

# Science through Art: Motivating Gifted and Talented Students

Ksenia S. Zhbanova  
*Mississippi State University*

## Abstract

Gifted and talented students have unique characteristics and needs. Arts Integration is an effective differentiation strategy that helps meeting these students' needs. STEM subjects are easily and organically integrated with the Arts because scientific and artistic inquiry are very similar. This practical article describes an arts-integrated project that provided the gifted and talented participants with an increased level of challenge, an opportunity for self-expression and for building social skills, amplified motivation, and a chance to deepen and demonstrate their knowledge of science, technology, engineering, mathematics, social studies and English Language Arts. In this project, identified gifted students completed figural transformations (creation of a new image by adding lines or shading to a given squiggle or geometric figure) related to one of these subject areas and learned a set of creative skills identified by E. Paul Torrance. The final stage of the project included students analyzing and reflecting on the progress they had made over the course of the semester in content knowledge and creativity.

## Key Words

STEM education, STEAM education, arts integration, figural transformations, gifted and talented students.

*Journal of STEM Arts, Crafts, and Constructions*  
Volume 3, Number 2, Pages 9-23.



**The Journal's Website:**

<http://scholarworks.uni.edu/journal-stem-arts/>

## Introduction

The figural transformation activity (changing a simple geometric figure or doodle into another recognizable image by adding lines, shading, or other) described in this article is a versatile exercise that can be effectively used for multiple purposes such as reviewing content, developing creativity, and strengthening critical thinking skills. This exercise embeds differentiated instruction. The activity described in this article aims to support gifted student motivation, develop creative skills, practice problem solving skills, and make interdisciplinary connections between Arts, STEM, and other subjects. In addition, artistic activities can also be used to identify gifted and talented students (Haroutounian, 2017; Webb, Zhbanova, & Rule, 2017).

## Literature Review

The following brief review of pertinent literature first examines the needs of gifted and talented students and how they may be supported through arts integration. Second, possible ways of identifying gifted students through the arts are addressed. Next, science and art connections through

inquiry are discussed. Finally, Figural transformations are explained.

### **How Arts Integration Addresses the Needs of Gifted Students**

Every child is unique and valued; however, there are certain characteristics that are common within the gifted and talented population that should be addressed in the education setting. According to Frasier and Passow (as cited in Wellisch & Brown, 2013), gifted students share the following characteristics: strong motivation, unusual interests, expressiveness, strong problem-solving skills, excellent memory, curiosity, insightfulness, vivid imagination, advanced reasoning abilities, and a well-developed sense of humor. Arts-integrated activities are a perfect match for students with such traits and for meeting the particular needs resulting from these characteristics.

All of the characteristics mentioned above cause a strong need for challenge (Mendaglio & Tiller, 2006; Kreger Silverman, 1998). These students have an intrinsic desire to solve complex issues. Without being challenged appropriately, the gifted and talented may lose motivation to learn (Phillips & Lindsay, 2006); because of boredom, they may adopt undesirable behaviors and accept low expectations (Bayat, 2012; Kautz, 2017). The concept of "flow" is a mental state a person can enter when performing a meaningful and challenging activity (Csikszentmihalyi, 2008). This state is characterized by a heightened level of motivation to reach a goal, increased focus, strong intuition, and harmony while engaging in the process of creation. Offering opportunities to apply knowledge in new, creative ways is one of the techniques teachers can use to provide gifted students with the challenge necessary for them to stay motivated and continue growing and developing.

The services offered to gifted and talented students vary from state to state; for not all school districts across the nation have a dedicated program to address the needs of the gifted (Kautz, 2017). Arts-integrated activities can not only be used in specific programs for the gifted, but can be an effective way to meet the needs of the gifted even in schools without a dedicated program.

Differentiated instruction is often used to meet the needs of the gifted and talented in a regular classroom (Tomlinson & McTighe, 2006). Arts-integration is one methods for such differentiation. Teachers can differentiate content by allowing students to delve into a subtopic at a deeper level, can differentiate process by giving the students a chance for a self-paced study of their own design, or can differentiate product by letting the students choose how they will demonstrate or apply their acquired knowledge through arts-integrated projects and others.

Arts projects allow much flexibility and are built on allowing students choice to pursue a topic in the manner most interesting to them (Cornett, 2015). For example, a study by Rule, Tallakson, Glascock, and Chao (2015) with upper elementary students involved them in each choosing a local wild animal to observe, photograph, and research, eventually making a three-dimensional diorama of its home, ecosystem interactions, and skeletal structure. Students delved into the form and function of its body parts, its design of a home, and its shapes and arrangement of teeth, making models and writing explanations of these that became part of the dioramas.

Another study by Gray, Elser, Klein, and Rule, (2016). presented the results of a literacy and arts-integrated science unit focused on environmental education. The content offered in this unit included more complex environmental issues compared to the regular school program. The participants researched the local environmental issues and literature on the topic. They had the freedom to study the issues of their interest in great depth. This arts-integrated unit had the real-life purpose of designing a pop-up construction that demonstrated each student-generated strategy of helping the local environment. Another way the students exhibited their learning was through writing an essay about the strategy. According to the teacher observations, this activity provided the students an opportunity to express their feelings and fostered collaboration among the participants, therefore helping address the need of gifted students to socialize with peers at the same developmental level (Brody & Muratori, 2015). The project also involved student personal interests related to improving the local community's environment.

Arts-integrated activities are authentic, comprising an additional challenge. This authenticity stems from the fact that in real life, no profession requires skills and knowledge strictly from one area (e.g. science or mathematics). For example, a scientist needs to be able to present her/his findings to an audience; hence, developing oral and written performance skills is necessary. The real-world applicability of effective arts-integrated projects provides meaningful goals for learning and knowledge application. These authentic learning experiences pique students' natural curiosity and inquisitiveness which leads to increased motivation. Arts-integrated projects provide additional motivation through giving students opportunities to express themselves, and therefore, address the student need for self-expression.

Another study (Olsen, Zhbanova, Parpu, Alkouri, & Rule, 2013) that investigated the effects of teaching science through the arts-integrated activity of making pop-up constructions demonstrated that arts-integrated activities are greatly enjoyed by students. The participants also expressed an increased level of concern for the wellbeing of the Earth and consistent engagement in the lessons.

Gifted and talented students have strong needs to socialize and work with likeminded peers (Brody & Muratori, 2015). The uniqueness of their interests and advanced levels of ability can be an obstacle to developing these social connections with peers. One of the gifts of the Arts is creating a sense of community and belonging through pursuing projects that are of equal importance to all participants (Cornett, 2015). The teachers in the latter study also observed an increased level of collaboration between the students (Olsen, et al., 2013).

Rogers and Silverman (as cited in Wellisch & Brown, 2013), state that gifted and talented students are sometimes more sensitive and tend to experience heightened levels of emotions or have fears that are more common for older individuals. The Arts provide a safe space to take healthy risks and build confidence (Cornett, 2015). Arts have been known for their therapeutic effect on people since the middle of 19<sup>th</sup> century, a finding which has been confirmed by a multitude of medical research studies (Ceausu, 2018). Art-therapy provides the participants a chance to freely express themselves while giving a sense of being a part of a group or

community (Ceausu, 2018). Likewise, offering arts-integrated activities to gifted and talented students can help with their hyper-sensitivity and fears, allow them the freedom to express themselves, and meet their social needs.

Arts-integrated activities allow freedom of expression and the use of humor, which constitute two of the characteristics of the gifted mentioned previously. For example, one can create a caricature or a comic strip that displays the relationships between the x, y, and c in an equation (See Figure 1).

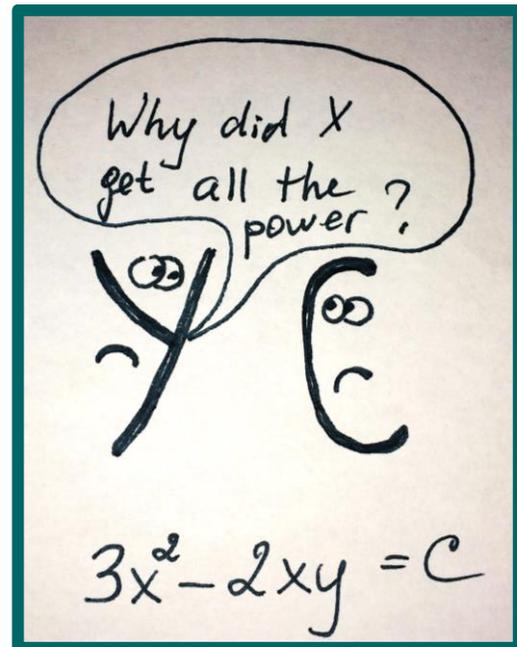


Figure 1. Humorous math equation cartoon

According to Root-Bernstein and Root-Bernstein (2013), the volume of arts-integrated activities students engage in at school significantly increases their chances for success in the workplace. Another benefit of arts integration is the transferability of the effects of the Arts (e.g. greater content retention (Rinn, Gregory, Yarmolinskaya, & Hardiman, 2011); higher test scores (Deasy & Stephenson, 2005), improved attention to detail, pattern-recognition, and problem-solving skills (Root-Bernstein, & Root-Bernstein, 2013) onto other lessons (Catterall, 1998).

Arts integration increases the level of complexity of projects, makes them more challenging, and helps students practice and improve problem-solving abilities. Arts integration teaches students to analyze and solve problems independently and creatively by fostering higher-level thinking skills (Crawford, 2004).

### Identification of Gifted Students through the Arts

There are multiple ways of identifying gifted and talented students. Analyzing student test scores is one of these methods (Harris, Rapp, Martinez, & Plucker, 2007). According to Card and Guiliano (2015), this method of identification is biased and often precludes certain groups of students like English Language Learners, minority students, and students from low socioeconomic backgrounds from being identified for Talented and Gifted (TAG) services. The need for alternative identification methods has been recognized for a while (Ford & Whiting, 2016).

It is safe to assume that if there is a need for alternative identification methods, there is also a need for alternative ways and strategies of meeting the needs of these diverse students because even the definition of giftedness varies from culture to culture (Wellish, & Brown, 2013). Moreover, because art is an attribute of every culture (Langer, 1966), using arts-integrated identification strategies and projects can help address the needs of diverse students and help them discover each other's culture while building social connections. Arts-integrated activities are also helpful when addressing the needs of English Language Learners (ELLs) that are also gifted and talented (Casey, Mireles, Vilorio, 2018). Although none of the students who participated in this project were English Language Learners, this activity could be beneficial for working with them as it does not heavily rely on the use of language, and allows students to demonstrate content knowledge through drawing.

### Creativity Development and Self-Expression

To create, according to Merriam-Webster (n. d.), means "to produce through imaginative skill; to make or bring into existence something new." Creativity is included in the list of the most important skills for success in life in the 21<sup>st</sup>

century (Applied Educational Systems, n. d.). Creativity is also often identified as one of the characteristics of the gifted and talented (Strickland, 2001). We need to provide students with an outlet for practicing creativity, and one of the most natural ways to do so is through Arts integration (Jacobson, Seavey, & Mueller, 2016). Integrating the Arts with STEM subjects helps develop student creativity while meeting the learning goals of the STEM subjects (Cornett, 2015).

Very few gifted and talented students are equally gifted in all academic areas. In fact, some gifted and talented students may be underachieving in many of the academic areas (Winner, 2000). Thus, for some of them, integrating the Arts with STEM subjects can provide a much-needed opportunity to learn, for example, science, in a non-threatening environment. Arts are used to lower anxiety and even help people heal from trauma (Ceausu, 2018). Incorporating this property of the Arts can benefit the gifted who are underachieving in STEM areas by providing an opportunity for creative self-expression while also addressing emotional needs of the students. Creative self-expression through arts-integrated projects can help naturally include the student culture and heritage in their learning. For example, a student who identifies as Native American could conduct a study on Native American scientists, learn about their main scientific contributions, and demonstrate his/her learning in a mixed media art piece.

According to Winner (2000), the goal of education of the gifted is to not only to help gifted students pursue their passions and become experts and innovators in the field of their choice, but to aim even higher, which means helping these children become creators who not only add to but alter the field, or go against the current order of things, breaking boundaries and inventing completely new domains. Arts integration and its focus on creative inquiry can provide fertile soil and a stimulus for development of creativity. Haroutounian (2017) states that the National Core Arts Standards organically fit the standards for the education of the gifted, and according to Zhbanova (2017), National Core Arts Standards naturally integrate with the Scientific method and Engineering design steps as well.

## Science and Arts Connections

One of the most important connections between the Arts and STEM subjects is inquiry (Boothe, 2013). Many scientific inquiry and artistic inquiry steps are identical (Bequette, & Bequette, 2012). Both the scientific method and creative inquiry contain the steps of gathering data, experimenting, creating multiple drafts, revising and editing, and sharing (Cornett, 2006). Connections between artistic and scientific inquiry provide a platform for application and development of critical and creative thinking skills as well as logic and reasoning (Bequette, & Bequette, 2012). Observation, as an important part of the data gathering step, is a highly-desired skill in the STEM areas; drawing has been shown to improve this skill (Root-Bernstein, & Root-Bernstein, 2013).

Conducting experiments does not always mean physically manipulating objects. Gedankenexperiment or thought experiment, is an experiment conducted completely in one's mind (Merriam-Webster, n.d.). These experiments are widely used in the areas of science, mathematics, economy, philosophy, among others; some examples of famous thought experiments include Maxwell's demon, Einstein's elevator or Schrödinger's cat (Stanford Encyclopedia of Philosophy, 2014). The ability to imagine and manipulate objects in one's mind is a strong predictor of success in STEM subjects (Root-Bernstein, & Root-Bernstein, 2013). Arts enhance development of visual thinking skills that are necessary to be able to manipulate objects without having these objects.

All areas of the Arts include identifying and creating patterns (Root-Bernstein, & Root-Bernstein, 2013). For example, the majority of songs follow a pattern in which verses are intercepted with a chorus. Rhythm is another example of a musical pattern.

One of the ways the Arts foster creativity is through creation of multiple drafts followed by revision and editing. For example, all drama and dance performances involve rehearsals in which the participants receive feedback from the instructor, search for solutions on how to improve their performance, and practice. The culmination of most artistic projects involves some form of presentation. Art galleries and theatrical performances, are examples of presentation of the results of artistic inquiry to others.

Problem solving embedded in arts-integrated projects constitutes another fundamental connection between the Arts and STEM subjects (Bequette, & Bequette, 2012). The Arts enhance the development of the skills of observation, analysis, attention to detail, and allow children to practice inventing (Crawford, 2004), which is essential for an innovation in any STEM or other subject area to occur. According to Crawford (2004), invention is the highest step that builds upon the knowledge already acquired to generate new solutions to problems. Arts-integrated activities are vital for the development of the ability to invent (Crawford, 2004).

## Figural Transformations

Guilford (1977, p. 37) defined transformation as, "... any kind of change in information." A figural transformation is one of the types of transformations identified by Guilford. For example, modifying an existing figure by adding strokes, contours, shading, etc. or changing the position of the figure in space would be considered a figural transformation according to Guilford (1997).

Transformation exercises help develop creativity because they require a purposeful and focused thinking process (Davis, Rimm & Siegle, 2011) that includes analysis, hypothesizing, thought experiments, and applying critical thinking to select the most useful and newest ideas. An example of a transformation could be creating a construction or a scene made of recycled items while ignoring the typical purposes of these items (Zhbanova, & Rule, 2014).

One of the most famous and reliable tests of creative thinking that is used in identification of the gifted and talented is the Torrance Test of Creative Thinking (Gifted Education TTCT, 2018). One of the two parts of this test is called the Figural TTCT: Thinking Creatively with Pictures (Gifted Education TTCT, 2018). This part offers students a set of activities that require altering a given geometrical shape or picture. This test assesses student skills of fluency, elaboration, originality, resistance to premature closure, and abstractness of titles, among several other creative strengths (Gifted Education TTCT, 2018). The project described in this article was similar to the figural transformations in the Torrance Tests of Creative Thinking. It involved deepening

and demonstration of student knowledge in the STEM areas, social studies and ELA in addition to practicing the skill of invention through a visual arts-integrated activity of figural transformations.

### Method

This project was conducted with identified gifted and talented fifth graders who were part of the school pull-out program for the gifted and talented. Students in the program were working on a deeper exploration of the topics of their interests related to one of the following school subjects: science, mathematics, computer science, social studies, or language arts. The figural transformations activity was used as an attention-focuser and content-connection hook at the very beginning of weekly meetings that lasted about 40 minutes.

The length of the project was one school semester. At the end of the semester, the students reviewed their weekly figural transformations to see if their creativity level, their ability to demonstrate the newly acquired content knowledge through figural transformations, and their ability to make connections between the disciplines increased. Over the course of the project, the teacher observed the positive effects of the figural transformation exercise on the levels of motivation of students.

### Setting

The project was conducted at a middle school in a rural town in the Midwestern United States. The majority of the students attending the school were Caucasian. The number of students participating in the project was 15: 4 boys and 11 girls. All students were in the fifth grade and ranged in age from 10 to 11 years of age.

### Materials

The teacher provided students with black and white printed copies of the figural transformations (See Figure 2) and black pencils. The teacher used a large poster board and a set of markers to summarize and demonstrate each creative technique taught.

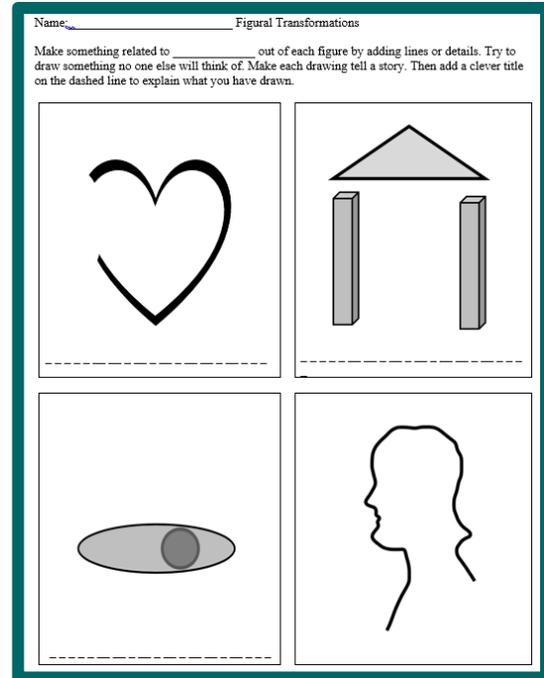


Figure 2. Figural transformation page provided to students.

### Subject Connections

The students were allowed to incorporate information from any of the following areas: science, engineering, mathematics, social sciences, English language arts, and computer science. Figures 3 through 6 provide examples of figural transformations related to these subject areas completed by the students.

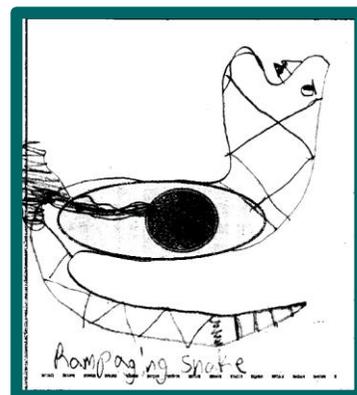


Figure 3. Figural transformation made by students related to science. The image shows a “rampaging snake.”



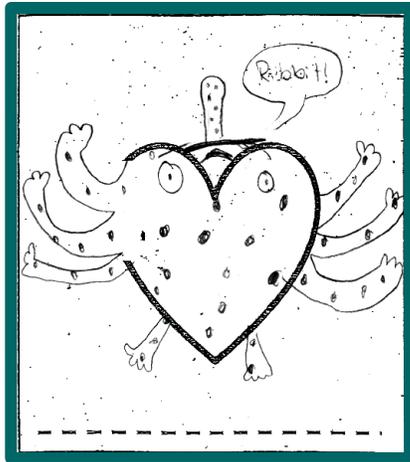


Figure 4. Another science-related figural transformation showing a future frog with many genetic mutations.

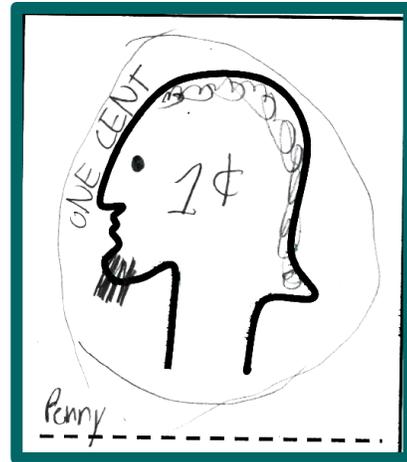


Figure 5. A social studies related figural transformation of a penny.

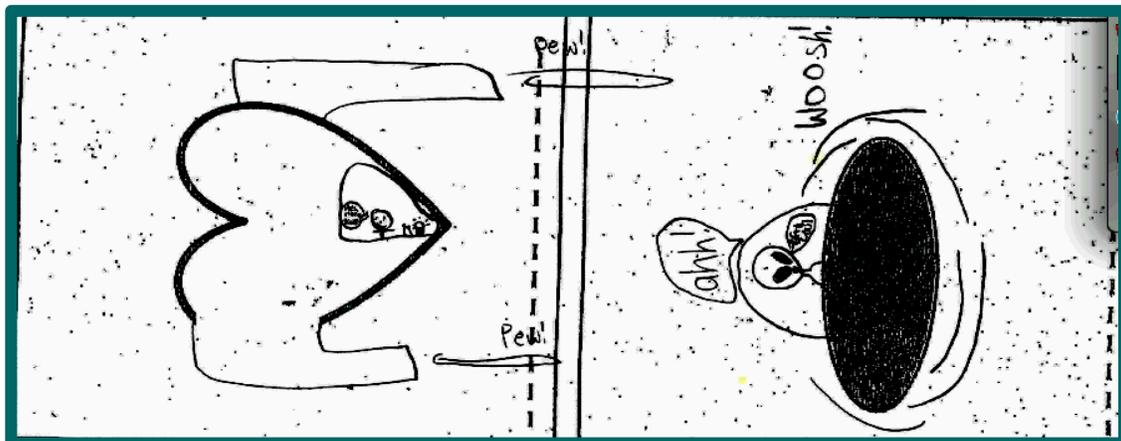


Figure 6. English Language Arts and Science Fiction Literature, technology. This is a human chasing an alien in a spaceship. The villain alien is trying to escape and turned his ship upside down to avoid being shot.

### The Lessons

The structure of each of the weekly lessons was similar. At the beginning of every lesson, students were given a sheet of paper with the pre-created figural transformation templates as was shown in Figure 2. The same templates were used during every lesson. Then, the students were directed to collaboratively generate several topics related to science, social studies, ELA, mathematics, and computer

science lessons and vote for the most interesting topic. Afterwards, except during the first lesson, the students were reminded to use Torrance's creative skills of fantasy; emotional expressiveness; movement or action; storytelling articulateness; three-dimensional visualization, unusual, or internal visualization; humor; artistic richness and sensory appeal of images, and breaking boundaries (Torrance, Ball, & Safter, 1992) taught during previous lessons.



The teacher gave the same directions every time. She said "Using the template provided, create picture(s) on the topic you just selected. Your work needs to be related to science, mathematics, computer science, social studies, or English language arts. Please do not talk to each other. Do your best and have fun!"

Then, the teacher set a timer for 5 minutes. The students were not required to use any particular writing utensil. During the first lesson, the students asked if they could use colored pens and pencils, and the teacher stated that they could. Once the time was up, the teacher directed the students to put their pens/pencils down. Then, the students were invited to show their works to peers and talk about every picture they had generated. The other participants were invited to comment on the presenter's figural transformations. The students were asked to give feedback on creative skills present in the pictures and explain connections to science, social studies, language arts, mathematics, and other lessons that the presenter made. The presenter had a chance to confirm and elaborate on the science connections proposed by the other students. Everyone was encouraged to share additional ideas or comments as well.

The next step of the project included learning a new creative skill (See Table 1). These creative skills were based on several creative strengths recognized by Torrance (Torrance, Ball, & Safter, 1992). Examples of figural

transformations exhibiting these skills are shown in the Appendix.

Afterwards, the teacher collected the student works. This project lasted one semester, and the teacher put each student creations separately in chronological order. At the end of the semester, the teacher and the students reviewed the transformations. Each student lined up his/her works in chronological order on the floor. The teacher instructed the students to compare the first figural transformation they made with the last one. Participants were then asked to review all their works starting with the earliest transformation. Next, they were directed to select a couple of works that they felt were the best, show them to their peers and talk about the creative strategies used, challenges they faced related to creating a figural transformation based on the content of the STEM subjects, ELA, or social studies. After each presentation, the peers gave feedback to the presenters. The teacher wrote the following guiding questions/prompts for feedback on the whiteboard. What do you find most interesting/creative/unusual about these transformations? Has the presenter omitted mentioning any creative strategies he/she used? If so, tell us what those are. What school subjects did these transformations connect with? Based on the transformation, try to recall specific information related to one of the subjects and tell us about it.

Table 1. *Creative Strategies Taught During the Lessons*

Strategy	Example
Fantasy	Including a fantasy character, such as a fairy.
Emotional expressiveness	An expression of fear on the face of a prey animal, and an expression of victory on the face of a predator.
Movement or action	Including waves on a lake surface or trees bending in the wind.
Storytelling articulateness	A transformation including a story with a beginning, middle, and end. For example, turning each of the four pictures offered for transformation into parts of a math story problem.
Three-dimensional visualization	Drawing a cube or any other three-dimensional object.
Unusual, or internal visualization	Including a dissected frog and showing the internal organs of the animal.
Humor	Including a joke or a pun.
Artistic richness and sensory appeal of images	Detailed drawing of an animal's fur.
Breaking boundaries	Connecting two or more figural transformation templates into one.



**Standards Addressed by the Lesson**

This project addressed various standards from each of the STEM areas, social studies, and English Language Arts. The selection of standards addressed depended on the

student’s collective choice of the general topic for that particular day and the individual choices of ideas for the figural transformations. Some of the standards addressed by the project are shown in Figure 7 with accompanying example student figural transformation.

	<p>LS4.C: Adaptation. For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.</p>
	<p>LS4.D: Biodiversity and Humans. Populations live in a variety of habitats, and change in those habitats affects the organisms living there. Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands.</p>
	<p>LS1.C: Organization for Matter and Energy Flow in Organisms. Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion.</p>

Figure 7. Examples of Student Works and Corresponding Standards

**Lesson Results**

The goal of this activity was to challenge students to apply their learning in creative ways, make interdisciplinary connections, and increase their levels of motivation and enjoyment of science, mathematics, and other lessons through the use of figural transformations. This section includes teacher observations of students who participated in this activity. The teacher focused on student reactions to the

activity and each other’s presentations. The examples of student works are also provided in this section.

**Teacher Observations**

Overall, this activity was successful. The students were enthusiastic and engaged during the exercise. For example, before working on the figural transformations, one of the students often rubbed his hands against each other preparing to take on the challenge. All participants were



actively engaged and discussing their creations; they were often smiling, laughing, and praising each other for finding new and creative ways to include subject content into their figural transformations. The teacher observed an increase in the level of concentration of the students during this project.

Some of the participants struggled with the activity at the beginning because it was unusual to them. Some of them had a puzzled look on their faces followed by questions about what they were allowed/not allowed to include or use. However, after a couple of weeks, every participant was enjoying it. There were two instances when the teacher slightly changed the agenda for the day; the students asked if they still could participate in the activity, explaining that they were enjoying it too much to discontinue.

As the culmination of the project, the students compared the earliest transformations with the latest. They were amazed at how different their works looked and were excited to report that they felt much more creative not only through using a greater variety of creative strategies taught but through generating more unusual main ideas/ messages/ meanings of their transformations. Many of them were able to recall content from other subjects (e.g. science). When looking at their works in chronological order, the middle schoolers noticed a somewhat gradual improvement in their transformations. However, several students saw an occasional but significant decline in perceived creativity of the transformations. They proposed that the topics collectively selected for those days were not interesting to them personally, which they felt, negatively affected their creativity. For example, one of the topics was "history of sports." Several participants noted that they felt their transformations were less creative because they were not interested in sports.

While comparing the works completed over the course of a semester, the students were able to practice self-reflection and critical thinking through critically assessing their products and determining if they had gained new knowledge and had increased their creativity. An additional benefit of comparing the student works was shifting the focus of the students from competing and comparing themselves with others to comparing and competing with themselves. This could be helpful in building self-esteem, increasing self-

efficacy, and subsequently, help them take ownership of their studies.

Arts-integrated projects help students learn to take healthy risks (Cornett, 2015). According to teacher observations, the group was very pleased with the growth in their creative skills. The teacher reminded the students that some of them expressed fear about the project at the beginning of the semester and pointed out that despite the fact that they may have been worried at the beginning, they chose to try something new, and through hard work, they had improved. The students seemed very happy to have heard this comment from the teacher and one of them said that it wasn't as hard as he thought it would be and was actually fun. Based on the emotional reactions of the students over the course of the semester, they were very involved in the project and motivated to be creative in using the content from lessons such as social studies, science, math, and others. At the end of the project, several students asked the teacher if they could do a similar project next semester.

Gifted and talented students need opportunities to work with peers of the same academic level who share similar interests (Winner, 2000). The teacher observed the students actively communicating with each other, encouraging and supporting one another during the project. The participants were eager to share positive comments and to find creative strengths or subject connections in each other's works during each lesson. This activity has the potential to help gifted students to build relationships and to improve social skills through providing an engaging, non-competitive atmosphere and a chance to socialize with likeminded peers.

The teacher noticed instances of integration of content of other subject areas that was taught a while earlier. For example, some students included information about animals that they had learned more than a year ago. This suggests that this arts-integrated project not only can help students demonstrate their knowledge of subjects, but create a more complete and connected picture of the world in which knowledge from different areas is interconnected and could be applied in creative ways to produce something new.

The students often incorporated STEM concepts in their works despite being allowed to select other subjects. This suggests that figural transformations are applicable to

STEM concepts and knowledge and can be used to help the students demonstrate their learning in a creative and intellectually-stimulating way. Through presentation and discussion of each student's work during every lesson, middle schoolers had an opportunity to review the content of STEM and other subjects. While discussing each other's works, the students had a chance to deepen their knowledge of the integrated subjects by asking each other questions and adding to the presentations of the peers. They were also free to select the level of complexity of the knowledge incorporated in the transformations. The students could select any of the six subjects and any particular topic within each subject, which helped differentiate the content of the lesson to meet the needs of the gifted and talented.

There were instances when the students struggled with a particular topic or part of the figural transformation template. The teacher observed some students apply their problem-solving skills to tackle the challenge. Some of the students moved to a different part of the room to help them see the template in a different way, some closed their eyes and mumbled ideas to themselves until they found one that satisfied them. Some students chose to move on to the next transformation and returned to a more challenging one later. Sometimes completing each transformation took several attempts. Despite that, the students seemed to have enjoyed the challenge. The teacher observed an increased level of joy and satisfaction when the participants felt that their problem-solving tactics resulted in a success.

The teacher witnessed students create unique stories when describing their transformations. One of the students incorporated a joke in which one of the turtles was following another one and complained about it being way too fast. Another story included a food poisoning incident and an investigation of the food to find out where the poison originated (See Figure 8 and Figure 9).

Some of the student transformations were unique and unusually creative; they included creative traits that were not taught or addressed during previous lessons. This suggests that figural transformations can help students demonstrate their gifts and talents and possibly aid in the identification process, particularly in identification of the

students who struggle in the area of English Language Arts, but are advanced in other areas.

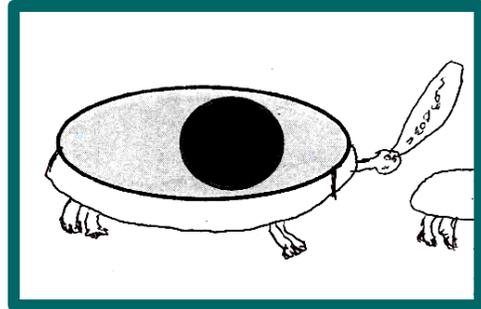


Figure 8. Example of student work containing a joke. The turtle in the picture says "Slow down!"



Figure 9. Example of student work containing a story of examining food for the source of food poisoning. The title says "Food examination."

## Summary and Conclusion

Meeting the intellectual, social, psychological, and other needs of the gifted and talented students is vital for their success (Winner, 2000). Arts integration is a very effective way to address the needs of the gifted and talented (Haroutounian, 2017). Arts naturally integrate with STEM and other subject areas (Cornett, 2015). The arts help develop

creativity, critical thinking, and allow the gifted and talented a much-needed flexibility to incorporate their talents, deepen the knowledge of the field of their interest, and an increased level of challenge. The therapeutic effects of the Arts provide additional benefit of a safe atmosphere conducive to learning, taking healthy risks, and collaboration (Cornett, 2015).

The exercise described in the current article is not exclusive to a particular subject. The participants were permitted to use knowledge from any STEM area or from social studies or English language arts. According to teacher observations, the integration of the content of all of these subjects seemed seamless with the participants visibly engaged and enjoying the project very much. Finally, according to teacher observations and student analysis of their figural transformations, the levels of creativity of the student works increased over the course of the school semester.

## References

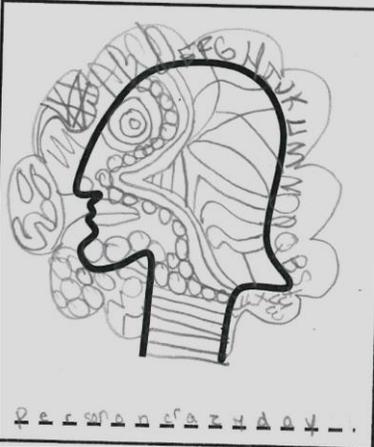
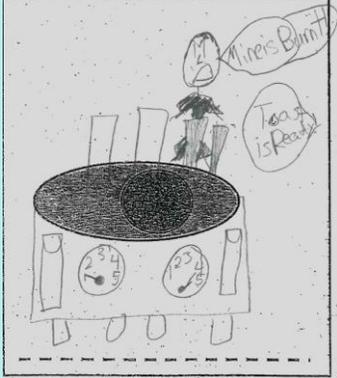
- Applied Educational Systems. (n.d.). *What are 21st Century Skills?* Retrieved from <https://www.aeseducation.com/careercenter21/what-are-21st-century-skills>
- Bayat, M. (2012). *Teaching exceptional children*. New York, NY: McGraw Hill.
- Bequette, J. W., & Bequette, M. B. (2012). A place for art and design education in the STEM conversation. *Art Education*, 65(2), 40-47.
- Brody, L. E., & Muratori, M. C. (2015). Early entrance to college: Academic, social, and emotional considerations. *A Nation Empowered: Evidence Trumps the Excuses Holding Back America's Brightest Students*, 2, 153-167.
- Casey, J. E., Mireles, S. V., Vilorio, M. De L. (2018). Literacy & arts integration in science: Engaging English language learners in a lesson on mixtures and solutions. *Texas Journal of Literacy Education*, 6(1), 51-68.
- Ceausu, F. (2018). The healing power of art-therapy. *Review of Artistic Education*, 16, 203-211.
- Catterall, J. (1998). Does experience in the arts boost academic achievement? *Art Education*, 51(3), 6-11.
- Cornett, C. E. (2006). Center stage: Arts-based read-alouds. *The Reading Teacher*, 60(3), 234-240.
- Cornett, C. E. (2015). *Creating Meaning through Literature and the Arts*. Boston, MA: Pearson.
- Creativity. (n.d.). *Merriam-Webster Online Dictionary*. Retrieved from <https://www.merriam-webster.com/dictionary/creativity>
- Crawford, L. (2004). *Lively Learning: Using the Arts to teach the K-8 Curriculum*. Portsmouth, NH: Stenhouse Publishers.
- Csikszentmihalyi, M. (2008). *Flow: The psychology of optimal experience*. New York, NY: Harper Perennial Modern Classics.
- Davis, G. A., Rimm, S. B., & Siegle, D. (2011). *Education of the Gifted and Talented* (6th ed.). Boston, MA: Pearson.
- Deasy, R., & Stevenson, L. (2005). *Third space: When Learning matters*. Washington, DC: Arts Education Partnership.
- Ford, D. Y., & Whiting, G. W. (2016). Considering Fisher v. University of Texas-Austin. How gifted education affects access to elite colleges for black and underrepresented students. *Gifted Child Today*, 39(2), 121-124.
- Gedankenexperiment. (n.d.). *Merriam-Webster Online Dictionary*. Retrieved from <https://www.merriam-webster.com/dictionary/gedankenexperiment>
- Gifted Education TTCT. (2018). *Torrance Tests of Creative Thinking and Gifted Education Products at STS*. Retrieved from <http://www.ststesting.com/gift/>
- Gray, P., Elser, C. F., Klein, J. L., & Rule, A. C. (2016). Elementary students explore helping the environment through thinking skills, essays, and pop-ups. *Science Education International*, 27(1), 151-175
- Guilford, J. P. (1967). *The nature of human intelligence*. New York, NY: McGraw-Hill Book Co.
- Harris, B., Rapp, K., Martinez, R. S., & Plucker, J. A. (2007). Identifying English Language Learners for Gifted and Talented programs: Current practices and

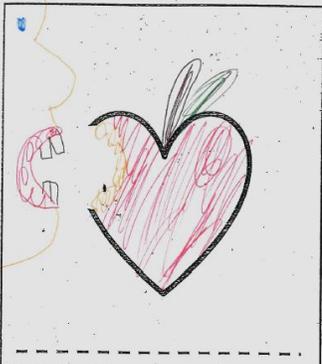


- recommendations for improvement. *Roeper Review*, 29(5), 26-29.
- Haroutounian, J. (2017). Artistic ways of knowing in gifted education: Encouraging every student to think like an artist. *Roeper Review*, 39, 44-58.
- Kautz, J. M. (2017). No "gift" giving here: The inadequate gifted education programs in New York State and the need for gifted education reform. *Journal of Law & Policy*, 25(2), 687-721.
- Kreger Silverman, L. (1998). Through the lens of giftedness. *Roeper Review*, 20(3), 1-7.
- Land, M. H. (2013). Full STEAM ahead: The benefits of integrating the arts into STEM. *Procedia Computer Science*, 20, 547-552.
- Langer, S. L. (1966). The cultural importance of the Arts. *The Journal of Aesthetic Education*, 1(1), 5-12.
- Mendaglio, S., & Tillier, W. (2006). Dabrowski's Theory of Positive Disintegration and Giftedness: Overexcitability research findings. *Journal for the Education of the Gifted*, 30(1), 68-87.
- National Bureau of Economic Research. (2015). *Can universal screening increase the representation of low income and minority students in gifted education?* Cambridge, MA: Card, D., & Giuliano, L.
- Olsen, B. D., Zhbanova, K. S., Parpucu, H., Alkouri, Z, & Rule, A. C. (2013). Pop-up constructions motivate and reinforce science learning for upper elementary students. *Science Activities*, 50(4), 1-15.
- Phillips, N., & Lindsay, G. (2006). Motivation in gifted students. *High Ability Studies*, 17, 57-73.
- Rinn, L., Gregory, E., Yarmolinskaya, J., & Hardiman, M. (2011). Why arts integration improves long-term retention of content. *Mind, Brain, and Education*, 5(2), 89-95.
- Root-Bernstein, R., & Root-Bernstein, M. (2013). The art and craft of science. *Educational Leadership*, 16-21.
- Rule, A. C., Tallakson, D. A., Glascock, A. L., & Chao, A. (2015). Science inquiry into local animals: Structure and function explored through model making. *Science Activities*, 52(3), 54-64. DOI: 10.1080/00368121.2015.1049581 (Taylor and Francis – Routledge Publishers).
- Strickland, B. R. (2001). Gifted. In *The Gale encyclopedia of psychology* (2<sup>nd</sup> ed.). (pp. 156-159). Ohio, OH: Eastword Publication Development.
- Thought Experiments. (2014). In *Stanford Encyclopedia of Philosophy*. Retrieved from <https://plato.stanford.edu/entries/thought-experiment/>
- Tomlinson, C. A., & McTighe, J. (2006). *Integrating differentiated instruction & understanding by design: Connecting content and kids*. ASCD.
- Torrance, E. P., Ball, O. E., & Safter, H. T. (1992). *Torrance tests of creative thinking: Streamlined scoring guide. Figural A and B*. Bensenville, IL: Scholastic Testing Service.
- Webb, A. N., Zhbanova, K. S., & Rule, A. C. (2017). An investigation of whether fantasy books, compared to same topic nonfiction, promote second graders' creativity. *Education 3-13*, 1-16.
- Wellisch, M., & Brown, J. (2013). Many faces of a gifted personality: Characteristics along a complex gifted spectrum. *Talent Development & Excellence*, 5(2), 43-58.
- Winner, E. (2000). The origins and ends of giftedness. *American Psychologist*, 55(1), 159-169.
- Zhbanova, K. S., & Rule, A. C. (2014). Construal level theory applied to sixth graders' creativity in craft constructions with integrated proximal or distal academic content. *Thinking Skills and Creativity*, 13C, 141-152. DOI 10.1016/j.tsc.2014.04.002
- Zhbanova, K. S. (2017). How the arts standards support STEM concepts: A journey from STEM to STEAM. *Journal of STEM Arts, Crafts, and Constructions*, 2(2), 1-14.



Appendix

Student work	Creative skills
 <p data-bbox="297 793 589 825">Title: Person's Crazy Day</p>	<p data-bbox="706 373 1258 478">Internal visualization Elaboration Artistic richness and sensory appeal of images</p>
 <p data-bbox="329 1270 557 1302">Title: Snake Attack</p>	<p data-bbox="706 871 1015 903">Storytelling articulateness</p> <p data-bbox="706 940 1429 1081">Story: A person ignored the warning signs in the zoo and got into the enclosure with snakes. Snakes became angry and started biting him. The person yelled in pain, and the bystanders called police.</p>
 <p data-bbox="232 1696 654 1795">The robot is saying "Toast is ready" The person is screaming "Mine is burned!"</p>	<p data-bbox="706 1348 1015 1417">Emotional expressiveness Storytelling articulateness</p> <p data-bbox="706 1455 1421 1591">Story: An inventor created a robot-dining table that is supposed to cook breakfast. For several weeks, every morning the robot burned the toasts. The inventor got tired of trying to fix the robot and is about to kick it in anger.</p>

Student work	Creative skills
 <p data-bbox="306 680 578 709">Title: Deer that is shot</p>	<p data-bbox="704 279 954 308">Movement or action</p> <p data-bbox="704 348 1370 420">The vertical lines in this transformation represent blood spraying out of the wounds.</p>
 <p data-bbox="386 1163 500 1192">Title: Zoo</p>	<p data-bbox="704 758 1084 787">Three-dimensional visualization</p>
<p data-bbox="306 1209 626 1251">details. Try to draw something no one else Then add a clever title on the dashed line to</p> 	<p data-bbox="704 1241 954 1270">Breaking boundaries</p>