

# Enhancing Science Curriculum with Cognitive Development Through the Arts in Eighth Grade Science

Amber Hunter

**Abstract:** Middle school children are at a crucial turning point in their lives because they are becoming adolescents. Their brain is rapidly changing and pruning away unused connections. Because the brain loses neurons during adolescence, enhancing science curriculum through the arts is particularly important for cognitive development. The arts exercise certain areas of the brain that are used for learning. Research shows that children learn thinking skills through the arts that help them to be successful in eighth grade science. The arts enhance science curriculum through creative activities that promote thinking skills such as focusing, organizing, analyzing, interpreting, evaluating and reasoning. These skills help children develop higher levels of thinking and they help children to learn and understand eighth grade science.

## Introduction

Integrating the arts into eighth grade science for reasons that support cognitive development is fitting for this age group. The inclusion of the arts incorporates music, dance, drama and art into the curriculum and involves activities that are creative. When looking at cognitive development as it concerns thinking skills, the arts and eighth grade science are very much intertwined with one another. The arts encourage students to think critically and creatively (Eutsler, 2017). The famous artist, Picasso, attributed his paintings to research and experiment. He used his critical thinking skills to skillfully paint portraits. He referred to his paintings as a process of analysis and experimentation of many different innovative and creative ways to produce a desired combination of effects. He did not see them as works of art (Karakas, 2010). The scientific method, for example, is mimicked by critical thinking skills. The disciplines of science are used in critical thinking (Karakas, 2010). Statistical evidence proves that the arts influence cognitive development and intelligence (Baker, 2013). Middle school students benefit from the inclusion of the arts because they not only gain knowledge of science, but they also gain experience in thinking skills which refines cognitive operations for learning.

Cognitive abilities such as spatial and quantitative understanding, vocabulary growth, and cognitive and intellectual growth are all benefits of visual arts projects and integrating the arts into eighth grade science (Raiyn, 2016). Cognitive factors that are influenced by art are planning, visual-spatial, verbal reasoning, vocabulary, nonverbal reasoning, memory and retrieval, and patterns and relationships (Baker, 2013). By focusing on cognitive development, teachers ultimately support academic achievement and higher levels of thinking.

The learning standards for eighth grade science are based on the students' ability to understand scientific concepts, language, theories, and application (Ohio Department of Education, 2019). They are strongly related to, if not the same, as

the thinking skills students develop as a result of incorporating the arts into eighth grade science. One standard for eighth grade science is being able to use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts. A second standard is to use precise language and domain-specific vocabulary to inform about or explain the topic (Ohio Department of Education, 2020). Research shows that cognitive development through the arts promotes thinking skills that help us learn, solve problems, make conclusions, use reasoning, compare and interpret information, evaluate, and reflect on information in a meaningful way (Eutsler, 2017). Cognitive development is important for children during the middle school years because they are starting to become intellectual thinkers (Ormrod, 2014). They are starting to engage and reflect on subject matter in strategic and formative ways.

## **Cognitive Development**

Cognitive development is how the brain develops and the processes people use to learn. The brain functions by releasing neurons through our axons that are protected by the myelin sheath. The myelin sheath of the axon is made thick through repetition which allows the brain to send electrical impulses at a faster rate. This thickening process through repetition is called myelination (Ormrod, 2014). If the myelin sheath of an axon is not there, the transfer of neurons is slow and the function declines. That is why it is important we focus on cognitive development. At this critical age, we can make a difference in growth of the myelin sheath. Repeated engagement of cognitive skills will thicken the myelin sheath which quickens electrical impulses. This increases the fluidity of thinking. By not using certain areas of the brain, it could lead to the death of certain neurons and synapses that help children learn (University of Illinois at Urbana-Champaign, 2007). Many theorists in the past have established well known theories of cognitive development. Piaget and Vygotsky are two prominent theorists known for their theories on cognitive development. Their theories are based on cognitive processes and abilities. They focus on the way our brain remembers, processes concepts and stores information.

### ***Cognitive Development and Thinking Skills in Eighth Grade Science***

Thinking skills that are influenced through the arts concern flexible thinking, reasoning, self-control, and self-regulation (Peng & Kievit, 2020). According to Piaget, at this stage (11 to 12 years), children should be able to use logical reasoning, proportional reasoning, idealism, and formulation. A child's academic level of achievement is based on their level of cognitive development and how well they can learn and execute certain tasks (Peng & Kievit, 2020). To encourage learning and success in eighth grade science, the arts can be used to promote thinking skills in a creative way. The arts have positive correlations with eighth grade science and thinking skills that are related to the subject. They develop the cognitive qualities Piaget and Vygotsky set forth in the stages of cognitive development, such as conceptual development, inductive logic and reasoning and abstract thinking. Based on ideas about thinking skills described by various researchers (Eutsler, 2017; Karakas, 2010; Baker, 2013;

Ormrod, 2014; Kievit, 2020), Table 1 outlines the thinking skills related to cognitive development that are promoted through the arts and in eighth grade science.

Table 1  
*Thinking Skills*

Thinking Skills	Definition
Focusing	To focus one's attention over a long period of time. Paying attention to chosen pieces of information while ignoring other stimuli. Staying on task. Focusing attention on the teacher. Teacher instruction influences higher psychological functions.
Organizing	Arranging information so that it can be learned or understood more easily. Organizational skills include but are not limited to grouping information together, creating graphs or tables, putting information in order of importance or significance and understanding concepts, theories, and formulas, like the scientific concept. Creating memorization mnemonics to remember information is an organizational skill, as well.
Analyzing	Includes ordering, comparing and contrasting information. To break down information into different components. Understand the structure, meaning, and relevancy of information and its relation to the subject.
Evaluating	To measure the value and importance of information. To measure the reasonableness and overall quality of information. To give an assessment of performance.
Interpreting	How one interprets information. Having the knowledge in subject areas. Combining ideas and making inferences.
Reflecting	Retrieving information and reflecting on what one remembers. Remembering information that is stored in long term memory or working memory.
Reasoning	Connecting previously learned information with new knowledge and making conclusions and finding solutions to problems. Finding a general pattern of connections that follows or covers an array of meanings and definitions.

### ***Cognitive Development and The Arts in Eighth Grade Science***

Cognitive development through the arts correlates with instructional based practices that influence cognitive development and higher levels of thinking. Children that are involved in the arts have the ability to reason, organize, focus, evaluate and reflect in core subjects (Baker, 2013). More importantly, during middle school years children are transitioning into adolescence. Teacher instruction is important and shown to influence students' levels of thinking. When introducing concepts and theories, children learn to reason, reflect and interpret information (Ormrod, 2014). They use analytical skills to make connections in their readings. They use their organizational skills to organize information, graphs, and tables. And they use their evaluating skills to problem solve and measure value.

**Music.** There are an array of music activities that can be done in the classroom to incorporate music into eighth grade science. For example, singing a song to remember a scientific theory is an activity that enhances one's ability to use their organizational skills, interpretation skills, focus and evaluation skills (Hayes, 2009). The child may even display reasoning skills because the song can incorporate a general pattern of memorization mnemonics that cover an array of definitions. Teachers can find songs that pertain to eighth grade science on the website, Songs for Teach-

ing (n.d.). Three songs that relate to science are the Solar System, Conservation Nation and The Elements Song. The first song relates to science concepts that are about the solar system, the second song talks about the concept of conservation and preserving and protecting the Earth, and the last song is about the elements on the periodic table. You can read about these songs through the website, and you can play them in your classroom for learning.

The cognitive benefits of learning through music include attention, memory, and expanding the working memory. Going further, Hayes (2009) gives us information about a scientist that theorized “heightened attention and novelty in musical stimuli contribute to improved recall of text and information”(p. 9). The improvement of recall of text and information through music, was proven to influence and enhance reflecting, organizing, and reasoning skills. Studies show that students perform well in their academics when they learn memorization skills through music and song. Creating music is also known to enhance spatial temporal reasoning (Baker, 2013). Spatial temporal reasoning is understanding patterns over a period of time to make conclusions about ideas and theories (Hetland, 2000). Music enhances spatial temporal reasoning because children are able to visualize the patterns in a song and use them to remember information, put things together step-by-step and stimulate them to create different patterns.

**Dance.** The activation of certain areas in the brain as a result of being involved in dance, are the same areas of the brain that are stimulated as a result of being involved in core subjects. Dance also helps with physical mastery, motivation and social intelligence. Students can use dance to learn about vocabulary, concepts, famous theorists, and so much more. For example, an activity that uses dance as a way to learn science concepts would be to create a dance routine about vocabulary words. Students can spell out each vocabulary word by performing a dance for each letter. In this way, they can use dance movements they are familiar with to remember the vocabulary words and concepts. A recent study based on the observations of Dr. Calvo-Merino’s and colleagues at University College London, concluded that, “dancers perceive the world differently because they have a special capacity to simulate what they observe” (Grafton, 2009, p. 4), The study showed the connection between dance and learning capabilities. The brain responded better and was more active in the motor areas when the dancer was familiar with the patterns and movement of a dance being observed, suggesting that prior knowledge and familiarity amplifies the ability to simulate others’ actions (Grafton, 2009). Dance has a positive impact on science curriculum by activating the areas in the brain used for observing and doing.

**Drama.** Project and thematic-based learning require cognitive operations such as planning, researching, and imagination. One of the direct connections to using drama in science is the use of analytical skills. When children participate in visual arts projects or thematic objectives (Baker, 2013), they use analytical skills that involve ordering, comparing and contrasting information to select the best fit response (Raiyn, 2016). Drama related activities in eighth grade science enhance thinking skills such as reflecting, self-regulation, reasoning, and interpreting. For example, students can learn about science through thematic objectives and drama related activities that explore the realities of the universe or nature. Students might

perform a routine where they explain about the different elements on Earth, such as gases, liquids and solids. They can dress up in material that represents each element. In their performance, one student may embody the element gas as being slow and sluggish and they can perform slowly and talk slowly to their classmates, and another student can embody the element liquid by moving their arms in a wave-like motion to show water and so on. Drama brings education to life for children (Moore, 2004) and therefore yields learning advances in science and other core subjects.

**Visual Arts.** Visual arts projects are a popular way for eighth grade teachers to introduce the arts into eighth grade science curriculum. The student's project may be to present the life of a star on a three-fold poster board. The poster board may consist of pictures and artistic features that are eye-catching to the audience. Through the presentation, the student uses their thinking skills to evaluate and interpret information. The student shows thinking skills, such as reasoning and organizing by presenting the information in a logical way. The student shows reflection skills by creating a poster board presentation and the student shows focusing skills by staying engaged in the activity and creating a project that envelops all the criteria needed for a completed assignment.

Learning the concept Punnett Squares and creating a visual arts project that represents the Punnett Squares is another example of a visual arts project that can be used in eighth grade science. The first part of the activity is to complete a series of Punnett Squares. A Punnett Square represents the probability of a specific trait occurring during reproduction. For example, if a female has the recessive trait for blue eyes and a male has the dominant trait for brown eyes, what is the likelihood their offspring will have brown eyes and so on. The purpose of the activity is to use the Punnett Squares to reflect on the genetic makeup of a human. The learning objective suggested for this activity is to accurately use the information and knowledge learned in the chapter to complete the Punnett Squares and then create a visual arts project that represents the Punnett Squares. Table 2 below, outlines and explains the thinking skills a student used when working on this particular activity. It explains in detail each skill observed during the activity and its importance and relevancy to eighth grade science. All of the thinking skills listed are important for cognitive development and eighth grade science.

Table 2

*Observation of Thinking Skills*

<b>Thinking Skill Displayed</b>	<b>Visual Arts Project</b>	<b>How This Leads to Success in Eighth Grade Science</b>
Focusing	Draw a figure based on your Punnett squares.	The student is focused and engaged in the activity. The student is focused on the activity because she likes art. The student creates a visual arts project that is complete.
Organizing	Draw a figure based on your Punnett Squares.	The student organizes Punnett Squares and organizes information on a table to represent the information provided in the Punnett Squares.
Evaluating	Draw a figure based on your Punnett Squares.	The student evaluates the probability or likelihood certain traits will be dominant or recessive.

Thinking Skill Displayed	Visual Arts Project	How This Leads to Success in Eighth Grade Science
Interpreting	Draw a figure based on your Punnett Squares.	The student interprets what she has learned about genetics and Punnett Squares. She also interprets what to draw by looking at the Punnett Squares and tables.
Reflecting	Draw a figure based on your Punnett Squares. Create a visual arts project that represents the Punnett Squares.	The student reflects on what she has learned in class and she reflects on the information she has collected, and organized. The student reflects on the information in the Punnett Square and uses that to draw a human. The student creates a visual arts project that is complete.
Reasoning	Draw a figure based on your Punnett Squares.	The student generalizes observations and draws a descriptive picture that applies to all of the observations.
Analyzing	Draw a figure based on your Punnett Squares.	The student analyzes the probability of certain traits happening, then creates a Punnett Square based on the analyzation of probability of certain traits being present.

The example in Figure 1 is an example of a Punnett Square. As you can see, students are given the genotype of both parents and they are told what each genotype means. In this example, the mother has the recessive trait for blue eyes and the father has the dominant trait for brown eyes. The capital letters represent the dominant trait, and the lower-case letters represent the recessive trait. Homozygous means two letters are the same, and heterozygous means the two letters are different.

Figure 1  
*Punnett Square*

Name: \_\_\_\_\_

1. B= Brown eyes b= blue eyes Mom= Bb Dad= BB  
What are the eye color possibilities if they chose to have children?

	B	B
B	BB	BB
b	Bb	Bb

Possible Genotypes: BB, Bb
Possible Phenotypes: brown
Chance of homozygous dominant offspring: 50%
Chance of homozygous recessive offspring: 0%
Chance of heterozygous offspring: 50%

The second part of the assignment is to create a visual arts project that represents the information provided in the Punnett Squares. The picture in Figure 2, is the example for the student's finished project. This example and the project in its entirety show how cognitive development, through the arts, promotes thinking skills and a higher level of understanding of the knowledge being learned. The student used her thinking skills to complete the project. She used her organizational skills to complete Punnett Squares and tables. She used her analytical skills to analyze

her tables and charts and the probability of certain traits being dominant or recessive. She used her interpretation skills to interpret the information presented on the squares and tables in order to draw a figure. She then used her reasoning skills to generalize her observations into one single representation of all the observations presented in her squares and tables. By evaluating and reflecting on the information she learned, she was able to create a visual arts project that was thoughtful and complete. She was focused and engaged in the activity and spent time on the drawing. In this picture, the student interpreted her child to have curly hair, brown skin, a square face, brown eyes, a small nose and a small smile.

Figure 2

*Student's Artwork for the Visual Arts Project*



## Science Curriculum and The Arts

The positive correlations between the arts and the sciences are encouraging to see and because there are many similarities and congruencies in their teachings (Karakas, 2010), there is a sufficient amount of research that talks about the inclusion of the arts and science and its impact in education. Cognitive development is an important area of study and with the research there is, it can be concluded that cognitive development through the arts promotes thinking skills that help students to be successful in eighth grade science. This is important for brain development and academic achievement. Not only do the arts enhance cognitive abilities but they also encourage learning in eighth grade science.

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### About the Author

Amber Hunter holds a Bachelor of Science from Kent State University. She is a substitute teacher at Sandusky Middle School. Amber previously spent three years as a director for The Volunteer Center of Erie County. She is looking to obtain her Master of Education in Early Childhood Education from the University of Toledo.