day, they present their masterpieces. The teacher scores the cars on three outcomes: (a) how far the car traveled (i.e., full credit if the car traveled over 30 inches), (b) how fast the car moved (i.e., full credit if the car traveled over 3 mph), and (c) how creative the car looks (i.e., full credit for colorful cars with individualized touches). Many students' cars receive full credit on race day. Yet, one student's car failed to travel 30 inches. Throughout the week leading up to the tests, however, this student brainstormed multiple ideas, carefully tested these iterations, made adjustments based on her data, and even worked on her project outside of class. Her final grade for the project represents a failed product, yet what she learned from the process is not communicated.

> "Conversely, even if the final project solution for the end user is unsuccessful . . . the student should ideally receive a positive assessment rating."

We would hope that the teacher does not care if the car traveled 30 inches/30 feet/30 miles, but rather assigned this project to inspire students to develop creative mousetrap designs and critically evaluate their designs through an iterative process. However, in this scenario, the teacher singularly assesses the end product without considering the development of creative or critical thinking throughout the process. While the distance may be easy to assess, what is easy to assess may not represent what actually matters. The distance, speed, and appearance of the car do not provide a valid gauge on the students' development of thinking processes and further, does not accurately convey the importance of those cognitive skills to the students.

As the introduction of design becomes more ubiquitous in the classroom (e.g., use of Makerspaces, project-based learning, design-based learning, design challenges, and related science, technology, engineering, and mathematics [STEM] education initiatives), we examine the need for assessment tools to

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evaluate students' process skill growth in conjunction with their final products. In the following article, we present multiple approaches for measuring cognitive process skills. We consider the following questions: How might we assess creative/critical thinking? How might we leverage a process model to provide structure for the entire problem-solving process? Collectively, how might we more accurately assess the process so that it conveys its importance in relation to the outcome?

Theoretical Framework

The field of gifted education has a rich history of proposing and implementing innovative pedagogical practices (e.g., Kaplan, 1986; Renzulli, 2001; Tomlinson et al., 2009; Van & Tassel-Baska, 1986; Ward, 1961). From authentic problem-solving opportunities to simulations to student-driven projects, gifted educators strive to engage students in meaningful and impactful learning experiences. The National Association for Gifted Children (NAGC) standards explicitly emphasize the development of critical and creative thinking (see Standard 3.4), and recent literature in the gifted field describes a paradigm shift from "being" to "becoming" gifted, highlighting the importance of developing cognitive skills over time (Lo & Porath, 2017).

Assessing the development of these complex cognitive skills, however, has proven challenging. Standardized assessments often fail to measure these types of skills, and teachers often emphasize what is assessed (Moon, Brighton, & Callahan, 2002). Furthermore, teachers communicate their values and expectations to students through assessments, so when projects emphasize neatness or grammar, students believe those are the most important components of the project. Many assessments we found in preparation for this article prioritize products or superficially represent important process skills. Historically, gifted literature has not emphasized the assessment of learning. Specifically, only 5% of publications examining assessments in the gifted field explored assessments designed for learning and growth, whereas the rest emphasized assessments used for identification and program evaluation (Cao, Jung, & Lee, 2017). Therefore, the goal of this article is to propose practical classroom assessment methods to measure what matters.

What Matters: Creative and Critical Thinking

The first goal in designing effective assessments would be to delineate what matters. Curriculum designers often discuss starting the curriculum design process with the end goals (i.e., what students should know, be able to do, and understand; Wiggins & McTighe, 2011). These goals should guide the development of assessments, which in turn should be used to create learning experiences. Internal consistency among the goals, assessments, and learning experiences increases validity and efficacy of the curriculum.

We propose designing assessments to address two primary process goals important to gifted education. NAGC standards emphasize both creative and critical thinking as these process skills are beneficial at both individual and societal levels. Specifically, creativity promotes healthy psychological functioning (e.g., Rasulzada & Dackert, 2009), student intrinsic motivation and creative self-efficacy (Beghetto, 2006), learning and long-term knowledge retention, and prepares students to make meaningful societal contributions (e.g., Elaldi & Batdi, 2016; Gajda, Karwowski, & Beghetto, 2017). Likewise critical thinking improves an individual's ability to analyze and synthesize knowledge to form cohesive arguments, promote intrinsic motivation, and prepare students to solve real-world problems (Dilley, Kaufman, Kennedy, & Plucker, 2015; Kong, 2006).

If creative and critical thinking are both inherently important and represent the goals of gifted curriculum, then assessments must be designed to measure students' development of these process skills. In the sections below, we propose rubrics to address creative and critical thinking, and then we combine these process skills into a full, general rubric using the Design Thinking Model (DTM). These individual rubrics are flexible, such that educators may choose to combine and integrate components across all rubrics to meet the desirable outcomes of any given project. In concert, these rubrics emphasize measuring what is important.

Assessing Creative Thinking

Deconstructing creativity and critical thinking into components illuminates what matters for students, guides the measurement of student growth, and supports the development of high-quality feedback. Measuring creativity, however, represents a challenging task. Creative thinking skills seem to represent broad and nebulous process skills, which can cause problems for deliberate assessment. Several issues emerge when surveying existing rubrics that include creativity. For example, creativity is often placed in a single rubric row and falls along the spectrum of "not creative" to "creative" or is combined with neatness and appearance. Within initial mousetrap rubric example, the student and teacher evaluate creativity by the color and individual touches of the mousetrap car. Although it is important to highlight aesthetics, creativity is a multidimensional construct, which is not well represented by the emphasis on color. Furthermore, the "not creative" to "creative" distinctions do not help students understand how they can improve in their creative thinking.

To address these common pitfalls, creativity needs to be operationalized, and there are multiple, defensible ways of approaching this. The goal of this article is not to explore all possible definitions, but to acknowledge that a definition should be selected and then leveraged to develop assessment criteria. (For a more thorough review of definitions, see Plucker, Kaufman, & Beghetto, 2015.) We anchored our approach with Guilford's (1950) definition, which includes fluency (quantity of ideas), flexibility (different types of ideas), elaboration (building upon ideas), and originality (uniqueness of ideas). We also considered usefulness as a component of creativity, indicating that creativity must serve a purpose within a social context (Runco & Jaeger, 2012). These components form an

Table 1. Sample Rubric Anchoring Assessment Criteria on the Definition of Creativity

	Novice	Developing	Expert
Fluency	Students considered one idea.	Students considered several ideas.	Students considered many[a] ideas.
Flexibility	Students considered one type of idea.	Students considered several types of ideas.	Students considered many types of ideas.
Originality	Student developed a common idea that many other students would have suggested and/or replicated an existing idea.	Student developed an interesting idea that several other students would have suggested and/or minimally added onto an existing idea.	Student developed a unique idea that few other students suggested and/or substantially built upon an existing idea in a unique way.
Elaboration	Students added minimal details and improvements to their ideas.	Students added a few details and improvements to their ideas.	Students added many significant details and improvements to their ideas.
Usefulness	Students proposed ideas that may meet the end-user's needs in certain conditions.	Students proposed ideas that would meet the end-user's needs.	Students proposed ideas that would meet the end-user's needs and significantly add value to their lives.
Specific creativity strategy[b]	Students randomly selected and implemented a creative thinking strategy, and/or they were unable to leverage the strategy to improve their ideas.	Students selected and implemented a creative thinking strategy to develop their ideas. They explained how the strategy supported their creativity.	Students deliberately selected and implemented a creative thinking strategy to develop their ideas. They explained how the strategy supported their creativity.

[a]The quantity of ideas may be provided for a given project, or teachers may just use general quantities, like "many" or "several" depending upon their class/project needs.
[b]Teachers should supply the specific strategy they introduce in class. Creativity strategies could include brainstorming techniques like reverse brainstorming, attribute listing, and analogical thinking, among others. Other strategies could help focus their ideas, like hits and hot spots or decision matrices. For more information about these various strategies, see Starko (2010) or Davis (2004).

operationalized definition that guides the development of specific criteria within a rubric.

For an example, Table 1 uses the definition of creativity to guide assessment practices. For any given project, teachers may select one or more of these rows to guide students' development of creative thinking. For example, the teacher may identify fluency as an important criterion demonstrating that creative thinking took place. This encourages students to develop multiple ideas, encouraging creative thinking to fulfill the task (and ultimately builds upon their own metacognitive awareness). Without the specificity of "fluency" in the rubric, the student may have selected the first idea that manifested and not consider other possibilities. Beyond definitional components, explicit creative thinking strategies could also be included in the rubric, like reverse brainstorming, analogicial thinking, and attribute listing. For more information about these various strategies, see Starko (2010) or Davis (2004).

Assessing Critical Thinking

Students preparing to enter contemporary society should also be able to think critically and make rational judgments by managing, analyzing, and synthesizing from multiple streams of information (Dilley et al., 2015; National Council of Teachers of English, 2013). Despite widespread agreement on its importance, classroom assessment methods do not often accurately engage and capture students' critical thinking skills. Parents and teachers often believe critical thinking skills are developed through providing greater breadth and depth of content material (NAGC, 2009), and many assessment techniques reflect this emphasis on content. For example, a common strategy for critical thinking in the literature and online is to ask students to reflect using probing questions (such as those based on Bloom's taxonomy) after learning new information. To illustrate this issue, consider a project surrounding *Charlotte's Web* by E. B.

White. Students may be assessed through developing responses addressing each level of Bloom's taxonomy, like at the comprehension level (e.g., "What animals lived on the Zuckerman farm?"). Higher levels of the taxonomy may assess students' ability to analyze (e.g., "Why did Templeton finally agree to help Wilbur?") or evaluate the situation (e.g., "Why was Wilbur allowed to live?").

The issues with this approach are the underlying emphasis on subject matter knowledge, and more importantly, the questions asked do not necessarily add to the students' toolbox of marketable or transferable critical thinking skills. The teacher is guiding each level of thinking with probing questions, so the students may not think beyond the prompted question and engage in deeper, self-directed analyses. If students do not realize they are analyzing or that their analysis is superficial, they will not be able to transfer their analysis skills to a new situation without teacher prompting. More specifically, this assessment does not gauge the success or failure of specific critical thinking strategies. Assessments should purposefully include strategies of the dispositions and commitments of a good thinker instead of assuming the skill will naturally evolve. With a more developed integration of critical thinking into assessment, teachers develop lessons that can contribute to the preparing their students for contemporary society's citizenry challenges.

To better assess critical thinking, we must first define it. According to Paul and Elder (1997), these critical thinking skills can be broken down into the following eight universal standards: all reasoning has a purpose, all reasoning is an attempt to conclude a problem, all reasoning is based on assumptions, all reasoning is done through a point of view (POV), all reasoning is based on evidence, all reasoning is shaped by constructs, all reasoning contains interpretations by which we draw conclusions, and all reasoning has implications. With these constructs purposefully highlighted in a rubric, the teacher may evaluate students' abilities to apply these universal standards to their reflection, analysis, and evaluation. After defining the types and components of critical thinking, we can build an appropriate assessment rubric that represents these key transferable processes (see Table 2). As stated previously with the creative thinking rubric, the criteria listed align with characteristics of a good thinker, but may be highly tailored to any given project.

Assessing creative and critical thinking must begin before and encompass more than the final product. Rubrics must help students recognize what is creative and critical thinking and how they may develop these process skills. These rubrics can be used across projects throughout the semester, and even within smaller assignments. On a daily basis, students may consider all their options (creative fluency) and select/defend one idea to pursue (critical analysis). However, projects, like the mousetrap car, may need a larger process rubric to support student development, and the DTM provides a potential anchor for these types of learning experiences.

Using the DTM to Assess the Full Process

The DTM is an explicit process model (of a similar lens to project-based learning) that purposefully embeds creative and critical thinking skills. In the next sections, we will introduce the basics of the DTM, illustrate benefits of the model for students and teachers in thinking processes related to solving real-world problems, and consider how these thinking processes may be collectively assessed through a full, general rubric.

DTM has evolved over decades—first as seven stages in 1969 when the Nobel Prize laureate Herbert Simon outlined one of the first formal models (Dam & Siang, 2017). This model has been adapted and utilized across various fields. In the field of design and education, it is described as a systemic, nonlinear process, which entails five stages: empathize, define the problem, ideate, prototype, and test (d.school, 2009). The stages do not necessarily happen sequentially and can be revisited and repeated iteratively (see Figure 1; d.school, 2009).

DTM offers several advantages for anchoring a thinking process rubric. First, the DTM emphasizes using the end-user's needs to drive solution development. This requires designers to empathize first and foremost, further positioning the designers to engage with the people who will be directly affected by their design decisions. This emphasis will help students think outside of themselves and gain a broader perspective of the world through critically considering their end-user's needs.

Another advantage of the DTM is its emphasis on solutions. Throughout the process, students are constantly designing solutions that address positively framed questions, like "how might we . . . ?" This helps students develop many, different ideas (i.e., creative fluency and flexibility) and encourages them to think of possible solutions, rather than just roadblocks. Furthermore, because the DTM is an explicit process-based model, it is not enough to assess the solution, but it acknowledges the process supporting the development of the solution. Through reflection and assessment, the designer must return to different stages of the DTM. And thus, the DTM provides a structure for students and teachers (i.e., the designers) when they experience roadblocks. This type of structured approach may actually provide more opportunities to be creative, as constraints have often been demonstrated to be helpful in the creative process (e.g., Haught-Tromp, 2017).

In addition to providing structure, this model also demonstrates the nonlinear, recursive nature of the design process. This reflects authentic design process and communicates the potential need for incubation time. Incubation time is an important factor for facilitating critical and creative thinking. If students need to return to a stage or develop new ideas, they may need more time. By documenting the process, teachers and students will be aware that time was well spent.

To better understand the DTM and how to use it for assessment purposes, we provide a brief description of each of the stages. These definitions, again, lead to more directed process assessments. To better illustrate the stages and

Table 2. Using the Components of Critical Thinking to Develop Assessment Criteria

	Novice	Developing	Expert
Summarizes topic or argument	Does not organize information, leading to inadequate understanding	Inconsistently demonstrates ability to organize information, leading to inadequate understanding	Consistently demonstrates ability to organize information, leading to adequate understanding
Considers previous assumptions	Assumptions are defined, but not explained as having significance to the position	Assumptions are defined and linked to topic ideas, but not clearly explained or elaborated upon	Assumptions are defined and linked to topic ideas; student can elaborate on assumptions and discuss implications
Communicates point of view	Does not identify own position on the issue	Identifies own position on the issue, drawing support from experience	Identifies own position on the issue, drawing support from experience, and information not available from assigned sources
Provides evidence of research	No evidence provided to support argument	Accepts evidence at face-value, even if incorrect, inadequate, or misrepresented to support argument	Information is gathered from appropriate and credible sources to support argument
Analyzes data	No analysis of a topic. Student only lists or defines concepts of topic	Demonstrates ability to analyze and make interpretations of topic	Demonstrates ability to analyze and elaborate on interpretations of topic
Considers other perspectives and positions	No identification of other perspectives and positions	Identifies other perspectives and positions	Identifies and assesses other perspectives and positions
Draws implications	Cannot explain or testify to the impact of new information	Explains or testifies to the impact of new information	Explains the impact of learning new information, making predictions, and generates new ideas
Assesses conclusions	No reflection of idea evolution on argument development	Limited reflection of idea evolution on argument development	Extensive reflection of idea evolution on argument development

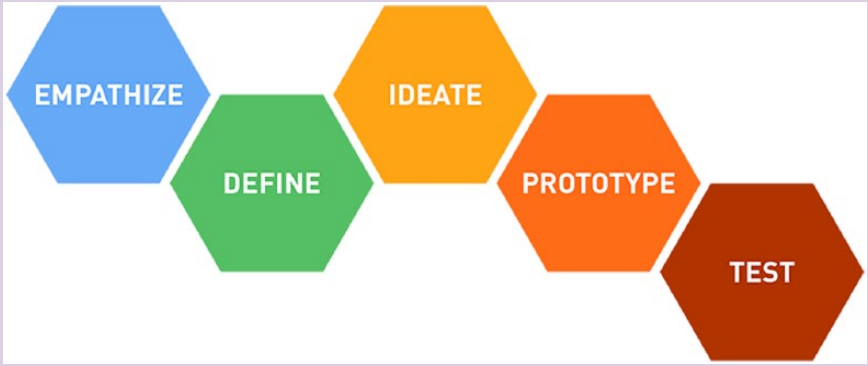

Figure 1. The five stages of the DTM.
Note. The DTM is described as a systemic, nonlinear process, which entails five stages: empathize, define, ideate, prototype, and test (d.school, 2009). DTM = Design Thinking Model.

assessment, we anchor this discussion in a fictional project. In general, many projects could fit within this design model. For example, teachers may provide students with a real-world problem to solve (e.g., https://goo.gl/61fz54), or teachers might create scenarios to situate students as inventors. For instance, some schools sponsor inventors' fairs each year as an opportunity for students to engage in the design process (e.g., https://goo.gl/JdMVVw), and this project could further be revised to include evidence of the process students employed to determine their own problem to solve. While there are many options to anchor a design challenge, we embed our discussion within a local problem that affects many students: satisfaction with school lunches. In each section below, we consider and define the specific stages, apply it to the school lunch example, and consider how to assess students' work in that stage.

Empathize

Drawing on the d.school's definitions of the design thinking stages, the first stage requires designers to empathize with the end user. The students' goal is to solve a problem for the end user, which requires a level of empathy. The student designer should feel invested in designing a product or a solution for someone else and consider the world from the user's perspective—imagining what the other person experiences. This can be accomplished through collecting end-user information via observation (i.e., watching what the person does), engagement (i.e., interviewing), and/or immersion (i.e., visiting the end-user's daily environments and activities). Examples of how the empathy mode might be implemented in a classroom vary in terms of real-world to fictional situations.

When considering our school lunch issue, students must begin by empathizing with those who eat the school lunches. Students observe classmates during lunchtime and take notes. Students may take photographs and videos to examine later. Then, students develop interview questions to ask their classmates about lunch. Students conduct their interviews, collecting responses and learning more about the lunch hour and students' feelings, thoughts, and ideas regarding lunchtime. Finally, students choose different lunchtimes to immerse themselves in the experiences of students across all grade levels while also taking more notes, photographs, and videos. Teachers may help students compile their data to analyze it and unpack their findings. For the final project, students are assessed on the quality of data collected and thorough analysis of the end user's experiences.

Define

The next stage requires defining the problem. Carefully defining the problem is an essential stage in this process because the solutions are designed to address the problem, such that if the problem is inappropriately defined, the solution will be designed for the incorrect problem. Furthermore, this stage encourages designers to reframe the challenges at hand, which serves to focus and streamline the design. Appropriate problem statements require synthesis of responses uncovered during the empathy mode. Furthermore, the problem statement must be meaningful and actionable, otherwise known as a Point of View (POV). The POV situates the designer to combine the knowledge about his users and their needs and insights into one statement describing the users' needs and why (see Interaction Design Foundation). Central to the problem statement is how one might solve this problem, leading to questions that begin with "how might we . . ." and "in what ways might we . . ." Both questions lead designers to brainstorming, also known as the ideation mode.

Returning to the school lunch example, after the data from the interviews and observations had been collected and analyzed, students learned that the environment was too loud and crowded, which made many students feel anxious. This information led to a sample problem statement: Children reported lunch was not satisfactory because the lunchroom was too loud and crowded. This problem statement resulted in questions to guide students' ideation: How might we design a school lunch space that is quiet, but still permits socializing? In what ways might the space become less crowded? During this stage, students are assessed based on their ability to develop a problem statement that represents their end-user's needs and guides the development of actionable solutions.

Ideate

During this next stage, the ideate stage, student designers generate creative solutions and ideas to address their problem statement and questions identified during the define mode. This mode requires students to develop many, different ideas (i.e., creative fluency and flexibility) and encourages them to think of several original solutions. The purpose of brainstorming (e.g., saturate and group) aims to formulate distinct, diverse, and numerous ideas. This mode requires both critical and creative thinking as students develop many ideas, choose several to elaborate upon, and then purposefully decide which ideas to prototype.

Returning to our school lunch example, students generate ideas to solve the problem by asking a "how might we . . ." question (e.g., How might we design a school lunch space that is quiet, but still permits socializing?). Strategies we might employ to brainstorm are many; some may include reverse brainstorming, attribute listing, and SCAMPER (i.e., an acronym of question prompts to guide idea generation; Substitute, Combine, Adapt, Minimize/Maximize, Put to other uses, Eliminate, Reverse/Rearrange) (Davis, 2004). These strategies require designers to think beyond simply gathering ideas for solutions. They require student designers to ask critical questions to ignite creative thinking and problem solving through iterative strategies. Some questions that one might ask to generate ideas using the SCAMPER strategy include as follows: What can we substitute in the lunch space to reduce noise? What can we combine in the lunch space to reduce noise? How can the lunch space be improved to reduce noise? Can we change the room, furniture, and/or walls to make it less noisy? Can lunch take place somewhere else? These are just a

few questions that students might ask to generate ideas using the SCAMPER strategy. To assess the ideate stage, students must record all their ideas. This demonstrates to teachers that the students did not just proceed with the first idea that came to mind. Then, once students generate their ideas, they sort them into categories and determine which ideas to prototype.

Prototype and Test

The final stages of the DTM include prototyping and testing. During these stages, designers sketch, draft, and build various models of their most feasible idea(s) to solve the problem. Prototypes can appear as physical items, rough drafts, storyboarding, and sketches. These prototypes are shared with the aim to receive feedback through observation and engagement with the users. Designers document and refine their designs based on user interactions with their prototypes with the intent to test their revisions. The test mode is similar to the prototype mode, but it requires a revised, working prototype that the audience can interact with and/or observe. The purpose of this mode is to receive feedback about the idea, make additional revisions, and observe and learn about how the intended audience percieves the idea.

Examples of prototyping in classrooms may already be in practice. Within our school lunch example, students' prototypes may be displayed at a school fair or presented to the principal, other students, and cafeteria managers; specifically, students may share their prototypes (e.g., sketches, storyboards, models) of their lunch spaces with an audience who can then provide feedback. After the students receive feedback, they revisit their design and incorporate the feedback before submitting their final project. Furthermore, they will need to reflect upon the process of receiving feedback and how they incorporated the feedback into their design.

In general, across stages, rather than only assessing the end product, students' processes can be evaluated as they design the solution(s) for specific problem(s). Thus, it is not the student with the most successful end design that earns the highest marks, but the students who can illustrate their process and demonstrate their creative and critical thinking skills as a result of their experience, which reflects the true goal of learning. Thus, our proposed assessment tool (Table 3) encompasses and acknowledges the entire design process. Anchoring assessment practices within this model communicates the importance of the process to students and encourages them to focus more on that process. In addition to assessing each step of the process, this rubric also includes a reflection component. This supports the development of metacognitive skills within students, which is also emphasized within NAGC standards and life.

Practical Considerations for Process Assessments

We hope our rubric examples communicate the feasibility of creating a rubric that align with the teacher's true goals of design projects, assessing both creative and critical thinking skills (thus encouraging students to purposefully practice these skills sets). The creativity (Table 1) and critical thinking (Table 2) rubric components dovetails with the DTM, and teachers can combine these rows with the DTM rubric (Table 3) to meet a variety of objectives. For example, usefulness connects with the emphasis on designing a product to meet an end-user's needs (empathy), and many of the stages require creative fluency. The final rubric could then include the full DTM, creative fluency, and provision of research evidence from the critical thinking rubric. However, these components may connect so closely that teachers may find it unnecessary to include both.

In this article, we provided many criteria for teachers to assess thinking process skills in any given project, but particularly highlighted the natural intersections of creative and critical thinking in the DTM. An additional benefit to incorporating these thinking process skills into the rubric is to *show* students the characteristics of becoming a good thinker and the types of skill sets required to solve real-world problems.

Just as a math teacher encourages students to show their work, teachers who are implementing the DTM or assessing thinking process skills should also require students to show their work. Documentation of initial ideas and the evolution of ideas into a feasible solution or artifact provides proof to the teacher of how the student used creative and critical thinking to navigate to final solutions. If any of the five stages of DTM are skipped, shallowly explored, or the evidence provided is weak, then the grade can reflect students' diligence. Conversely, even if the final project solution for the end user is unsuccessful, as long as the five stages were implemented, deeply explored, and well documented, the student should ideally receive a positive assessment rating.

To collect information on cognitive processes, a number of approaches can be used in the classroom for documentation of thinking processes. The process should be recorded throughout the project. For example, teachers may use daily exit cards geared toward process reflections, and at the end of the project, the students reflect across those cards. Drake and Burns (2004) also suggested multiple additional options for students to document their process, such as journals, observation, portfolios, and checklists. A particularly useful tool for the DTM is the portfolio. Portfolios are a student-centric pedagogical tool that collects evidence from multiple sources of student work in a culminating document or other communicative platform. Portfolios may be tailored to the class and provide accommodations for student reflection—the opportune time to assess for creative and critical thinking. Another option could include mini-video recordings, like a student-crafted documentary, following the development of their project. For example, Puppet or Keepy, both iOS apps may be utilized to create visual journals with voice over capabilities. Students can photograph their process and then record their thoughts and/or describe how or what they are doing in their photos, which prompts further reflections on their process in an external manner.

Table 3. Sample Rubric Using the DTM[a] as Assessment Criteria

	Novice	Developing	Expert
Empathy	Students did not adequately collect data to explore the end-users' needs. The data may not be clearly presented or not carefully analyzed or synthesized. The data may only represent the students' perspective.	Students explored the end-users' needs through interviews, observations, purposeful engagement, and/or research. Students presented their findings, but did not fully synthesize across sources. Students were able to describe how the end-users needs are unique and present an opportunity.	Students actively and deliberately considered the end-users' needs through in-depth interviews, observations, purposeful engagement, and/or research. Students synthesized across multiple types of data to represent various perspectives. Students were able to describe how the end-users needs are unique and present an opportunity.
Define	Students presented limited methods to define the opportunity. Students seemed to randomly choose the problem without a provided defense. The problem statement may be too broad to help direct the subsequent stages. Furthermore, there is little evidence that the data collected from the empathy stage was considered.	Students considered several ways to define the opportunity. Students choose the problem statement and could defend their choice. The problem statement may be too broad to help direct the subsequent stages or it may not incorporate the data collected from the empathy stage.	Students considered multiple ways to define the opportunity. The designer integrated the knowledge gained from the empathy stage into the problem statement. Students carefully choose the problem statement to anchor their work and could defend their choice. The problem statement is meaningful and actionable. The problem statement provides structure for the next stages.
Ideate	Students considered a few different ideas as potential solutions for the opportunity. Students were able to elaborate upon one of their ideas and defend which idea they would use to develop their prototype.	Students considered several different types of ideas as potential solutions for the opportunity. Students were able to elaborate upon one of their ideas and defend which idea they would use to develop their prototype.	Students considered many ways to develop solutions for the opportunity. Students presented unique and flexible ideas to address specific needs. Students were able to elaborate upon a few of their best ideas and defend which idea they would use to develop their prototype.
Prototype and test	Students documented a few iterations, changes, and adjustments to the design, experiment, or model. Students were satisfied with their first idea.	Students documented specific iterations, changes, and adjustments to their design, experiment, or model. Students continued to elaborate or adjust their first idea throughout the process.	Students documented in-depth, specific iterations, changes, and adjustments to their design, experiment, or model. Students continued to elaborate or adjust their first idea throughout the process. Students used actual data collected from an authentic audience to make positive changes.
Reflection[b]	Students briefly reflected upon the design process by addressing a frustration or triumph. The reflection includes one idea for future exploration. Students neglect to support their reflection with specific evidence.	Students reflected upon the design process by addressing some of the project's frustrations or triumphs. The reflection includes future avenues for exploration. Students provide some evidence for these reflections.	Students thoughtfully reflected upon the design process by specifically addressing the project stages, frustrations, improvements in processes and products, and future avenues for exploration. Students provide valid evidence for their reflections.

Note. DTM = Design Thinking Model.

[a]For more information on each stage, see Stanford's d.school's webpage for free resources ("Tools for taking action," 2018).

[b]If students used the DTM in the past, they could also reflect upon how the current project/application demonstrated growth or change from previous projects. This will encourage metacognition and awareness of growth within students.

Conclusion

Teachers often use rubrics to communicate what is important and to direct student projects; however, not all rubrics are created equally, and oftentimes, they emphasize what is easy instead of what is important. For example, determining how far the mousetrap car travels may be easy to measure, but it may not represent the most important educational goal(s). Also, teachers can only assume that students used specific processes to generate their solutions to problem, but they do not have concrete evidence documenting those process skills. Therefore, successful products may be the result of luck or outside assistance, and unsuccessful products may be the unfortunate outcome of meticulous effort and important process skill development.

In this article, we address this issue by considering the operational definitions and methods for the assessment of two important goals of gifted education—creative and critical thinking—both process skills that are widely employed and valued across contemporary society. We synthesized across these skills with the full process model of DTM, ultimately designing three rubrics that assist teachers in assessing creative thinking, critical thinking, and a five mode-system of solving problems for an end user. We hope the individual creative and critical thinking rubrics provide daily and flexible support for teachers, and the DTM rubric may provide a stronger foundation for more complex design projects. The DTM can bring problems of the real world into the classroom and can easily incorporate best practices for gifted students.

Through the implementation of these assessment tools, teachers measure student growth in creative and critical thinking. Rubrics and assessment criteria communicate what matters to students and guide what feedback teachers provide. Deliberately assessing the process emphasizes the importance of student effort and the value of specific creative and critical thinking strategies. Furthermore, specific feedback regarding the process may help students develop self-regulation and metacognitive thinking abilities. Therefore, by focusing on what truly matters, we are providing guidance on how students can contribute to our global future. Although more research is needed examining the implementation of these rubrics across the curriculum, this is an important first step in measuring students' creative and critical thinking, transferrable process skills that matter.

Conflict of Interest

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Bios

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