Mars Mysteries: Landform Pictograms

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Abstract

Graphic organizers are a way for teachers to accommodate students with disabilities such as poor memory or emotional disorders. This technique allows organization of thoughts and visual representation of relationships between ideas and facts. Indeed, poor memory affects students' reflection and retention of information while emotional disorders can cause a lack of focus in the classroom. Accommodations for students with these disabilities is important because students with emotional disorders may experience social isolation, which in turn may negatively affect their levels of academic achievement. Twenty high-achieving doctoral students participated in a teaching experience designed to introduce gifted students with learning disabilities to using de Bono thinking skills to mediate the possible negative effects of the disabilities through an arts-integrated project focused on some of the mysteries of the planet Mars. The results of this practical lesson showed that the students used their previous experiences in most cases to interpret the different photographs presented. Graphic organizers helped them organize their thought processes and the learning experience. Instruction needs to be woven tightly with the use of interactive materials and graphic organizers.

Key Words

Mars mysteries, twice exceptional gifted students, emotional disability, dyslexia, Edward de Bono CoRT Thinking Skills, arts integration

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Introduction

Helping students adjust emotions to maintain self-regulated learning and motivation is a key to successful teaching and academic achievement (Mega, Ronconi, & De Beni, 2014). Pointing to the need for a solution to the problem of students' dwindling interest in science as they mature, U.S. students lose enthusiasm for science in elementary school or middle school (Greenfield, 1996), while the number of students who continue to pursue science in high school and college continues to drop dramatically (Simpson & Oliver, 1990). Gifted children whose educational needs are not met can experience lack of motivation, decrease of self-esteem, anxiety, emotional and mental dropout, isolation, discouragement or laziness, and can be seen as underachievers in the classroom (Betts & Neihart, 1988; Brody & Mills, 1997).

Adjusting and arranging the learning environment for gifted students, for students with disabilities, or for twice exceptional students who are both gifted and have a disability encourages the learning process. For example, Rodgers (2007) argued that gifted learners should be provided with opportunities to socialize and to learn with like-ability peers. A number of other effective practices are available for children with emotional disorders such as self-monitoring, direct

instruction, practice in natural settings or positive reinforcement (Landrum, Tankersley, & Kauffman, 2003). Academic issues have also been reported for individuals having attention-deficit/hyperactivity disorders (ADHD; Currie & Stabile, 2006). Empirical research by other investigators has supported the potential explanatory value of working memory deficits among individuals with ADHD. Indeed, recent meta-analyses have shown that working memory, which allows individuals to retain and manipulate information for a few seconds, is impaired in those who have been diagnosed with ADHD (Martinussen, Hayden, Hogg-Johnson, & Tannock, 2005). Developing strategies in the classroom focused on working memory would lead to greater in school-readiness skills than content-based skills (Diamond, Barnett, Thomas, & Munro, 2007).

Using tools such as graphic organizers to help students with disabilities, including gifted students with disabilities, appears essential (Marzano, 2010). The use of graphic organizers in classrooms to manage facts or simply organize content information or vocabulary is supported by studies which demonstrate a connection between student retention and graphic organizer use (Dexter & Hughes, 2011). Use of graphic organizers constitutes a valid and meaningful tool helping students with the retention of facts, vocabulary terms, key concepts, and basic information (Dexter & Hughes, 2011; Gallavan & Kottler, 2007).

The goal of this project was to create an effective lesson for gifted students with emotional issues and poor memory, incorporating several de Bono thinking skills and exploring some mysteries of the planet Mars while using a graphic organizer to structure the instruction. The lesson focused on several pictograms found on Mars in comparison with others found on Earth.

Literature Review

Mars and its mysteries have been investigated for a long time (Morse, 1906). Currently, the knowledge gained through scientific study includes the properties of the planet such as weight, size, axis of rotation, and the presence of life or existence of objects on its surface. This latter fact has been the object of stories and movies and has always piqued the curiosity and interest of the public. More recently, the magnetic activity on the planet has been studied to explain the presence of terrestrial oceanic crust (Fairen, Ruiz & Anguita, 2002).

The interpretation of some forms on the surface of Mars as human faces or creatures can be attributed to the phenomenon of Pareidolia. Pareidolia is a psychological mechanism that gives people a strong impression that faces or familiar forms are present (Hadjikhani, Kveraga, Naik & Ahlfors, 2009). Some famous representations of faces on the surface of Mars have been recognized as pareidolia phenomenon by some investigators. Indeed, some discoveries from NASA photographs seem to suggest some representation of pictograms or manufactured objects on the surface of the planet Mars. For example, Figure 1 shows a portion of a JPL/NASA (Jet Propulsion Laboratory/ National Aeronautics and Space Administration) close-up photo taken of the Martian soil by Opportunity Rover. This photo clearly shows a circular object or pattern with a cross inside. Another NASA photograph taken by Viking Orbiter 1 in 1976 shows a face about 2 km wide by 3 km from chin to forehead on the surface of Mars. See Figure 2. Part of the caption released by NASA stated, “Shadows in the rock formation give the illusion of a nose and mouth” (JPL/NASA, 1998, para 1). This official statement implies that pareidolia is taking place when one recognizes a face. However, other researchers, (Brandenberg, DiPietro & Molenaar, 1991) have studied this and other images of the face taken at different angles, concluding that the features are not tricks of light and shadow, but genuine three-dimensional shapes. These features include eyes, nose, mouth, a helmet or headdress, as well as cheek ornaments, and an indentation over the right eye (Brandenberg, et al., 1991).

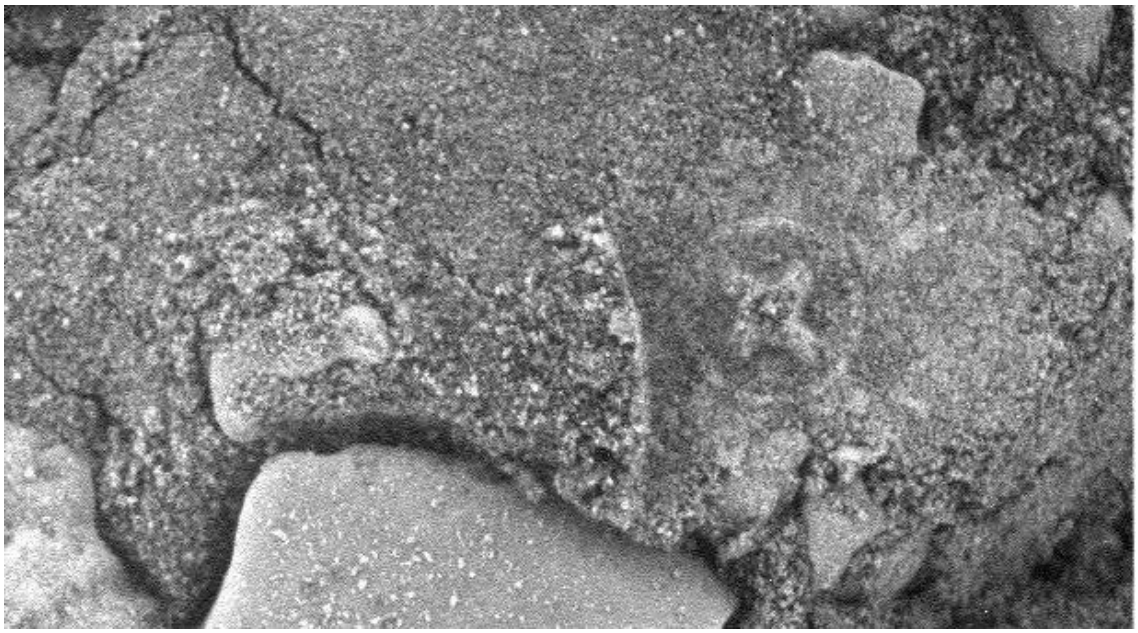

Figure 1. Close-up of soil on Mars taken by Opportunity Rover on SOL 3720 showing a circle with a cross inside. Image Courtesy NASA/JPL-Caltech (JPL & NASA, 2015a).

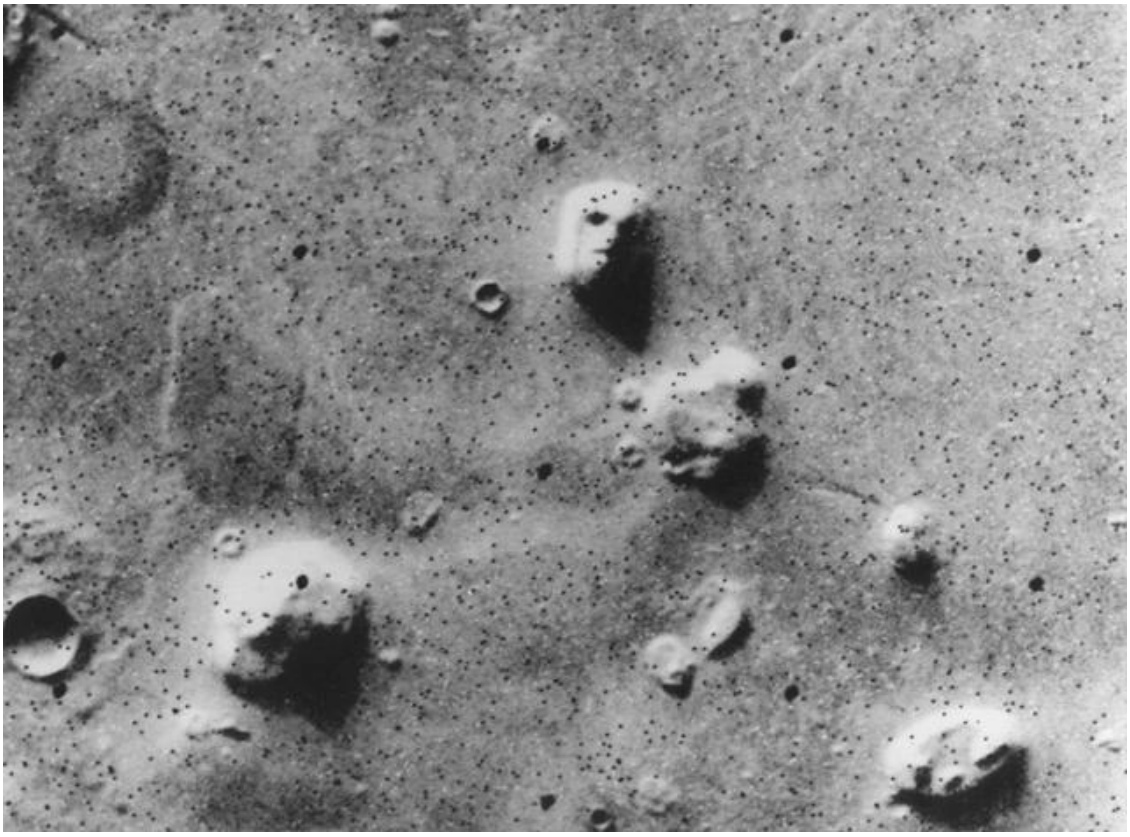

Figure 2. Famous Face on Mars (upper middle of photos) photographed in 1976 by Viking Obiter 1. Image Courtesy NASA/JPL-Caltech (JPL & NASA, 1998)

Educating Students with Poor Memory

Memory is the name given to the ability of living organisms to acquire, retain, and use information or knowledge (Tulving, 1987). Different forms of memory have been established in the literature. Memory can also be classified as long-term and short-term memory (Tulving, 1987). According to the same author, long-term memory can be separated into episodic, semantic, and procedural memory. Episodic memory refers to the faculty to remember personal happening of the past (Tulving, 1987), semantic memory is related with knowledge expressible in language and allows people to construct mental models of the world both concrete or abstract (Quillian, 1966; Tulving, 1966; Tulving, 1972; Lockhart et al., 1976), while procedural memory expresses itself by habits, automatic and inarticulate manner and encompasses both cognitive and motor activities (Cohen & Bacdayan, 1994).

Like other executive functions, the proficiency of working memory matures considerably with development from preschool through adolescence (Conklin, Luciana, Hooper, & Yarger, 2007). Working memory has been found to predict academic achievement (Alloway, Gathercole, Adams, & Willis, 2005). For example, a study of a community sample of school-aged children revealed that working memory performance is associated with achievement scores in English and math. In adolescents, strong links persist between working memory and achievement in science and math but not in English (Gathercole, Pickering, Knight, & Stegman, 2004).

One of the consequences of poor memory is dyslexia and the incapacity to read and write correctly (Silver & Hagin, 2002). People with dyslexia repeat words and make confusions, transpositions, and omissions when reading and writing. They are easily distracted by sounds, have difficulty putting thoughts into words, hear things not said or apparent to others, and have poor memory for sequences, facts, and information that have not been experienced (Tafti, Hameedy, & Baghal, 2009). Considering that visual imagery and holistic perception play important roles in the learning process, and that cognitive processing in a person with dyslexia is done with pictures rather than words, Davis and Braun (1997) concluded that, as they are easily pictured, dyslexics have fewer problems with words referring to concrete objects, compared to those referring to abstract concepts for which they have no mental pictures. If teachers perceived students with dyslexia as visual-spatial learners capable of lateral and intuitive thinking and instinctive problem solving, making certain leaps, and spinning objects in their heads to see them from every angle (Everatt, 1999), then learning environments would be much more hospitable. Teachers' attitudes, and in more general terms, the cultural environment, determine not only how students with dyslexia are viewed and taught, but how they blossom and wilt (Tafti et al., 2009).

Social and Emotional Problems with Gifted and Talented Students

Gifted children can experience emotional issues because of advanced intelligence, high degrees of creativity, exceptional moral sensitivity, or strong commitment to task, which occur in degrees asynchronous to age-peers (Brody & Mills, 1997). This emotional instability can be expressed by divergent thinking, excitability, sensitivity, perceptiveness, and entelechy (Lovecky, 1992). A construct for children with emotional issues encompasses delinquency, aggression, attention problems, somatic complaints, anxiety, depression, and social problems (Nelson, Benner, Lane, & Smith, 2004). Emotional issues can lead to anxiety disorders which intensify psychosocial difficulties, school problems, low self-esteem, and psychological degradation such as depression, suicidal behavior, and substance abuse (Birmaher et al., 1997; Breslau, Schultz, & Peterson, 1995). In most cases, the consequence of these emotional disorders is associated with social skills deficits and rejection of other students reflected in isolation and limited positive social experiences (Mathur, Kavale, Quinn, Forness & Rutherford, 1998). Students with emotional disorders are less likely to attend postsecondary school, pointing to the importance of meeting their emotional needs during K-12 education so that they may be stable enough to continue with their schooling and reach their full potentials (Kauffman, 1997).

A study of school achievement of 150 K-12 students concluded that adolescents with emotional disorders were more likely to experience academic achievement deficits in all the foundational areas of learning including reading, writing

and mathematics (Nelson, Benner, Lane, & Smith, 2004). A meta-analysis (Reid, Gonzalez, Nordness, Trout & Epstein, 2004) reported that students with emotional disorders tend to reach a lower level of achievement than those without disabilities.

Accommodation and services for students with emotional disorders are needed. The failure to identify students with emotional disorders early may result in lessening of the effect of the eventual interventions (Bradley, Doolittle, & Bartolotta, 2008). Qualified teachers to instruct students with emotional disorders are lacking (Henderson, Klein, Gonzalez, & Bradley, 2005). Instructional tools such as graphic organizers and a calm, prepared environment that includes student choices such as listening to music, working in isolation or working with partner can assist students with emotional disorders in learning.

The Lesson

The lesson focused on creating detailed short stories or legends about the pictograms on Mars discovered by NASA spacecraft. Activities were designed to practice three specific de Bono Thinking skills (de Bono, 1985, 1999) in exploration of possible pictograms or pictorial landforms on Earth and on Mars. These thinking skills allowed students to analyze situations and content in a clearer and broader manner. The three de Bono thinking skills chosen for this lesson were Planning, Deciding, and Recognizing. The lesson followed a step-by-step guide designed to instruct gifted students who may also have the additional exceptionalities of poor memory and an emotional disability.

Participants

The participants were adult, high-achieving doctoral students (mean age = 39), many of whom had been identified for gifted services in their K-12 schooling. Emotional or memory issues were not documented. Twenty one students (11 male, 10 female) participated in the lesson as a part of their regular class meeting.

Photographs presented

Earth Pictures. Picture #1 represented a drawing from a cave that was discovered in the south of France. The drawing represented an animal that may be related to a horse or cow. The animal is detailed with colors to represent the different parts of the body (legs, face, tail). Picture #2 represented a landscape of Native American mounds from the Effigy Mound National Monument in Iowa, USA, taken from a 'helicopter" view. In this landscape, composed of trees and trails, the snakelike shape of the mound can be seen. Picture #3 is an aerial view of a dry plateau (the Nazca area in Peru) with carvings representing something resembling a bird or phoenix. Picture #4 is a view from "helicopter" showing a circle of grass with a shape composed of rocks that looks like a bird.

Mars Pictures. The Mars pictures used in the lesson were NASA photographs. The images are shown in Figure 3, Figure 4, Figure 5, and Figure 6.

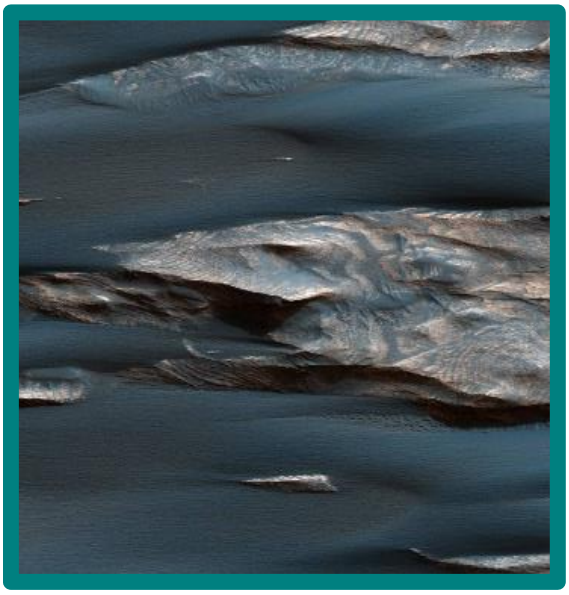

Figure 3. Windblown Dunes in Ganges Chasma taken May 27, 2017 by Mars Reconnaissance Orbiter. Image courtesy of NASA/JPL-Caltech/Univ. of Arizona (JPL/NASA, 2017a)

Figure 4. A World of Snowy Dunes on Mars taken May 21, 2017 by Mars Reconnaissance Orbiter. Image courtesy of NASA/JPL-Caltech/Univ. of Arizona (JPL/NASA, 2017b)

Figure 5. To Great Depths taken by Mars Reconnaissance Orbiter. Image courtesy of NASA/JPL-Caltech/Univ. of Arizona (JPL/ NASA, 2015b)

Figure 6. Ares 3 Landing Site taken May 17, 2015 by Mars Reconnaissance Orbiter. Image courtesy of NASA/JPL-Caltech/Univ. of Arizona (JPL/NASA, 2015c)

Lesson Procedures

When teaching students in a general education setting, especially those who are considered gifted or having disabilities, a variety of engaging teaching strategies need to be used. This lesson focused on the use of graphic organizers to aid retention, organization, and understanding of the information presented on the pictograms of Mars. The graphic organizers assisted students in making connections, retaining important facts, and the planning phase of assessment (Marzano, 2010). For this reason, this lesson used graphic organizers and photos to build student understanding of pictograms on Mars.

Anticipatory set. The instructors showed images of pictograms from a variety of Earth settings such as cave drawings, earth mounds, and Nazca lines. The instructors asked students to identify the objects in the images presented to them. This information allowed the teachers to assess levels of participants' prior knowledge of pictograms on Earth.

Accessing prior knowledge. Students were shown four pictures of pictograms that can be found on Earth (as described previously). On a graphic organizer (Figure 7), they filled in a blank with a word that best described each object being represented. The participants then discussed their responses with their group members to establish a "consensus" idea regarding each photograph. The teacher asked the groups to justify their choices for the class.

Earth Picture #1	Earth Picture #1	Earth Picture #1	Earth Picture #1

Figure 7. Graphic organizer for recording ideas about Earth pictograms.

Acquiring new knowledge. Students were shown four pictures of pictograms from Mars that have been captured by NASA. The students filled in the blanks on the worksheet with "their best description" of each picture. Then, the participants shared their ideas with others in the group. Next, the students used a graphic organizer, as shown in Figure 8 and in Figure 9, to arrange ideas and plan a short science fiction story based on the images from Mars.

Mars Pictograms

Directions: Fill in the boxes below to match your thought to the corresponding picture on the screen. Be sure to write neatly, to ensure that is can be read.

Part 1

Picture #1	Picture #2	Picture #3	Picture #4

Recognize

Directions: Answer the following questions about your recognition of the images from the pictures listed above.

What clues allowed your to recognize the images in the pictures?	
What Prior Knowledge did you use to make your assumption?	
What characteristics of real animals did you recognize in the pictures?	

Figure 8. First page of graphic organizer used with the Mars photographs.

Directions: Fill in the boxes below, using the words from the word bank, to match your thought on the corresponding picture on the screen. *You may only use four (4) words, so choose wisely!* Be sure to write neatly, to ensure that is can be read.

Part 2

Picture #1	Picture #2	Picture #3	Picture #4

Word Banks

dolphin	**whale**	**fish**	**snake**
bird	**paw print**	**jellyfish**	**worm**

Decision

Directions: Answer the following questions about how you decided which of the words best fit (from the word bank) for the images from the pictures listed above.

Why did you decided to use the labels (from the word bank) you did?	
What prior knowledge did you use to determine what each pictogram was?	
Does your culture, upbringing, or experiences influence your decisions?	

Figure 9. Second page of the graphic organizer for the Mars photographs.

Creating a story. The process of completing graphic organizers and creating a short story had the following steps. First, the teacher provided every participant with a flowchart and a graphic organizer with a word bank to aid in organizing thoughts. The flowchart is shown in Figure 9. Second, the students used words from the word bank to complete the top portion of the flowchart. See Figure 10. Students, then, provided additional details to support the stories. The students checked with the facilitators to ensure that the flowcharts were completed correctly. Once the flowcharts were approved, the instructors provided each student pieces of "space"-themed paper to create a short story telling how the pictograms were created. When completed, the students gave their stories to the instructors for assessment.

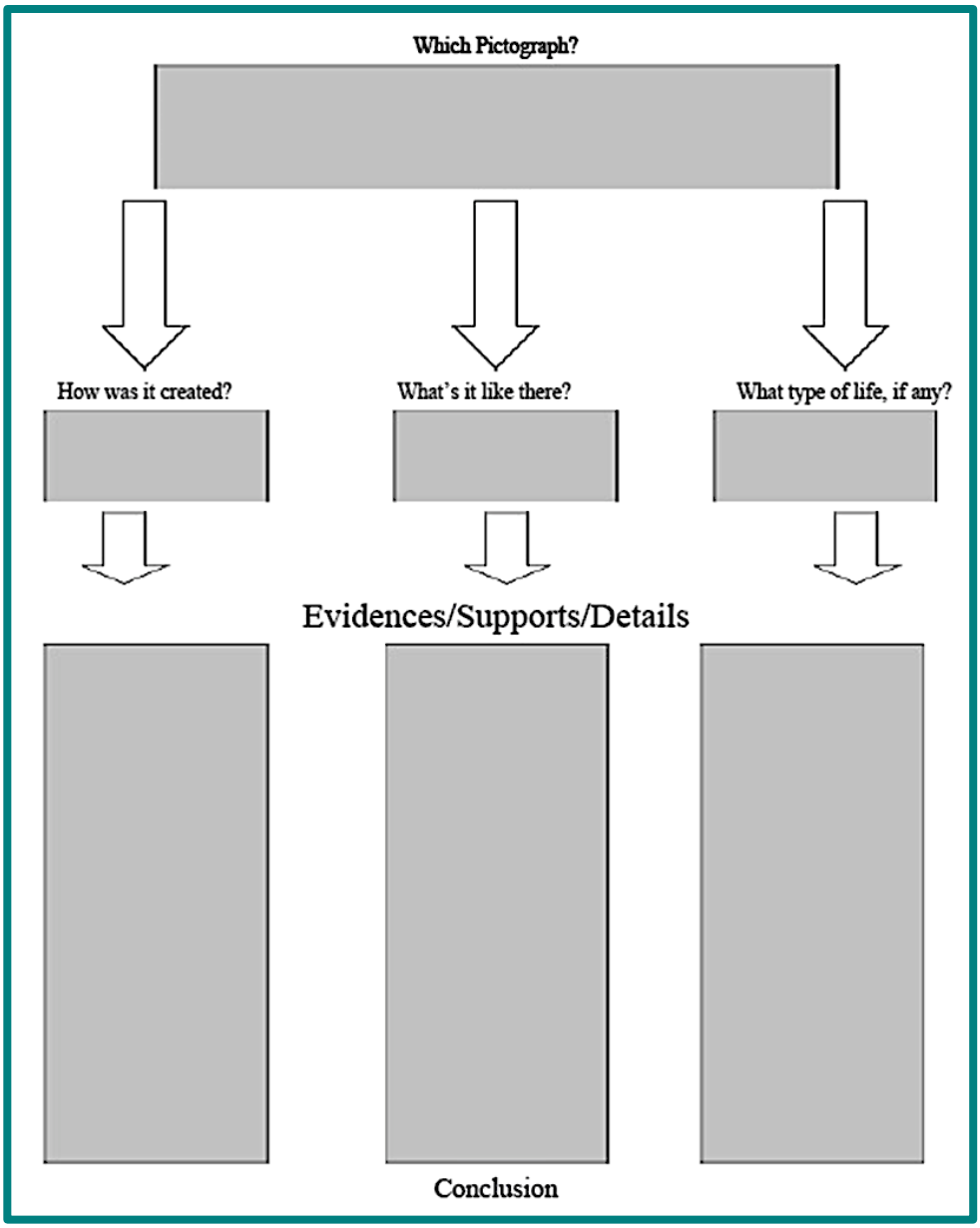

Figure 10. Flowchart used by students to create a detailed account of their story

Essential questions. Essential questions are large, complex questions that guide students throughout a unit of study and are created by unpacking content specific standards that are assessed throughout the unit. Three essential questions identified by the instructors follow. Why do pictograms appear on both Mars and Earth? Is it possible that the same group(s) of creatures created pictograms on both planets? What are the origins of the pictograms on Earth and why did they appear on Mars?

Learning targets. The students were able to recognize pictograms from Earth shown on multimedia as specific shapes, animals, or items. Then, the students demonstrated their understanding of pictograms by identifying similar ones on Mars. The students used a graphic organizer

and word bank to organize and create the rough outline of their short story before writing the final version.

Learning outcomes. The students were able to make connections between their previous knowledge of pictograms on Earth and those on Mars. Using a graphic organizer and writing prompts, students created short stories/legends about the origins of the pictograms on Mars.

Modifications and accommodations. Because this lesson was designed for gifted students with and without additional disabilities, the students who had emotional issues were allowed to choose their work environment such as working alone or with a partner, laying down, listening to music, and other options. Students with poor short or long-term memory were allowed to use a graphic organizer to structure ideas and for reference when writing the short story or legend. To address possible issues with student confidentiality and the question of "fairness", the instructors afforded these choices to *all* students.

Assessing student learning. Student learning was assessed for understanding of the concepts and writing skills using a writing rubric. The information from the short story and flowchart was used to determine the students' ability to use organizational skills, create a logical sequence of thoughts, and write to communicate effectively. The rubric determined content specifics as well as grammar, sentence structure, and effective writing skills.

Results and Discussion

This lesson focused on teaching of three of Edward de Bono's Thinking Skills: Recognition, Decisions, and Planning, through exploration of mysterious Mars Pictograms. Students were introduced to each skill individually, using photos in making choices and generating ideas for each of the three thinking skill areas. Students used graphic organizers, which included a box for the description of the photographs and a box for higher order thinking questions about each of the first two skills, recognition and decisions. See Figure 7, Figure 8, and Figure 9. For the planning thinking skill, participants used a flowchart to organize their thoughts which, then, culminated in the activity of writing a legend or short story about the pictogram from Mars each student chose. See Figure 10. Figure 11 shows student participants working during the lesson.

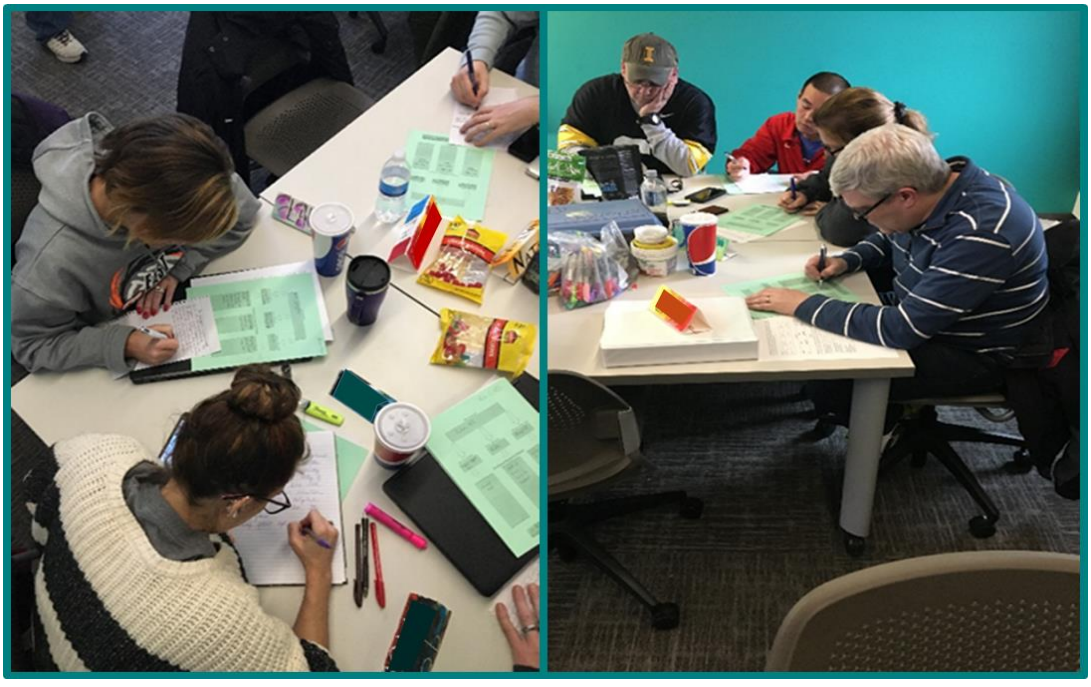

Figure 11. Students working during the lesson.

Recognizing Pictures

To assess students' ability to use de Bono thinking skill of recognition, the students were shown photographs of four unidentified pictograms from the planet Earth: (1) Cave painting of a horse from France; (2) Aerial view of serpent mound at Effigy Mounds (Iowa); (3) hummingbird image in Nazca lines; and (4) bird image from Georgia (USA). In the first section of the graphic organizer, students were asked to identify the pictograms in the photographs using only their prior knowledge and understanding while labeling each picture. As shown by the Table 1, in the majority of responses, the participants recognized each pictogram as a form of animal.

Table 1. *Choices made by students about pictograms on Earth*

Photograph number and subject	Student interpretation using prior knowledge	Frequency
1. Cave painting from France	Four-legged mammal, real	19
	Four-legged mammal, unreal	2
2. Serpent mound from Effigy Mounds (Iowa)	Snake/serpent	12
	Abiotic/abstract	6
	Bipedal and quadruped animals	3
3. Hummingbird Nazca lines in Peru	Bird, descript, specific	13
	Bird, nondescript	6
	Other: B-52, insect, unicorn	3
4. Bird image from Georgia (USA)	Turtle/sea turtle	12
	Other, abiotic (non-living): storm water pond, lake	2
	Bird, nondescript	2
	Bird, descript/specific: eagle, vulture	6

The second section of the graphic organizer used with the recognition skill, focused on what allowed students to identify these pictograms in the way they did. This section asked open-ended questions pertaining to why students identified the pictograms in the manner they did. Once the data were collected, categories were formed to identify recognitions skill categories and to assess student's thought process. To determine the student prior knowledge, the questions, with student responses noted, shown in Table 2 were asked.

The analysis of student responses to each of the three reflection questions, demonstrated that the students relied heavily on their prior knowledge and experiences while determining what each pictogram represented. Students also use essential characteristics to assist in the identification process. One significant factor that influenced students' identification processes was the opportunity to collaborate with peers following the independent identification of each pictogram. Students shared, defended, and argued for their perspectives of each pictogram and reflection question, fueling effective discussions.

Table 2. *Student answers to open-ended questions of recognition of pictograms*

Question to which students responded	Student responses	Frequency
What clues allowed you to recognize the images in the pictures?	Characteristics such as size, shape, color	18
	Shape or Gestalt	11
	Prior knowledge of the site	7
	Actual features such as horn, ears, tails	4
	Context, such as where pictogram was found on Earth	2
What prior knowledge did you use to make your assumption	Experience with animals	8
	Knowledge of animals	6
	Artwork/photographs	5
	Comparison to other animals	2
What characteristics of real animals did you recognize in the pictures?	Appendages	21
	Wings	8
	Head	7
	Tail	7
	Features	6
	Body covering	4

Decisions

To assess students' ability to use the de Bono thinking skill of "Decision," the students were shown photos of four pictograms from the planet Mars (See Mars photos in Figures 3 through 6). In the first section of the graphic organizer (See Figure 2) on decisions, students were asked to recognize the possible pictograms in the photos using their prior knowledge and understanding to label each picture; however, unlike the recognition graphic organizer, the decision graphic organizer included a word bank with eight pictogram choices (See Figure 2). Students were required to use only the words from the word bank in their decision making process. The word bank was used to illuminate the skill of decision making. As shown in Table 3, students had a wide variety of answers using the word bank for each picture. To better understand the decision-making process, the second section of the graphic organizer required the participants to answer open-ended questions about their thought-processes.

Table 3. *Student choices on Mars pictograms using word box words*

Mars Photograph number and location	Student decision of what the image represents	Frequency
1. Mars Reconnaissance Orbiter; Mars northern hemisphere; taken May 21, 2017	Whale	6
	Bird	5
	Paw print	4
	Dolphin	3
	Fish	2
	Snake	1
2. Mars Reconnaissance Orbiter; Ganges Chasma	Jelly Fish	10
	Snake	5
	Whale	2
	Worm	1
	Dolphin	1
	Bird	1
	Fish	1
3. Mars Reconnaissance Orbiter; Hallas Canyon	Worm	9
	Snake	8
	Fish	4
4. Mars Reconnaissance Orbiter; Acidalia Planitia Region; Taken May 2015	Paw Print	13
	Jelly Fish	5
	Whale	2
	Fish	1

The second section of the graphic organizer used with the decision skill concentrated on what allowed students to make the decision based on the given words from the word bank. In this section of the lesson, the facilitators asked open-ended questions pertaining to why students decided to label the pictograms in the manner they did. The analysis of the student responses resulted in several decision-skill categories representing the student thought process. The questions shown in Table 4 were asked to assess the student decision-making process with the results listed in the corresponding tables.

Students relied heavily on prior knowledge and experiences to make the determination of what each pictogram showed. The fact that a word bank limited the choices and labels of each pictogram seemed to have a limited effect on the decisions made by students in identifying the pictograms from Mars. Instead of feeling restricted to the word box choices, students still relied heavily on identifying characteristics to assist in their decision-making. As in the recognition portion of the lesson, an important step in student learning was the ability to collaborate with peers following the independent identification of each pictogram. During the discussion, the participants shared ideas, gave each other feedback critiqued each other's perspectives.

Table 4. *Influences of culture, upbringing, and experiences on ability to identify pictograms*

Question to which students responded	Student responses	Frequency
Why did you decide to use the labels (from the word bank) you did?	Best fit from word box	12
	Similarities to real animals	3
	Features	2
	Influence from peers	2
	Process of elimination	2
What prior knowledge did you use to determine what each pictogram was?	Knowledge of shape	10
	Knowledge of animals	5
	First-hand experiences	3
	Previous Observations	2
	Words in the box	1
Does your culture, upbringing, or experiences influence your decisions?	Experience: visiting zoo, living on a farm	11
	Culture: Sacred animals, astronomical signs	4
	No Influences: Really have never been close to animals or studied beyond basic levels	3
	Upbringing: Family discussions, education of animals beyond basic level, exposure	3

Planning

To assess students' abilities to use de Bono's thinking skill of planning, the students were given a flowchart (See Figure 3) in which they chose one of the four pictures from the decision skill activity on which to focus their work. On the flowchart, the students wrote ideas related to the kind of life that would be found there, what it looked like, and how the object in the photo was created. Students then used the flowchart to add details about each of the previous questions. This allowed them to actively plan their legend/short story and ensure that all ideas were well thought out, coordinated, and developed. The graph in Figure 12 shows the number of times each pictogram was chosen.

The analysis of the student-created plans of the legends/short stories demonstrated that they tended to select the most familiar pictogram. Restricting student word-choices to the word bank helped them focus more on planning their stories rather than selecting appropriate words. Through the process of planning, the participants were able to add detail and create written examples that had a coherent flow and logical order. The de Bono skill of planning lead directly into the final art project, which concluded in composing a legend or short story. Planning is essential for students to make connections between the lesson and the assessment.

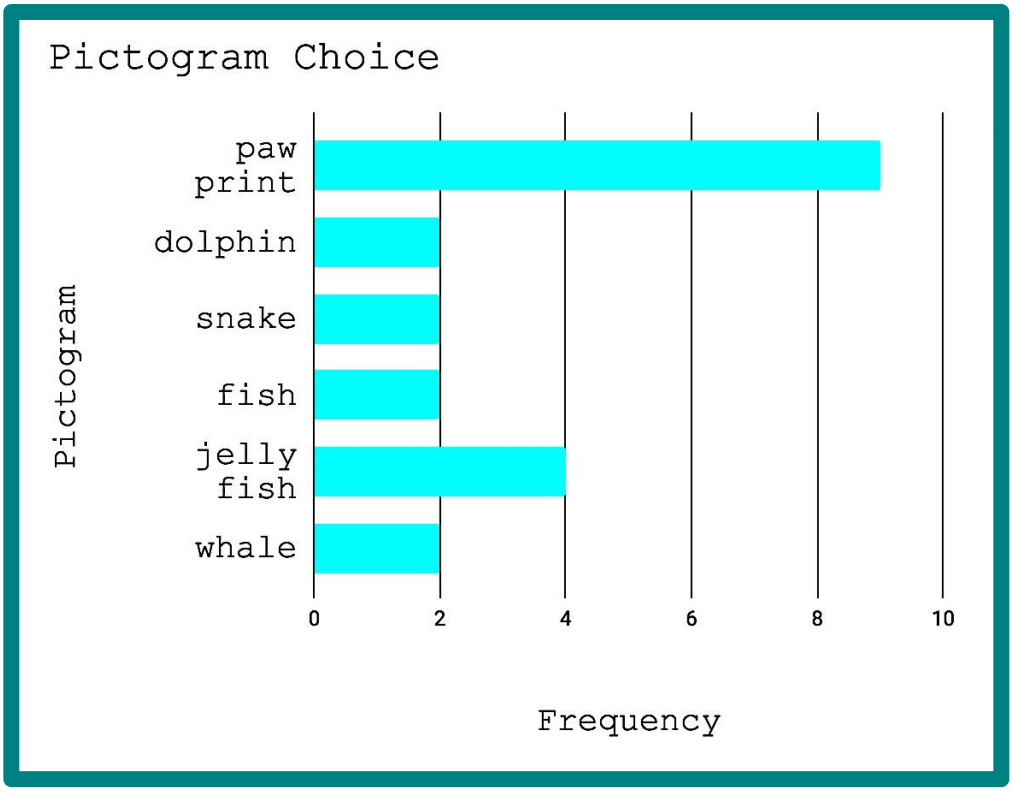

Figure 12. Bar graph of the subjects related to the pictograms that students chose for their stories.

Planning the short story with a flowchart allowed the students to design their writing pieces with three key writing prompts in mind. The three prompts were: 1. How was the object on Mars created? 2. What was it like there? 3. What type of life is there, if any? For students with poor memory, the writing prompts provided assistance and support when making decisions about the particular pictogram they had chosen. In addition to the writing prompts, the flowchart also allowed the participants to select and list appropriate supporting evidence under each thought, as well as write conclusions based on the evidence. After completing the flowchart, the students became better equipped to add detail, have a coherent plot, and avoid repetition. Therefore, the flowchart was an effective aid in creating interesting and well-defined short stories or legends.

Table 5 represents four of the stories generated by participants. "The Legend of the Giant Fish" shows creativity through the understanding of the unusual orbit partner of Mars bringing it closer to the Sun during specific times in the year. In "The Legend of the Giant Fish", the students demonstrated their creativity through using their understanding of the science concept of the planet's orbit to generate an exciting twist of the story/legend plot. "Crater of Life" shows creative thinking through the use of an animal legend to show understanding of the pictograms and their meanings. The creative application of the students' personal interest in art to explain the origin of the formation on Mars is a creative trend in the story "Artist Martian". The last story, "Dogs of Mars" includes creative use of the students' prior knowledge of dogs and their actions to create a myth about how the paw print pictogram appeared on Mars. The types of creativity expressed in these stories indicate the participants' ability to think creatively when viewing unexplained pictograms on Mars.

Table 5 Examples of Participants' Stories

The Legend of the Giant Fish	Crater of Life
Many years ago, there were many forms of life on Mars. Animals and plants were abundant. However, as Mars's orbit approached the Sun, the ocean dried up and killed all of the fish. Legend states, there was a giant type of fish. This fish was over 100 feet long and had an 18-foot jaw. However, now there is no life anymore on Mars, and the fish has faded away with the elements.	In the crater of life on Mars, a giant fish swims aimlessly. Suddenly, a fisherman's fly is cast in the crater. At a moment's notice, the giant fish opens its mouth to chomp on the fly leading to its impending doom!
Artist Martian	**Dogs of Mars**
Upon return from a year-long exploration, Calvin returned to the red planet he called home to document his findings. Because of his artistic abilities, he set out to create what he saw and experienced in painting and sculpture. He hoped he would be able to put these together and submit them to the local museum. He set about gathering his paint, water, and other materials and wandered to his backyard studio. Here he began to form clay-like soil into the circular shape of the head of a creature he witnessed. Then, he formed the swirls of the tentacles and added the water and paint to create the shine and the color. Though he didn't know what to call his creature, he has been mesmerized by it.	On Mars, there is a large colony of dogs. Each dog has left its own massive paw print on the surface of the planet. In the hot, dry, and sandy planet's surface, the large, massive dogs walk around leaving these massive imprints. The many dogs that live on Mars and in space, are constantly wandering around leaving these prints in the sand, but the lack of wind on the planet has caused very little disruption to the paw prints. This means we do not know how old the paw print is. We may not know how old the paw prints are, but we know dogs living on Mars made them. The colony of massive dogs continues to visit from planet to planet adding more and more paw prints in the sand.

Conclusion

The activity described in this paper was designed for students who are twice exceptional, particularly, those with emotional disabilities and long-term and short-term memory difficulties. For this reason, the three de Bono's thinking skills: recognition, decision-making, and planning, were taught through the use of effective research-based tool, the graphic organizer.

Instructor Reflection

The findings from student responses showed that the majority of students based their decisions and recognitions on prior experience, character traits of animals, and prior knowledge. When planning the instruction for the decision portion of the lesson, the authors envisioned that the word bank would help the students in the decision-making process. Nevertheless, the analysis of the student responses showed that the majority of them based their decisions and conclusions on prior experience, character traits of animals, and prior knowledge. Absence or presence of the word bank didn't seem to have influenced the base for the decision-making process of the students. This finding was unexpected and interesting.

Peer discussions showed that the students felt limited by the word bank. Some participants mentioned feeling forced to choose from things they have not recognized in the photographic images. When conducting this lesson in the future, the word bank could be omitted or made optional.

Some also remarked that the quality and the size of the NASA photographs made it hard to see the exact pictograms. Including arrows or drawing a circle around the exact part of the photograph where the pictogram is located, could help ease the task of finding the pictogram in the photographs.

Implications for Practice

The results of this project are important for the practice of teaching twice exceptional students with emotional and memory disabilities for several reasons. The most significant reason is the benefits of utilizing graphic organizers with all students, but especially with those who are served in alternate programs or settings. Completing the graphic organizer kept the students in this study engaged, but still allowed for differentiation of instruction to meet the individual student needs within the lesson. The other key implication is the opportunity to collaborate, which allowed the participants to share and discuss their ideas regarding the pictograms, which opened their minds to alternative ideas during the story-planning process. This discussion among peers is an essential part for successfully teaching the de Bono's thinking skills in the classroom.

Possible Extensions of the Lesson

Using these three de Bono thinking skills in combination seems beneficial based on the results of this lesson; however, it is possible that a better combination of three of the de Bono CoRT thinking skills for the tasks of the lesson exists. Perhaps, the skill of decision-making could be combined with skills that focus on alternative positions. The findings from this lesson show that students tended to rely heavily on prior knowledge and experiences to make determinations of pictograms. It would be interesting to see the degree to which the participants would rely on their prior knowledge and experiences if the pictograms were not resembling any of the objects the students have prior knowledge of. This may cause the students to be more dependent of word banks, collaboration with peers, or new knowledge gained on the subject. Therefore, conducting this lesson again may lead to a deeper understanding of student use of prior knowledge in new and novel settings.

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