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Perceptions of K-12 Teachers on the Cognitive, Affective, and Conative Functionalities of Gifted Students Engaged in Design Thinking

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ABSTRACT

Gifted students are our nation's natural resource of technological inventors and innovators, but oftentimes do not receive differentiated instruction in technology/engineering design learning environments. This is not negligence or lack of care by the instructor, but a national issue of not sufficiently providing pre- and in-service teachers with formal training opportunities in gifted education. The purpose of this study was to understand the perceptions of K-12 teachers, trained in gifted education pedagogy and the Design Thinking Model (DTM), after their gifted students engaged in design thinking activities. Fifteen K-12 educators of different content areas reflected in focus groups upon how their gifted students performed. Teachers noted cognitive, affective, and conative phenomena, such as development of 21st Century capabilities, externalizations of psychosocial behaviors (e.g., perfectionism, avoidance of failure, gifted underachievement), and strong motivations to solve problems for end-users. The researchers suggest that with the reality of educators unable to receive formal training in gifted education, developing an awareness of intrapersonal functionalities of gifted students engaged in design thinking can be a significant step toward providing supportive learning environments.

Keywords: Design thinking; Design Thinking Model; gifted education; Technology and Engineering Education

Introduction

Today's educators are tasked with preparing a diverse, heterogeneous group of students for complex and undetermined jobs. Two key components of this charge include (a) understanding unique students' needs and characteristics, and (b) implementing pedagogical practices that develop 21st Century capabilities such as collaboration, communication, creative and critical thinking (NCTE, 2013; Partnership for 21st Century Skills (P21), 2011; Snape, 2017; Walser, 2018). First, regarding student needs, most classrooms are grouped by chronological age, rather than educational readiness, resulting in students with abilities spanning six to ten grade levels (Diezman et al. 2001; Firmender et al., 2012; Peters et al. 2017). The majority of teachers' time is spent addressing students who are struggling, while overlooking average and advanced students (Farkas & Duffett, 2008). This may be occurring due to extreme pressure to meet state and national standards (Moon et al., 2007), but it may also be due to a lack of teacher preparation in differentiation, especially for gifted and talented students. Within the United States, on average, pre-service teachers receive less than two hours of total instruction on meeting gifted students' needs (NAGC, 2015-a), and often, professional development opportunities are ineffective at changing classroom practices (McCoach & Siegle, 2007; Peters & Jolly, 2018).

The second challenge is to integrate pedagogy that facilitates 21st Century capabilities into the curriculum; however, given the current educational climate, this too can be difficult. Most state and national assessments emphasize knowledge acquisition or lower level process skills in language arts and math. The outcome is reduced classroom time spent on other subjects and less time devoted to deeper level process strategies (Au, 2007; Dee & Jacob, 2010). One strategy to address both of these challenges is to integrate design thinking opportunities into all classrooms.

Literature Review and Theory

Design Thinking

Across myriad industries, design thinking has many definitions and meanings (Buchanan, 1992). Within this article, design thinking is conceptualized as a paradigm for innovation and a process for problem solving (Dorst, 2011). Dym and colleagues (2005) refer to design thinking as a "systemic, intelligent process in which designers generate, evaluate, and specify concepts for devices, systems, or processes whose form and function achieve clients' objectives or users' needs while satisfying a specific set of constraints" (pp. 104). While these definitions explain the purpose, recent stage-based models provide explicit guidance on how to facilitate the process. The Design Thinking Model (DTM) provides a linear, yet recursive five stage process: empathy, define, ideate, prototype, and test (Plattner, 2010; Cook & Bush, 2017). Table 1 summarizes the five steps.

Technology educators have been promoting design thinking for years, including studies examining how educators implementing design thinking to teach mastery of STEM content, art, and humanities (Bequette & Bequette, 2013) and cognitive processing skills (Lammi & Becker, 2013; Shively et al., 2018). Previous studies of design thinking within curriculum and instruction suggest this pedagogical approach positively impacts the learning experiences of traditionally underrepresented populations in STEM disciplines (Kramsky, 2017; Santovec, 2012, Tyler & Johnson, 2017). In general, design thinking tasks can be approached from different readiness levels and intellectual abilities, making them a natural method of differentiation in heterogeneously grouped classrooms (Gentry et al., 2008). Further, these tasks are interdisciplinary, require the integration of content knowledge, and promote deeper cognitive processing.

Table 1
Summary of Design Thinking Model (DTM)

Stage	Description
Empathy	Connect with the end-user and learn as much as possible about this person's wants and needs.
Define	Develop a specific problem statement inspired by the empathy engendered in the prior stage. The purpose of this stage is to clearly identify a logical goal designed to solve the end user's want/need.
Ideate	Research, generate, modify, and co-construct new versions of ideas to fulfill the goal
Prototype	Select an idea(s) to create a prototype and justify the decision. The purpose of this stage is to create a model of the idea, moving the abstract to a tangible or representative form.
Test	Experiment with the prototypes to evaluate functionality and ability to address the problem of the end-user. Consider the information gathered and developed within previous stages to revise and redesign ideas, prototypes, and eventually re-test them within the cyclical structure of DTM.

Gifted Students and Design Thinking

While design thinking addresses these current needs (i.e., supporting a heterogeneous student population in the development of 21st Century capabilities), little research considers how gifted students actually engage with design thinking and the outcomes of DTM implementation. A literature search using the terms "gifted" and "design thinking" in several databases (i.e., Academic Search Premier, PsychINFO, PsychARTICLES, and ERIC), yielded seven journal articles. Many gifted students may have unique reactions, experiences, and stressors as their talents intertwine with their still-developing physical and emotional maturity (Field et. al., 1998), and many educators may not be prepared to recognize these unique needs and characteristics (NAGC, 2015-b). Gifted students' unique characteristics could be conceptualized as: cognitive (i.e. intellectual abilities and higher order thought processes), affective (i.e. emotions and emotional development), and conative (i.e. motivation and motivation development). With these additional complexities of giftedness, gifted students may be uniquely impacted when engaging with design-based learning experiences.

The federal definition of giftedness is:

> Students, children, or youth who give evidence of high achievement capability in areas such as intellectual, creative, artistic, or leadership capacity, or in specific fields, and who need services and activities not ordinarily provided by the school in order to fully develop those capabilities (NCLB, 2002).

However, states and districts are not required to use this definition. The students of this study were identified based on Indiana's identification measures as they performed, or showed potential for performing, at an "outstanding level of accomplishment in at least one domain when compared to other students of the same age, experience, or environment; and is characterized by exceptional gifts, talents, motivation, or interests" (Indiana Department of Education [IDOE], 2013, para 3). The local school district of the students further specifies the domains, often math and language arts.

In 2013-2014, there were approximately 3.3 million students in the United States enrolled in gifted and talented programs (Office of Civil Rights, 2014). Gifted program coordinators, teachers, educational leadership, and families often work collaboratively to provide critical services to meet the diverse needs (e.g., academic, cognitive, social, emotional) of the gifted student. Advocacy measures call for the continued support of gifted students to develop competencies for success in the 21st century; however, lack of financial resources and unfamiliarity with gifted student characteristics may lead to students not receiving the services needed (NAGC-a, 2015).

Technology and engineering education, career and technology education, and displine predecessors are ideally positioned for intersections of natural differentiation, relevancy, and creativity to benefit gifted students (Brenneman, Justice, & Curtis, 1980; Colson, Milburn, & Borman, 1983; Dailey, 2017; Dailey, Cotabish, & Jackson, 2018; Gentry, Hu, Peters, & Rizza, 2008; Mentzer, Reed, Alnouri, & Barbarji, 2018). According to Mann et al. (2011):

> For students who have been identified as gifted but spend the majority of their day in regular education classrooms, engineering design activities present opportunities for varying levels of sophistication, breath, and depth of understanding, thus providing them with appropriately challenging tasks" (p. 651).

Unfortunately, technical programs remain an afterthought for gifted student programming or they are even perceived as inappropriate by educational colleagues outside of the technology education field (Greene, 2006; Gentry et al., 2008). Compounding this issue, many technology and engineering educators are unfamiliar with the complex spectrum of gifted characteristics and aptitudes. The most talented students may be overlooked and do not receive sufficient attention in classrooms (Gentry et al., 2008).

Study Objectives

Therefore, to prepare teachers to support students in solving complex problems, our research team implemented DTM professional development workshops with K-12 teachers to design and actualize classroom DTM learning experiences. The purpose of this study was to understand the impressions of K-12 teachers teaching who implemented the DTM with gifted students within their inclusive classrooms. Within focus groups, researchers, who were not involved in the professional development sessions, discussed with the teachers how gifted students responded to the DTM learning experiences. Gifted students were placed in inclusive, hetergeneous classrooms, grouped with peers who were not identified as gifted. The transferability of this study to other classroom environments is notable, as it is likely that education practitioners of design thinking across the nation also have gifted students embedded within the general population classrooms. Thus, this study presents teachers' observations and perceptions of gifted students' cognitive, affective, and conative characteristics when engaged in design thinking.

Method

This investigation used a qualitative approach as a means to promote deeper understanding of human experiences (Bogdan & Biklin, 1992). Teacher participants received voluntary, paid, professional development training on DTM for two weeks during the Summer 2017 and continued professional development/coaching once a month throughout the 2017-2018 academic school year. Teachers completed surveys, submitted DTM unit artifacts online, and participated in focus groups sessions to share their experiences using the DTM in their classrooms. This study examines the focus group data pertaining to gifted students. Focus groups for this study were used for the following reasons: a) within this specific school, teachers often act as a collective group and share students, b) teachers' attitudes and perceptions already influence each other in the natural school environment, and c) the existing comfort and relationships allow for a more candid conversation than would happen with individual interviews. The focus group conversations were audio recorded, transcribed, and analyzed for overarching themes.

Sample

The teacher participants of the focus groups (n = 15) taught K-12 across different content areas- including arts and humanities. Thirteen of the participants were female and over 50% of all participants had 15 or more years teaching experience. The choice-based school accepts a higher than average number of gifted students (i.e., 20% or more of each class is earmarked for students identified as gifted through state testing procedures). The teacher participants have received, or are in the process of receiving, gifted and talented teaching licenses in a nationally accredited gifted licensure program.

Data Collection

Focus group interviews were conducted with teacher participants in small groups ranging in size from 2-5 teachers. Focus groups, rather than individual interviews, are particularly beneficial when the experiences and understandings of participants are socially constructed (Merriam, 2009). In this case, homogenous groups comprised of teachers who work with similar grade level students, and often collaborate on unit design and planning, were chosen which can help encourage open discourse (Sagoe, 2012). This was particularly beneficial because their shared experiences allowed them to hear each other's thoughts, spark conversations, allow for thoughtful reflection, and ultimately add to the richness of the data (Merriam, 2009; Patton, 2002). The focus groups were facilitated by two interviewers with no existing connections to the school or the DTM professional development, further encouraging open discourse. Each focus group lasted approximately 45 minutes, conducted on-site, in a closed classroom allowing for open discussion. All participants were informed of the focus group's purpose and were assured of confidentiality.

Semi-structured interview protocols are an effective way to allow researchers to explore what is important to participants in a conversational tone, while still covering similar topics across groups (Merriam, 2009). A semi-structured interview protocol was developed for use with the focus groups prior to data collection and utilized similarly with each focus group to capture open-ended responses (See Appendix A). Questions were developed as open-ended questions, intended to encourage discussion among participants without prompting or leading to certain responses. Teachers were asked to reflect about their overall experiences with DTM and their students' experiences, but they were not led to discuss cognitive, affective, and conative characteristics, as those characteristics emerged after data collection. All focus groups were audio recorded and transcribed for further analysis.

Data Analysis

To support the canons of validity, this study's data analysis replicates Anafara, Brown, and Mangione's (2002) approach for transparency in the coding process (See Table 2). It should be read from the bottom up, as the raw data serves as the foundation anchoring the process, leading to the development of themes. After transcribing the raw data, the researchers individually read and reread the data to familiarize with the focus group texts. With the first iteration, the responses underwent a surface content analysis of initial codes. In the second iteration, pattern variables were identified. The third iteration of analysis addressed applications to the data set. After coding all of the data separately, condensing the codes, and a final read of each transcript, the researches met together to reach group consensus of coding results, and then collapsed the codes into themes to convey rich, thick description. Though an inherently inductive study, the primary investigator recognized the pattern variables of the second iteration unintentionally represented the operational definitions of interpersonal, gifted functionalities (Moon, 2013). Therefore, the inductive codes were organized and categorized under this existing theory.

Table 2
Code Mapping of Data Pertaining to Teacher Perceptions of Gifted Youth*

Focus Group A	Focus Group B	Focus Group C	Focus Group D
Third iteration: Themes			
Cognitive Development: Design thinking provides an opportunity for gifted students to develop 21st Century capabilities. Affective Development: With an open-endedness of design thinking, gifted students needed to develop more adaptive methods for collaborating and addressing their perfectionism and avoidance of failure/risks. Conative Development: Design thinking leads to motivation, engagement, and self-direction.			
Second iteration examples: Pattern variables			
• Students collaborated with peers and showed creativity and critical thinking • Emotional challenges: perfectionism, avoidance of failure, and gifted underachievement	• Students initially experienced difficulty in design thinking, but found the process to be rewarding when solutions were successful • Inspired to invent and innovate	• Students enjoyed the real-world relevance and helping others. • Failure was negatively perceived for many gifted youth, and they did not want to participate	• Students had to think creatively and critically to solve real world problems • Motivated to be correct right away instead of going through multiple iterations
First iteration examples: Initial codes**/surface content analysis			
88. Collaboration generated in ideas 91.A. Excited by prototype success 94.B. Problem solving and communicating 94.C. Compared to non-gifted, experienced greater challenge in design 100.A. Taking control of group	77. Real world relevance 87.A. Preference for design thinking activities. 87.B. Strong engagement by students with excitement 102.A. Difficulty adapting ideas	34. Learn by doing 147.A. Empathy, enjoy coming up with solutions to help others 147. B. Purpose to design thinking 232.A. Students pumped 232. B. Failing with grace	201.A. Experienced greater difficulty than non-gifted kids to solve ill-defined problems 201.B. Driven to be 100% correct 201.C. Challenged, later developed design thinking capabilities
Raw data	Raw data	Raw data	Raw data

**The numbers correspond to the initial codes agreed upon by the researchers. With this numeric system, multiple researchers could locate codes in need of consensus throughout subsequent iterations.

Quality Criteria

The current qualitative study exacted deliberate methods to establish and ensure quality criteria were met including credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985). To promote transferability, the findings and sampling strategy were transparently presented in this article to foster replication of the study or application of the study in various contexts. The findings reflect an iterative process of categorizing and analyzing the qualitative data among multiple research members. The themes were reviewed repeatedly and by different members of the research team. This flexibility of analysis process increased the dependability of the study and ensures the quality of findings with relation to the context of the study. Through similar methods, the study ensured confirmability by utilizing peer reviews, researching literature in the field of gifted education and technology and engineering education, and tracking changes throughout the research and analysis processes.

Results

The findings describe K-12 teachers' perceptions of how gifted students engaged in design thinking. Students were expected to use the DTM (Empathy, Define, Ideate, Prototype, Test) to solve a problem for an end-user. The subsequent outcomes were discussed in the focus groups.

Cognitive Development: Design Thinking Provides an Opportunity for Gifted Students to Develop 21st Century Capabilities

Cognition refers to "mental processes or forms of informational processing" and includes skills such as attention, memory, learning decision-making, reasoning, and problem solving (Solomon, 2013). Gifted students were cognitively challenged throughout the process in multiple ways. Design thinking in the classroom forced students to develop flexibility within their thinking; however, this was not easy. One teacher described the struggles associated with specific stages:

> ...if you tell them, 'no, you need more', they'll just write down something...they're not really thinking, they have made their decision, then they're just trying to appease you. The other thing, when they're thinking about evaluation testing, they're going to say it's okay, because they don't want to go back and fix it.

Another teacher observed the struggle with cognitive rigidity, "My higher group, they're the ones that did the worst compared to the other kids. Because they [gifted students] couldn't adapt their ideas, 'no this idea has to work, it will work,' ...they couldn't move past it."

Similarly, an additional teacher shared:

> For some of our high ability students, [DTM has] been more of a challenge because they're used to succeeding. [When they] have to really problem solve and translate what they created on paper into a creative 3D project, that was very difficult. Our other students, they just went at it. They just did it.

Gifted students may have faced additional challenges because their original ideas were so complex and intricate that they were challenging to bring to life. One teacher commented, "Sometimes I think for our high ability students … it was how elaborate their thought process was, and so to create that was almost impossible. So, I think that that was part of the problem with our [gifted students].” Therefore, these students were cognitively challenged to translate their original ideas into functioning prototypes.

Affective Development: With an Open-endedness of Design Thinking, Gifted Students needed to Develop more Adaptive Methods for Collaborating and Addressing their Perfectionism and Avoidance of Failure/Risks

Affective growth is part of human development, which includes a combination of emotional development, emotional regulation, and recognition of socially appropriate responses toward the emotional functioning of others (Yirmiya & Seidman, 2013). Teacher participants emphasized how DTM experiences impacted students’ affective development, including students’ social skills (i.e., collaboration) and emotional regulation (i.e., perfectionism and avoidance of failure).

Collaboration

Within the DTM tasks, students were often placed in groups to tackle certain tasks. In general, teacher observations indicated differences in how students at varying levels reacted to collaborative learning experiences. Teachers discussed how most students worked cohesively in DTM groups rather than displaying competitive behaviors:

> They pick up on, “...my friend needs me to help with this,” so there isn’t an, “I’m smarter than you, I’m going to do this,” it’s just...they start looking at skills and talents and they look at who draws people better than someone else, who is [best able] to write this sentence…

The conversations were problem/solution focused and students supported each other. As one teacher described, “I really loved when they were working, and a friend would say, ‘Did you think about using this,’ or, ‘Have you thought about this?’ that creates [ideas] and stimulates the kids.” Several teachers reflected on the way in which students collaborated and celebrated small successes. One shared, “They cheered when the houses stood…they [the students] even cheered when their friends or their dwellings stood and withstood [the external forces during the testing phase].”

Yet, as teachers shared their positive observations of student reactions, they also noted negative group dynamics. For example, one teacher described:

> One of our identified high ability students was trying to take control of the whole situation and not listen to anyone else and not accept anyone else’s suggestions. Constantly saying ‘I already know this this is what we need to do.’ At the end, he panicked and…for the life of him, he couldn’t understand as he looked around at the other groups and they were successful. ‘Why were they successful and his group not, especially when he was in charge?’

Conversely, other gifted students struggled to find their place within the group: “[this student] could not find his niche in this group, and he struggled, he said, ‘they’re not letting me do this, or they’re not giving me a job to do.”

Perfectionism and Avoidance of Failure

Teacher impressions were largely positive because even when DTM tasks were challenging, these tasks provided students with opportunities to develop their social and emotional skills. Specific examples of perfectionism, and avoidance of failure were also discussed. Often those experiences led to breakthroughs, but the struggle was significant. One teacher elaborated, "At first they struggled, because it had to be right, and it had to be perfect, and they thought there was only one right answer. And the more we've done it, they're like, 'okay, let's go!'"

The gifted students needed to learn to handle failure and setback, which the teachers identified as supporting students' emotional regulation capabilities. This observation was echoed by multiple teachers across grade levels. One teacher shared, "Our more general ability students seem to take it in stride." Another teacher added, "Failure is more of a debilitating, hard to come back from thing for [the gifted] kids." With more exposure, several teachers observed positive growth. A teacher shared, "[The students were] pumped, once they realized that failure was okay." As one teacher stated:

> My high ability kids were my hardest to break from the one right answer mentality. They were really, really, really driven on 100 percent correct, all the time, being told that they were correct. So, getting them to break and try different things for the same purpose was a little challenging. Now, once they get out of that habit, they were like, off the charts…but at the beginning, it was really tough.

The elicitation of affective responses was perceived by the teachers when activities were anchored in the Design Thinking Model.

Conative Development: Design thinking leads to Motivation, Engagement, and Self-direction

Conation refers to motivation and motivation-related processes such as "goal setting, persistence, and student interests" (Moon, 2013). There are many reasons why DTM tasks promotes motivation, including engagement, differenitation, and interest integration. First, teachers shared how students were actively engaged, excited, and driven to design solutions to improve the life of an end-user. For example, students were tasked with designing a dwelling for the gingerbread man (end-user), and the teacher reflected, "One of our students, when we were building our prototypes and making our models, actually said this was the best day of school ever!" Purposeful design thinking motivated the students, as a teacher explained:

> I have some who don't want to do anything else during the day, but as soon as we do a design thinking project, they are up, they are excited, and you actually see a smile on their face. I have enjoyed that part of it, when I can give it.

Overall, teachers commented about observed motivation toward design thinking in their students. One teacher concluded, "They get to design their projects, and then, just trying to build them, it's a lot of fun!"

Beyond simply enjoying the hands-on nature of design projects, students experienced increased motivation, as they have the opportunity to approach the task at their own levels. In DTM, teachers observed that gifted students are challenged daily while pursuing interests and developing relevant skills. A teacher shared:

> ...it was interesting how everybody got something really important out of it and everybody understood the end game and the goal. The neat thing with this is you don't have to differentiate because they differentiate on their own and they come where they are, and they leave in a variety of different places. Each of them gets their own experience.

Using the DTM, teachers gave students an opportunity to use their talents and explore their interests. One teacher stated:

> The thing that I probably value the most about this was that it allowed each student to shine in their own way...differentiation was an intentional part of them not me. That's how the differentiation occurred, it wasn't me specifically saying, 'Oh, you're high ability so you're going to do this,' or 'Man you need some help here, I'm going to…' it was allowing them to work at their own level at their own creative speed...it allowed them to do that, and that's how I feel that young children learn best.

Another teacher shared more about the differentiation of DTM, "...it's natural, it is individual, it is not prescribed by the teacher or by the curriculum…it is a wholly natural process."

Another potential reason for increased motivation was the authentic, transferable nature of the challenges. A teacher described how she used a real-world issue to develop a DTM unit, "…the hurricane project was really relevant to our class because we had just been talking about the Texas hurricane and the Florida hurricane, so they were interested. They'd been hearing about it on the news." Other teachers reported their observations of learning that transferred to other contexts of students' days. Referring to the school's recent science fair, a teacher described one student's reaction:

> She said, 'I did this, so to help people know which type of drinking water to buy, which one is healthiest for you, and saves you the most money. You know what I mean?' She had, right out front, a reason why she had tested all these different bottles of water. I was like, 'alright, you have a purpose.' There is application to it.

Teachers were purposeful in their DTM lessons to address local, regional, national, and global problems and perceived that gifted students had positive conative responses with design challenges.

Discussion

The purpose of this paper was to share the reflections of K-12 teachers of their gifted students' experiences with the DTM within inclusive classrooms. We reported the externalizations of student design thinking observed by participant teachers. The gifted characteristics revealed in this study may be indicative of many gifted students, while still not describing all gifted students. However, similar phenomena may surface in scenarios within other classrooms that implement design thinking or related design-based pedagogy. The themes provided in this study may inform technology and engineering educators in ways gifted students engage in design thinking.

Cognitive, affective, and conative processes are three intrapersonal human functions that were addressed in the data and align with Moon's (2009) categories of intrapersonal human functioning. Cognitive functioning was addressed by teachers through students' academic pursuits of design. Affective functionalities were addressed by teachers describing the emotional responses of students to the design challenge and to each other. Conative functionalities were addressed by teachers through descriptions of how the natural differentiation of design thinking created opportunities for student interests to be integrated.

Cognitive Development: Design thinking provides an Opportunity for Gifted Students to Develop 21st Century Capabilities

As research within the field of gifted education has evolved, so have researchers' conceptions of the importance of gifted students' talent development in a technologically driven society (McMath, 2016; Olszewski-Kubilius, Subotnik, & Worrell, 2016). With implementation of DTM, teachers perceived student performance in many ways fulfilled the call for growth of 21st Century capabilities (NCTE, 2013; P21, 2011; Snape, 2017; Strimel, 2012; Walser, 2018). The Pre-K-Grade 12 Gifted Education Programming Standards by the National Association for Gifted Children (NAGC) places great emphasis on gifted curriculum and instruction that provides critical and creative thinking opportunities to students (NAGC, 2010). The teachers perceived these cognitive processes were developed as students struggled with cognitive rigidity. Adaptability was initially a struggle among the gifted students. Teachers noted students were reluctant to fail and hesitated to return to earlier stages of the DTM, however; as experiences progressed, teachers commented that students appeared to grow in this area. Students had to practice the iterative process and seeing solutions from a variety of angles. Their end products were evaluated across multiple components of critical thinking and creativity (for rubrics of novice/developing/expert components see Shively et al., 2018). Students were initially hesitant to provide answers for ill-defined problems, but with more exposure to DTM lessons, they became more fluid with exhibiting the characteristics of good thinkers like graceful acceptance to the ideas of others and pursuing different solutions if the first solution did not work

Affective Development: With an Open-endedness of Design Thinking, Gifted Students Needed to Develop More Adaptive Methods for Collaborating and Addressing their Perfectionism and Avoidance of Failure/Risks

In the focus groups, teachers spent a significant amount of time addressing the interpersonal processes of students. DTM is grounded in human processes such as intuition, pattern recognition, self-expression, emotional meaning, and functional meaning which makes it inherently tied with social/emotional skills sets (Brown & Wyatt, 2010). When students were tasked to flex their social and emotional skills with design thinking activities, the teachers observed social and emotional phenomena well-recognized within the gifted education community.

Collaboration

Teachers shared how students developed communication capabilities throughout the five stages of DTM through oral, written, and artistic forms. The DTM requires students to select a single idea from the multiple ideas generated by the group, and further pushes students to expand, adjust, and elaborate on the solution as they progress. Gifted students needed to learn how to interact with one another and build upon each other's contributions. Some students reportedly began the DTM units viewing themselves as the leaders, but then realized, through vicarious learning, that successful groups had used a team approach. Within groups of varying ability levels, students began collaboratively brainstorming and providing feedback to each other on the originality and usefulness of the solutions, but this needed to be supported. Students were learning to delegate responsibilities and identified unique strengths within their groups during the process.

Perfectionism and avoidance of failure

A prevalently researched roadblock to wellbeing and academic achievement among students in the gifted population is perfectionism (Miller & Speirs-Neumeister, 2017). Students with perfectionism may experience burnout, eating disorders depression, loss of balance with school, family, and friends (Webb, 2016; Greenspon, 2018). Teachers shared that the gifted students ruminated heavily during the ideate, prototype, and testing stages compared to their peers. Some students had to take control of the group's problem-solving efforts to guarantee an absolute solution. However, the phases of DTM necessitates prosocial behaviors when the design challenge is a group activity. The inability to fully control the design challenge caused some students significant anxiety and challenged their emotional regulation. See Adelson & Wilson (2009) or Pyryt (2004) for strategies to support students with unhealthy perfectionism.

Teachers shared that high ability students found failure as an unexpected reality and had difficulty accepting initial design failures as a state separate from their self-worth. Some students initially resisted making revisions when introduced to DTM, but with practice in a supportive learning community, they revised more positively. Once acclimated to the DTM process, teachers found student mindsets shift regarding revisions. Understanding that failure can elicit significant negative affective and physiological stress reactions compared to their non-gifted peers (Roberts & Lovett, 1994), teachers can facilitate the shift to embrace revisions and view failures positively. See Dweck (2015) for a list of strategies to support students with failure avoidance behaviors.

While many gifted students worked extremely hard to avoid failure, other gifted students refused to even try (an alternative approach to avoid failure). Though the teachers did not specifically use the word "gifted underachievement" in their discourse, this phenomenon was alluded to when describing students who wanted to give up instead of attacking the design thinking activity. Gifted underachievers display gaps between measured levels of achievement and measured ability levels apart from any diagnosed learning disabilities (Reis & McCoach, 2000). The complexities of giftedness often lead to social asynchronization with peers and can be noted within collaborative frameworks like DTM. Technology and engineering teachers should also be aware of gifted underachievement as strategies are available in the literature to combat its devastating effects on the academic aptitude of the student. See Siegle (2013) for an inclusive list of strategies to support students who are gifted underachievers.

The Conation: Design Thinking leads to Motivation, Engagement, and Self-direction

Curriculum for gifted students should address their specific needs and provide support in developing their gifts (Marland Report, 1972; Silverman, 1993). Teachers shared the self-directed ways that students differentiated their own learning and chose the pace of stage accomplishment within the DTM framework. Allowing gifted students to use their strengths and work on their weaknesses promoted greater motivation. Specifically, DTM learning experiences provided opportunities for gifted students to grow in their areas of strength by requiring them to use their extensive knowledge base, conceptual reasoning abilities, problem-solving skills, metacognitive strategies, and "expert-like dispositions" (i.e., recognition that a complex problem may have multiple solutions; Gallagher, 2005, p. 287). Further, these learning experiences provide more authentic opportunities for problem solving, which is known as a hallmark of quality gifted curriculum (e.g., Tomlinson et al., 2009).

Conclusion

Among the various complexities surrounding the development of gifted children, they may exhibit unique cognitive, affective, and conative characteristics which require targeted strategies for support. Technology and engineering educators are well-positioned to design and cultivate exceptional learning environments for gifted students. The depth of cognitive and technical skills that can be explored naturally intersects with gifted students' motivations to invent or innovate solutions. Teacher participants perceived gifted students develop their 21st Century capabilities and attitudes in very positive ways; however, it is important to note, there were incidences of productive cognitive and affective struggles as well. Perfectionism, avoidance of failure, and gifted underachievement in particular were observed by teachers as students engaged in design thinking activities. When educators are more aware of gifted students' characteristics and specific resources to support differentiation, they are positioned to make a significant contribution toward designing and creating a positive learning environment for gifted students.

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Appendix

Appendix A.
Focus Group Protocol

1). **Experiences with PD**
   a. How do you think the PD is going?
   b. Thinking back on other professional development training you've experienced what, if any, differences did you notice about the delivery of this professional development?

2). **PD Outcomes for Teachers**
   a. Now, can you share some examples of some ways that you are implementing the learnings from the PD? What are the benefits? Challenges?

3). **PD Outcomes for Students**
   a. How would you describe the reaction your students have had to using The Design Thinking Model?
   b. Tell me about how you prepared for the various levels of learners that make up your classrooms or if you felt the need to do this at all.
   c. Can you tell me about any attempts you've made at assessing student learning as a result of the use of DTM?

4). **Final Reflections**
   a. What else would you like to share about your experiences that we haven't discussed?

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