EVALUATING THE EFFECT OF VISIBLE THINKING ROUTINES ON STUDENTS’ AWARENESS AND CONCEPTIONS OF THINKING AND UNDERSTANDING IN THE SCIENCE CLASSROOM

by

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ABSTRACT

This classroom action research project is inspired by the belief that “life outside of school is better characterized as a series of transfer opportunities than as a series of recall assignments to be done.” (Brookhart, 2010, p. 5) Furthermore, I believe that knowledge can only be transferred when one’s level of understanding for a particular topic goes deeper than simple recall. Researching best practices on improving students’ critical thinking skills that would enable them to integrate and transfer their knowledge led me to the realization that for students to have and to demonstrate a deeper level of understanding they first need to be aware of and fluent in thinking that leads to understanding. Students can accomplish a deeper level of understanding if the “thinking” is modeled for them and the students are given opportunities to practice thinking for understanding. In order to identify what thinking for understanding looks like and when they are engaged in it, students need to make their thinking visible.

To accomplish this, I model and introduce Visible Thinking Routines designed to help students become aware of and fluent in thinking that leads to deeper levels of understanding by focusing on the eight types of thinking that are vital to understanding as outlined in Making Thinking Visible (Ritchhart, Church, Morrison, 2011). I modeled and introduced six Visible Thinking Routines to my seventh grade students for a period of 14 weeks and had them complete concept maps, surveys and questionnaires to evaluate the effectiveness of the routines on their awareness and conceptions of thinking and understanding in the science classroom.

The use of these Visible Thinking Routines helped students’ awareness and conceptions of thinking shift from physical actions to more cognitive actions. Student thinking also shifted from simply identifying physical actions to making connections between the physical actions and the cognitive actions. Although results were positive, the treatment phase was not long enough for the students to fully comprehend the effectiveness or value of the Visible Thinking Routines on their understanding. Students were able to determine that thinking for understanding was valued in the classroom, but were unable to find value in it for themselves or value in using them in other classes. The Visible Thinking Routines and the emphasis on the thinking for understanding activities helped to establish a common cognitive language in the classroom.
INTRODUCTION AND BACKGROUND

Background Information

There is no other quote that better summarizes my current thoughts on education and assessment as Tony Wagner’s statement from his 2012 TEDxNYED where he stated, “The world doesn’t care what you know. What the world cares about is what you do with what you know” (Wagner, 2012, https://www.youtube.com/watch?v=hvDjh4l-VHo). This in addition to Susan M. Brookhart’s belief that “life outside of school is better characterized as a series of transfer opportunities than as a series of recall assignments to be done” (Brookhart, 2010, p.5) is the driving force behind my action research-based classroom project. Over the last three years I have researched and implemented different strategies for making students accountable for the disciplinary core ideas, science and engineering practices and cross-cutting concepts that make up the three dimensional approach to science education outlined in the National Research Council’s, A Framework for K-12 Science Education (2012) and the Next Generation Science Standards (NGSS) released in 2013. Inspired by Tony Wagner’s quote and the Understanding by Design (UbD) framework created by Grant Wiggins and Jay McTighe (2005), I stopped using the standardized type of assessments that accompany our issues based science curriculum and created all new formative and summative assessments that categorized questions according to Bloom’s Revised Taxonomy of educational objectives (Anderson and Krathwohl, 2001) and Norman Webb’s Depth of Knowledge (DOK) levels (1999).

I did this in an attempt to get a better understanding of my students’ depth of understanding and to determine if they could do more than just recall the content covered in class and actually apply and transfer their knowledge. To my dismay, I quickly
learned that my students were masters at recalling and explaining the ideas and concepts covered in class but that they consistently missed the mark when it came to the application of skills and concepts, the strategic reasoning skills that demonstrate sound reasoning with evidence and justification and the extended reasoning skills that demonstrate that they can integrate and transfer that knowledge. The majority of my students are unable to demonstrate that they can integrate and transfer their knowledge because they lack a deep understanding of the content and they simply do not know what to do to acquire that level of understanding. Basically, most of my students knew of the content and concepts being covered in class but did not really understand the content or concepts enough to do anything beyond recalling and explaining it at a surface level.

My attempts to figure out how to teach my students to gain a deeper level of understanding led me to Harvard Graduate School of Education’s Project Zero “Creating Cultures of Thinking Project” based on Ron Ritchhart’s work on thinking routines. Reading over articles on thinking routines led me to the realization that in order for students to have and to demonstrate a deeper level of understanding they first need to be aware of and fluent in thinking that leads to understanding. As students become more aware of their own thinking and the strategies and processes they use to think, they become more metacognitive (Richard, Turner, & Hadar, 2009). Students can accomplish a deeper level of understanding if the “thinking” is modeled for them and the students are given opportunities to practice thinking for understanding. In order to identify what thinking for understanding looks like and when they are engaged in it, students need to make their thinking visible.
There are many types of thinking such as creative (asking students to “think outside the box”), analytical (visualize and articulate gathered information), critical (evaluate data or facts), concrete (focus on literal translation or face value of information or things), and abstract (understand meaning from behind situations and events). For the purposes of this classroom action research project, I focused on the types of thinking that support and are vital to understanding as outlined in Making Thinking Visible (Ritchhart, Church, & Morrison, 2011). These include 1) wondering and asking questions, 2) observing things closely and describing them fully and in detail, 3) building explanations and interpretations, 4) reasoning with evidence, 5) making connections, 6) looking at different viewpoints and perspectives, 7) capturing the core of a concept and 8) uncovering complexity and going below the surface of things.

Research Questions

I introduced and modeled Visible Thinking Routines to my seventh grade students. The implementation of these thinking routines enabled me to get a better understanding of how students’ awareness of the process of thinking and conceptions of thinking changed through the use of thinking routines designed to make thinking more visible in the classroom. Additional information I was interested in collecting included the students’ perceptions of the effectiveness of the Visible Thinking Routines in targeting their intended key thinking skill and how the inclusion of Visible Thinking Routines would affect me as the classroom teacher. The main question of my research is: How do students’ awareness and conceptions of the process of thinking change with the use of thinking routines designed to make thinking more visible in the classroom?
The sub questions for my research are:

A) How effective are the Visible Thinking Routines in targeting their intended key thinking skill for the students?

B) How will the inclusion of the Visible Thinking Routines affect me as the classroom teacher?

Support Team

Throughout the classroom action research project I consulted with a group of colleagues with various areas of expertise to serve as my support team. This group included Mary Porter, Elizabeth Otani, and Dr. Cos Fi. Mary Porter is my EAL support teacher and co-taught with me throughout the treatment period. Mary and I met once a week for forty-five minutes during a shared planning period to determine a timetable for the project, decide on the most appropriate and effective time to introduce each thinking routine within the scope and sequence of the current unit and to look over the data gathered from the daily and weekly student surveys.

Elizabeth Otani is a high school language arts and creative writing teacher. She has been a valued sounding board for all of the strategies I have implemented in my classes throughout the years and I value her feedback, suggestions and constructive criticism. Elizabeth and I met three times after school to discuss the status of the research and to go over any written analysis of the data I had completed thus far. She was a great source of moral support, and enthusiastic cheerleader.

Dr. Cos Fi is a mathematics professor. Dr. Fi and I officially met 3 times during the research project. During our first meeting we went over the initial data collected and
compared it to the research questions they addressed to ascertain that I would be able to use it. Based on his recommendations, I made slight adjustments to the student surveys that would make it easier to gather the information I needed. Our second meeting focused on some initial data analysis and the most effective means to represent the gathered data. Due to numerous and extended student absence it was decided that I would focus on overall trends and use specific student data that either supports or contradicts the trends for individual analysis. The third meeting was conducted at the end of the data collection phase and focused on additional data analysis and effective visual representation. All three colleagues were essential in helping me determine the effect of visual thinking routines on student’s awareness and conceptions of thinking and understanding.

CONCEPTUAL FRAMEWORK

Introduction and Background

In order to get to the root of the problem I had identified in my students I had to take a step back and look at what I wanted my students to be able to do with the practices, content and concepts I had covered in class. It was not enough that my students knew the information and could recall it on a test. What I was really interested in was what my students could do with that knowledge and how they could transfer that knowledge and use it in new situations. It was important for my students to realize that knowing something was not the same as understanding something since aside from knowing the content outlined in NGSS disciplinary core ideas, my students are expected to carry out the NGSS performance expectations for each standard. These include providing evidence, asking questions to clarify evidence, construct scientific explanations
based on evidence, analyze and interpret data, apply scientific principles, gather and synthesis information, and construct an argument supported by evidence among others. Each of these performance expectations easily fits one of the six levels of cognitive processes outlined in Bloom’s Taxonomy of 1956 or Anderson and Krathwohl’s Revised Bloom’s Taxonomy of 2001. Bloom’s taxonomy is hierarchal in its design and assumes that one cognitive process leads to another and if so than “understanding” or “comprehension” is the key that unlocks the door to all the other cognitive processes. Essentially, if I wanted my students to perform better on the critical thinking questions, based on Bloom’s Revised Taxonomy, I needed to focus more on teaching for understanding.

As cited in Ritchhart (2011), Blythe & Associates (1998), E. O. Keene (2008) and Wiggins & McTighe (1998) suggest that today most educators would argue that understanding is indeed a very deep, or at least complex, endeavor and not in any way a lower-order skill as the revised taxonomy suggests. As Wiske (1997) noted, research into understanding, conducted with colleagues from Project Zero, indicates that, “understanding is not a precursor to application, analysis, evaluating, and creating but a result of it” (as cited in Ritchhart, 2011, p. 7). Ron Ritchhart (2011) makes the argument that understanding is not a type of thinking like the rest of the cognitive processes outlined in Bloom’s taxonomy but the main goal of thinking. With this in mind, I decided that teaching for understanding was not enough and that I needed to focus on their thinking skills, specifically the thinking skills that lead to understanding.
So then how did I define understanding? I used a definition by John Dewey (1933) that states,

Understanding is the result of facts acquiring meaning for the learner: To grasp the meaning of a thing, an event, or a situation is to see it in its relations to other things: to see how it operates or functions, what consequences follow from it, what causes it, what uses it can be put to (as cited in Wiggins & McTighe, 2005, p. 38).

In essence, to understand is to be able to apply, analyze, evaluate and create. This definition of understanding added to the notion that a student that truly understands a concept or idea is able to transfer that concept or idea to other situations formed the basis of my classroom action research question. According to Wiggins and McTighe (2005):

Understanding is about transfer, in other words. To be truly able requires the ability to transfer what we have learned to new and sometimes confusing settings. The ability to transfer our knowledge and skill effectively involves the capacity to take what we know and use it creatively, flexibly, fluently, in different settings or problems, on our own. Transferability is not mere plugging in of previously learned knowledge and skill. In Bruner's famous phrase, understanding is about ‘going beyond the information given’; we can create new knowledge and arrive at further understandings if we have learned with understanding some key ideas and strategies (p. 40).

If students can successfully transfer and apply content knowledge to new situations then they could transfer the thinking skills that lead to understanding to other unknown phenomena and this would have a ripple effect that would go beyond the treatment phase of this classroom action research project. Ritchhart (2011) outlines eight types of thinking that support and are vital to understanding. He suggests that students be engaged in all of these types of thinking multiple times throughout a unit of study to help them develop a deeper level of understanding.
Engaging students in thinking that leads to understanding is not enough if the students themselves are not aware of the “significant role thinking plays in cultivating their own understanding” (Ritchhart, 2011, p. 37). It is important for students to know the reason or the logic behind why we carry out certain tasks within a lesson or unit. “To be properly metacognitive, then, students have to be realistically aware of their own cognitive resources in relation to the tasks demand, and then to plan, monitor and control those resources” (Biggs, 1987, p. 75). The first step was then to find out what my students thought it meant to think and the role it played in understanding. In order to accomplish this, I used a measuring tool developed in 2005 by the research team of Ron Ritchhart, Terri Turner, David Perkins and Linor Hadar, as part of the Cultures of Thinking Project (COT) at Bialik College in Melbourne, Australia. The COT Project (http://www.pz.harvard.edu/projects/cultures-of-thinking), seeks to develop students’ dispositions toward thinking through the creation of classrooms where thinking is valued, visible, and actively promoted as part of the regular, day-to-day experience of all students. Students need to be able to understand and see how this type of “thinking” leads to this type of “understanding”.

The Cultures of Thinking Project research team used a concept map to explore and measure students’ explicit awareness of the process of thinking and any changes in these conceptions among students in COT classrooms where teachers incorporated Ritchhart’s Thinking Routines (2002). Ritchhart et al. (2009) were interested in uncovering “students’ conceptions of what it means to think rather than their
beliefs or theories about thinking or the purpose of thinking” and “students’ awareness of thinking moves they might undertake that can facilitate their learning, problem solving, decision-making, and judgment” (p. 6). The study involved 239 students in grades three to eleven whose teachers were participants in the COT project. The concept maps were completed as part of the students’ regular classwork at the beginning and end of the school year. In order to score the maps, the team used an inductive coding approach that allowed them to “best represent all of the data from the maps, as well as to articulate a new frame for understanding students’ conceptions of thinking” (p. 13).

Data Analysis

The team categorized the students’ responses into four main response types: Associative, Emotional, Strategic and Meta. To establish reliability among the varied format and clarity of the 172 initial concept maps, the team created guidelines to help align researchers in coding that helped to determine when to count an item as a single response or as a multiple response. The finalized guidelines and schema resulted in an inter-rater reliability of at least 80%. Reliability for the final concept maps was also established prior to scoring. The initial and final concept map responses were grouped according to curriculum and developmental differences and are represented in Table 1 and Table 2 (Ritchhart et al, 2009, p. 18 and 19).
The results showed that the younger students’ responses were predominantly Associative in nature and that these types of responses decrease as students mature despite it still having the largest number of responses. Researchers also noted that developmentally, older students included more strategies than younger students and that “students at all levels show an awareness of the role of emotions in thinking though there was no significant difference between grades in either Emotions or Meta thinking comments” (Ritchhart et al, 2009, p. 19).
The differences between the responses in the initial and final concept maps showed that there was a “significant decrease in Associative responses and a significant increase in the category of Strategies reported.” For grades 7-11 there were decreases in Emotional responses and an increase in Meta responses. The differences between the initial and final conceptions are shown in Table 3 (Ritchhart et al., 2009, p. 20).

Table 3

<table>
<thead>
<tr>
<th>Conception of thinking categories</th>
<th>Percent of responses Grades 3-4</th>
<th>Percent of responses Grades 5-6</th>
<th>Percent of responses Grades 7-11</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>χ²</td>
</tr>
<tr>
<td>Associative</td>
<td>71.51</td>
<td>51.20</td>
<td>25.28*</td>
</tr>
<tr>
<td>Strategies</td>
<td>16.47</td>
<td>39.54</td>
<td>21.79**</td>
</tr>
<tr>
<td>Emotions</td>
<td>12.02</td>
<td>7.91</td>
<td>0.17</td>
</tr>
<tr>
<td>Meta comments</td>
<td>0.00</td>
<td>1.35</td>
<td>0.00</td>
</tr>
</tbody>
</table>

*p<.05, **p<.01

Through their research the COT project research team was able to show that it is possible to code students’ responses on a concept map to illustrate their present mental model of thinking. They also showed that the concept maps could show “evidence that students’ conceptions of thinking are malleable and can be advanced beyond expected developmental progress” (p. 23). According to the team, their study provides other researchers, like myself, “with one potentially useful measure for capturing the effects of interventions that promote students’ thinking.” (p. 23). The COT concept map tool allowed me to measure the effect of incorporating the Visible Thinking Routines in my classroom had on my own students’ explicit awareness and conceptions of thinking.
and thinking for understanding.

**Theory**

Modeling thinking routines is an important aspect of getting students thinking for understanding. Since thinking happens in our minds and is thus invisible to others and ourselves it is important for teachers to model effective thinking through speaking, writing, or drawing. According to Ritchhart & Perkins (2008), externalizing our thoughts and making our thinking visible to students fosters thinking. “Visible thinking also emphasizes documenting thinking for later reflection” (p. 58).

Visible Thinking Routines go beyond modeling to establishing routines. According to the Visible Thinking website, routines are the patterns by which we operate and go about the job of learning and working together in a classroom environment (Thinking Routines section, para. 1). The word routine implies that these are strategies that are used repeatedly and become part of the structure of everyday life in the classroom to accomplish specific goals or more importantly a part of the everyday structure of learning and understanding. Thinking routines focus on the establishment of structures that weave thinking into the fabric of the classroom and help to make the thinking of everyone in the classroom more visible and apparent (Perkins, 2004). Whereas an instructional strategy may be used only on occasion, routines become part of the fabric of the classroom through their repeated use (Ritchhart, Palmer, Church & Ticshman, 2006, p. 6). Just as effective teaching demands that teachers establish routines to guide the basic physical and social interactions of the classroom, so too thinking routines need to be established to help guide students’ learning and intellectual interactions (Leinhardt & Greeno, 1986; Leinhardt, Weidman, & Hammond, 1987 as cited in Ritchhart et al, 2006, p. 2). In the case
of thinking routines, the goal of the routine is to scaffold and support a particular set of thinking moves (Ritchhart et al., 2006).

The thinking routines established by Ritchhart (2011) can be carried out on an individual or group basis and therefore their usefulness extends outside the classroom. Unlike previous standards, the 2013 NGSS not only includes what a student should know but what they should be able to do with that knowledge. The standards are presented as performance expectations and as such require students to apply their learning and show their level of understanding by doing. The thinking routines fit nicely with these expectations as they clearly define “that learning involves actively doing something with the topic at hand, rather than just absorbing information” (Ritchhart et al., 2006, p. 17). The epistemic message that “learning is doing” also aligns with a performance theory of understanding, which says that learners demonstrate, as well as construct, their understandings of a topic when they engage in performances that make use of what they know (Blythe & Associates, 1998 as cited in Ritchhart et al., 2006, p. 17). Albert Einstein is credited with saying, “I never teach my pupils; I only attempt to provide the conditions in which they can learn.” I hope that through the modeling of the Visible Thinking Routines I am not only providing the conditions in which they can learn but also giving them the strategies with which to learn to understand.

**METHODOLOGY**

**Demographics**

I carried out the classroom action research from October 31st, 2016 to March 10th, 2017. The treatment period was for a total of 14 weeks with a 3-week break from December 16th to January 8th and another two-week break from January 23rd to
February 6th. Research was carried out at Dalian American International School in Dalian, People’s Republic of China. The school is an international school founded in 2007 to serve the educational needs of international residents. The research project was focused on my seventh grade class. The class consists of ten boys and ten girls. Of the twenty students in the class, seven are classified as English as an Additional Language Learners (EAL). Six out of the seven students receive additional language support in class because they are at a level three or below on the World-class Instructional Design and Assessment (WIDA) scoring scale. The remaining student is currently at a level four or above on a WIDA scoring scale and is expected to exit the program during this school year. One of the EAL students also has an individualized education program (IEP) and receives additional, non-language based, in-class support. An EAL teacher that co-teaches along side me provides this additional support.

I gathered data on all twenty students for the first five weeks of the treatment period. Due to the needs of six of my EAL students, the EAL department and I decided it was best that these six students not participate in the daily or weekly surveys completed in the last ten minutes of class because they needed that time to check in with their support teacher. Whenever possible these students completed the daily or weekly surveys at home. I also had two students not return to school in January after the winter break and one student with an extended absence from November 14th to December 16th.

A typical trimester is nine weeks long and the students rotate between an A and B day schedule. On A weeks I teach the seventh grade class three times a week. On B
weeks I teach the seventh grade class two times a week. Class periods are ninety minutes long, Monday through Thursday and seventy-five minutes long on Fridays.

The students come from the United States, Canada, Germany, Japan, China, Korea, and India. Out of the twenty students, ten are new to the school. I have taught six of the remaining ten students for six consecutive years and the other four for at least two consecutive years. The students are exceptionally well behaved, outgoing and seventy percent of them consistently score at a level three or above, on a four point grading scale, on all summative assessments. Although they do not need any additional incentives to complete their classwork or curb unwanted behavior, I am using gaming strategies through Classcraft™ to encourage them to challenge themselves and take more risks.

**Treatment**

Visible Thinking Routines are simple activities focused on a set of questions or limited sequence of steps used for the process of learning that help to promote a culture of thinking within a learning environment. The Visible Thinking Routines used throughout the treatment phase are from Making Thinking Visible (Ritchhart et al., 2011). The routines are patterns of action that can be integrated and used in a variety of contexts. The routines work to promote the development of a student’s thinking and the classroom culture because they are 1) goal oriented and target specific types of thinking, 2) are used repeatedly in the classroom 3) made up of a few steps, 4) easy for students to learn and for educators to teach, 5) easily supported when students are working on them, 6) used across a variety of contexts and 7) used individually or in groups (Ritchhart et al., 2011). Table 4 provides an adapted overview of the thinking routines included in Making
thinking visible: How to promote engagement, understanding, and independence for all learners that I used in class and how they relate to Bloom’s taxonomy.

Table 4
Thinking Routines Matrix

<table>
<thead>
<tr>
<th>Routine</th>
<th>Description</th>
<th>Key Thinking Skills</th>
<th>Overview</th>
<th>Bloom’s Taxonomy Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Routines for Introducing and Exploring Ideas at the Beginning of a Unit</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Think-Puzzle-Explore</td>
<td>An adapted version of KWL chart that has student document what they think about a topic instead of what they know, what puzzles them about the topic, and how they can investigate the puzzle.</td>
<td>Activating prior knowledge, wondering, planning</td>
<td>Used at the beginning of a unit to direct inquiry and identify and uncover current level of understanding, ideas and misconceptions.</td>
<td>Remember, understand</td>
</tr>
<tr>
<td>Chalk Talk</td>
<td>An open-ended silent discussion where students consider ideas, questions or problems by responding silently in writing. Builds understanding in a collaborative way.</td>
<td>Uncovering and Identifying prior knowledge, questioning</td>
<td>Open-ended discussion on chart paper where all students participate and are given time to think. Used during the unit as a way for students to track the changes in their thinking.</td>
<td>Understand, apply, analyze</td>
</tr>
<tr>
<td>Routines for Synthesizing and Organizing Ideas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Headlines</td>
<td>Students capture key points using a limited amount of words but communicate the core message.</td>
<td>Summarizing</td>
<td>Quick summaries of the big ideas covered in class. Used at the end of each lesson.</td>
<td>Understand, apply, analyze</td>
</tr>
<tr>
<td>I Used to Think…, Now I Think…</td>
<td>Students examine and explain how and why their thinking has changed as they consolidate new learning.</td>
<td>Reflecting and metacognition</td>
<td>Reflection tool used to help students gauge how their thinking has shifted or changed over time.</td>
<td>Understand, apply</td>
</tr>
<tr>
<td>Routines for Digging Deeper into Ideas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What Makes You Say That?</td>
<td>Used throughout a class discussion to get students to elaborate on their thinking and fosters a disposition for evidential reasoning.</td>
<td>Reasoning with evidence</td>
<td>Question asked by the teacher during discussions to help students give evidence for their statements. Used as a follow up comment on assessments to get students to dig deeper into the topic.</td>
<td>Understand, Apply, Analyze</td>
</tr>
<tr>
<td>Tug-of-War</td>
<td>Students create a visual tug of war by placing cards that explore the arguments for both sides of a dilemma to go beyond the surface and develop an appreciation for deeper complexities.</td>
<td>Gaining perspectives, reasoning and identifying complexities</td>
<td>Identifying and building both sides of an argument or dilemma. Used at the end of a unit to gauge our understanding of the issues related to the topic.</td>
<td>Understand, Evaluate, Apply</td>
</tr>
</tbody>
</table>

Thinking routines for introducing and exploring ideas were modeled and carried out at the beginning of a semester-long unit. Routines in this category included, Think-Puzzle-Explore and Chalk Talk (Appendix A and B). Table 5 provides a breakdown of
the teacher and student goals for each routine. The table also includes information for how and when the routines were modeled and used by the class.

Table 5
*Routines for Introducing and Exploring Ideas Matrix*

<table>
<thead>
<tr>
<th>Routine</th>
<th>Teacher’s Goal</th>
<th>Student Goal</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Think, Puzzle, Explore</td>
<td><strong>Lesson Planning:</strong> 1. Identify student’s current level of understanding and misconceptions. 2. Identify what my students wanted to know to determine how I would fit it into the standards. <strong>Assessment:</strong> 1. Gauge how students plan out an inquiry <strong>Classroom Culture:</strong> 1. Promote curiosity/demonstrate my passion and interest in the topic to spark student interest</td>
<td>1. Create a visual of what they think about the topic. 2. Opportunity to identify and formulate questions about what they want to know or don’t understand. 3. Express interest and curiosity level in topic 4. Express and plan how they would explore this topic</td>
<td>• Modeled and used at the beginning of the unit. • Class poster left up for a week following the introduction so we could add to it. • Individual posters placed in student’s folders so they could refer to it throughout the unit. • Students asked to update the posters as new subtopics were introduced.</td>
</tr>
<tr>
<td>Chalk Talk</td>
<td><strong>Lesson Planning &amp; Assessment:</strong> 1. Get a visual of students’ level of understanding to determine specific and class needs for scaffolding or review. <strong>Classroom Culture:</strong> 1. Provide opportunity for ALL students to express their ideas and ask questions in a non-intimidating platform. 2. Promote communication between peers as students respond to their peers’ thought and questions.</td>
<td>1. Make connections between their own ideas and the ideas of others 2. Dig deeper by elaborate on their own and other’s thinking 3. Communicate with others by commenting on the ideas of others 4. Ask questions/seek clarification</td>
<td>• Completed three times during the weather unit as new information was presented. • Chalk Talk poster displayed throughout the classroom for the entire unit so additional responses could be added.</td>
</tr>
</tbody>
</table>

Thinking routines for synthesizing and organizing ideas were modeled and carried out mid-semester/mid-unit. Routines in this category included, Headlines and I Used to Think…Now I think… (Appendix C and D). Table 6 provides a breakdown of the teacher and student goals for each routine. The table also includes information for how and when the routines were modeled and used by the class.
Table 6
Routines for Synthesizing and Organizing Ideas Matrix

<table>
<thead>
<tr>
<th>Routine</th>
<th>Teacher’s Goal</th>
<th>Student Goal</th>
<th>Use</th>
</tr>
</thead>
</table>
| Headlines                | **Lesson Planning:**  
1. Identify information that can be used to plan future lessons or review.  
2. Build understanding of big ideas and core principles.  
3. Review synthesis and summary skills  
**Assessment:**  
1. Assess individual student depth of understanding.  
2. Assess reflection, explanations and reasoning skills.  
**Classroom Culture:**  
1. Emphasize importance of summarizing our understanding  
2. Encourage sharing of thought process with each other.  
3. Encourage and emphasize reflection to gauge our own understanding. | 1. Consider a topic from multiple angles.  
2. Identify most important information.  
3. Provide opportunity to practice reflecting and synthesizing  
4. Build understanding of big ideas  
5. Share reasoning with others  
6. Explain and justify their choices | • Used at the halfway point in a unit before building onto our basic ideas and at the end of the culminating unit project.  
• Individual headlines accompanied by written explanation.  
• Individual headlines shared with lab partner.  
• Headlines poster displayed for a few weeks/ students encouraged to add additional headlines |
| I Used to Think…, now I think… | **Lesson Planning:**  
1. Identify lingering misconceptions and need for scaffolding or review.  
**Assessment:**  
1. Gauge how well students can consolidate new learning and identifying new understandings, opinions, and beliefs.  
2. Gauge students’ reasoning abilities, and the identification of cause-and-effect relationships.  
3. Identify lingering misconceptions  
4. Assess if a students thinking has grown, deepened or changed to determine proficiency level.  
**Classroom Culture:**  
1. Encourage development of metacognitive skills by reflecting on their thinking and identify how and why thinking has changed. | 1. Recognize the difference between accumulation of facts and changes in thinking that lead to deeper levels of understanding.  
2. Develop reasoning abilities and recognize cause and effect relationships.  
3. Develop meta cognitive skills by identifying and explaining their own thinking. | • Used after each lesson within a unit.  
• Completed on an individual basis, then shared with their lab partner.  
• Collected responses where added to class poster and displayed for the duration of the unit. |

Thinking routines for digging deeper into ideas were modeled and carried out at the end of the semester/unit. Routines in this category included Tug-of-War (Appendix E). The What Makes You Say That? Visible Thinking Routine was used throughout the semester and unit to encourage students to elaborate on their thinking during class discussions and provide evidence for their claims during formative and summative
assessments (Appendix F). Table 7 provides a breakdown of the teacher and student goals for each of these routines. The table also includes information for how and when the routines were modeled and used by the class.

Table 7
*Routines for Digging Deeper into Ideas Matrix*

<table>
<thead>
<tr>
<th>Routine</th>
<th>Teacher’s Goal</th>
<th>Student Goal</th>
<th>Use</th>
</tr>
</thead>
</table>
| **Tug-of-War**  | **Lesson Planning:** 1. Identify points of interest or gaps in information to plan future lessons. 2. Ensure all factors; reasons or influences are taken into account when presenting a topic. **Assessment:** 1. Gauge individual and classroom perceptions. 2. Identify gaps in reasoning and depth of understanding based off individual student responses. **Classroom Culture:** 1. Provide opportunity to engage in complex issues. 2. Develop an appreciation of a dilemma or complex issue instead of just skimming the surface. | 1. Examine the many different forces that “tug” opposing sides of a topic. 2. Look at both sides of a complex issue to find supporting reasons/evidence, without taking a side. 3. Evaluate the strength of our arguments. 4. Visualize the factors, reasons and influences involved in a complex issue. | • Modeled and completed four times during the treatment period at the end of the unit or major lesson.  
• Students were responsible for creating the individual “tugs”.  
• “Tugs” were evaluated and classified as a whole class.  
• Tug-of-War poster left on display for a few days. |
| **What Makes You Say That?** | **Lesson Planning:** 1. Plan deeper discussions 2. Identify gaps or misconceptions in student learning to provide scaffolding or review 3. Encourage students to create their own explanations, theories and reasons 4. Determine need for differentiation of tasks **Assessment:** 1. Identify individual or class misconceptions 2. Elicit justification and evidence behind choices on a multiple-choice test to gauge depth of understanding. 3. Assess students reasoning skills and ability to cite evidence **Classroom Culture:** 1. Foster a disposition for evidential reasoning 2. Establish a classroom practice of offering reasons that can be substantiated by proof | 1. Allows students to consider multiple viewpoints and perspectives during whole class discussions 2. Provide opportunity to elaborate on thinking behind a given response 3. Allows students to identify basis for thinking | • Used throughout the treatment period on a daily basis after assertions, explanation, interpretations or opinions were expressed by students.  
• Asked on formative assessments to probe students to think deeper.  
• Added to multiple-choice questions on summative assessments to determine proficiency level. |
Data Collection

I gathered data throughout the fourteen weeks to help me address the classroom action research questions I identified earlier. The data collection methods I used are outlined in Table 8.

Table 8
Data Triangulation Matrix

<table>
<thead>
<tr>
<th>Research Questions</th>
<th>Data Collection Methodologies</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Student Evaluation of Thinking Survey (initial and final)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1A. How do students’ awareness of the process of thinking change through the use of thinking routines designed to make thinking more visible in the classroom?</td>
<td>Concept Map on Thinking</td>
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<td></td>
<td>Student Visible Thinking Routine Questionnaire</td>
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</tr>
<tr>
<td>1B. How do students’ conceptions of thinking change through the use of thinking routines designed to make thinking more visible in the classroom?</td>
<td>Daily Student Exit Ticket</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
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<td></td>
<td>Daily Teacher Reflection Survey</td>
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<td></td>
<td>Teacher Perception Survey</td>
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<tr>
<td></td>
<td>Teacher Visible Thinking Reflection Questionnaire</td>
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<tr>
<td>2. How effective were the Visible Thinking Routines in targeting the intended key thinking skills for students?</td>
<td>X</td>
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<td></td>
<td>X</td>
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<tr>
<td>3. How will the inclusion of the Visible Thinking Routines affect me as the teacher?</td>
<td>X</td>
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The initial and final Student Evaluation of Thinking Survey (Appendix G) helped me gauge students’ perceptions and awareness of the thinking process. In it, students were asked to rate the frequency in which fourteen specific activities are carried out in
class. These activities are directly related to the thinking routines I modeled in class. Students completed an Evaluation of Thinking survey during the first and last week of the treatment period.

The Concept Map activity (Appendix H) was used to obtain baseline data on the seventh grade students’ conceptions of thinking. The students were asked to create a concept map of the things that go on in their heads when they are thinking. Students were prompted to come up with more ideas about what thinking is and what is involved in thinking by 1) thinking of a time when it was difficult or hard for them to think and explain what kinds of things they did then, 2) think about times when they knew they were engaged in good thinking and explain what they were doing then and 3) think of someone they consider to be a good thinker and explain what kinds of things this person does that makes him or her a good thinker. I used a concept map student-recording sheet from the Culture of Thinking Project. Students had previous experience with concept maps as they had successfully completed concept maps in groups or individually as part of the unit of study they had completed earlier on in the year. The Concept Map activity was completed a second time at the end of the treatment to compare the students’ conceptions of thinking and identify any changes.

The Visible Thinking Routine surveys were designed to collect feedback about the effectiveness of each routine after the students had several opportunities to engage in it. Students were asked to rate and describe how much the routine had pushed them to think, how effective it was in targeting the intended key thinking skills, and if they saw value in using it on their own or in other classes. Students completed Visible Thinking
Routines surveys on Think-Puzzle-Explore (Appendix I), Chalk Talk (Appendix J), Headlines (Appendix K), I Used to Think…Now I think… (Appendix L), and Tug-of-War (Appendix M). Students did not complete a stand-alone survey on the What Makes You Say That routine, as this was incorporated into each of the other surveys.

The Daily Student Exit ticket (Appendix N) consists of four questions related to what the students did in class to help them develop a deeper level of understanding of the content covered in class. The data gathered from this survey helped me determine individual student awareness and conceptions about thinking and the kind of thinking they engage in to better understand the content being presented in class. Students did not complete Daily Student Exit surveys for class periods dedicated to testing or were not full blocks due to early release schedules or special events.

The Daily Teacher Reflection survey (Appendix O) consists of four questions related to what the students did in class to help them develop a deeper level of understanding of the content covered in class. In this survey I indicate the top three thinking for understanding activities the students were engaged in during class. The Teacher Perception Survey (Appendix P) was completed at the beginning and end of the treatment. In this survey I rate the frequency in which fourteen specific activities were carried out in class. The survey is similar to the Student Evaluation of Thinking survey. I used the results of this survey to gauge changes in my approach to teaching and lesson planning. I used these two surveys in conjunction with the Teacher Visual Thinking Routine Reflection Questionnaire (Appendix Q) to determine how the inclusion of the Visible Thinking Routines affected me as the teacher.

Validity and Reliability
I used a process of triangulation, looking at data gathered from three or more perspectives, to check that the evidence that I had gathered from the data was valid and not just a mere coincidence. To analyze how the students’ awareness and conceptions of the process of thinking changed with the use of thinking routines designed to make thinking more visible in the classroom I used data from the Initial Student Evaluation of Thinking Survey, the Thinking Concept Maps, the Daily Exit Tickets, and the Final Student Evaluation of Thinking Survey. Data from the Initial and Final Student Evaluation of Thinking Surveys, the Visible Thinking Routine Questionnaires, and the Daily Exit Tickets were used to analyze how effective the Visible Thinking Routines were in targeting the intended key thinking skills for students. I also used the data from these surveys, the Daily Teacher Reflection surveys, and the Teacher Thinking Routine Reflection Questionnaire to determine the effects the inclusion of the Visible Thinking Routines had on me as the teacher.

Although the claims I am making in this paper do not hold social validation since others have not validated them, the claims do hold personal validation since the evidence gathered from the data was used to support the personal values that inspired the classroom action research project.

To ensure reliability of the instruments used throughout the classroom action research project, I used the test-retest reliability method by having students complete the same surveys throughout the entire treatment. In this way I was able to ensure that the instruments consistently measured what they were intended to measure. Despite the fact that it is unlikely the exact same results will be obtained each time using different groups
of students in different schools since participants and situations vary, in this case reliability is indicated by a strong positive correlation between results of the other surveys.

The research methodology used during this AR project received an exemption by Montana State University’s Institutional Review Board (IRB) and compliance for working with human subjects was maintained (Appendix R).

DATA ANALYSIS

Changes in Awareness and Conceptions of Thinking

Analysis of the data gathered from the above-mentioned treatments is presented in this section. The Thinking Maps were created to gauge students’ initial awareness and conceptions of thinking and provide baseline data (Appendix H). The responses gathered from these maps were categorized into four main response types consisting of Associative responses, Emotional responses, Strategic responses and Meta responses ($N=18$). Associative responses are any student ideas that are associated with thinking but not descriptive of thinking. These responses focus on the where and when of thinking. Typical Associative responses would be, “in math class” or “during a test.” Emotional responses describe moods, feelings or attitudes about or toward thinking. These responses usually include affective words and phrases. Typical Emotional responses would be “happy”, or “nervous about the test.” Responses describing actions involved in the processes of thinking were categorized as Strategic responses and provided a baseline for the kinds of strategies students rely on when required to think and how they correspond to higher order thinking skills as outlined in Bloom’s revised taxonomy. Like
the COT research team, these responses were of particular interest to me because they helped me identify the types of strategies for thinking students were most familiar with and using in class. Typical Strategic responses included specific strategies like “repeat it over and over” and motivational strategies like “be in a quiet room.” Responses that described the nature of thinking were categorized as Meta responses and provided a baseline for students’ attitudes and opinion about the purpose of thinking. Meta responses serve as “partial indicators of a greater awareness of the purpose and complexity of thinking, learning and understanding” (Ritchhart et al., 2011, p. 39). These response categories are identical to the response categories used in COT.

Data from the initial and final Thinking Maps showed 1) how students’ awareness of the process of thinking changed through the use of thinking routines designed to make thinking more visible in the classroom and 2) how students’ conceptions of thinking changed through the use of thinking routines designed to make thinking more visible in the classroom. The initial Concept Map responses are found in Figure 1.

There were 101 responses included in the completed maps. Out of those responses 65% represented Associative responses, ideas that were associated with thinking but not
descriptive of the act of thinking. These included responses such as, “can help in school and in everyday life”, “when your brain cells start moving” and “when you lose something and you think about what you did that day to try and find it.” Emotional responses made up 18% of the responses. Responses in this category included, “it is hard to do” and “when you’re proud of what you got in the end.” Strategic responses made up 15% of the overall responses while 2% described the nature of thinking and were categorized as Meta-responses. Strategic responses included many specific thinking strategies such as “visualizing through diagrams or graphs”, “creating concept maps”, and “comparing and contrasting”. The Meta responses were, “piecing together all parts of a problem or gathering all the evidence to understand how they make a whole” and “looking beneath the surface to see what other things cause it to do what it does because there is always more.” I was not surprised by the amount of Associative responses included in the initial concept maps as many students expressed having a difficult time finding the words to describe the kinds of things going on in their heads when they are thinking. This was also the case with the initial concept maps gathered by the COT research team. Initially many students identified school or home related day-to-day situations in which they were required to think. Asking for further clarification led students to identify general strategies used during these situations. The EAL students had the most Emotional responses. I used the two distinct categories devised by the COT research team (2009) to categorize Emotional responses. Ritchhart et al. (2009) categorized initial responses to calls for thinking such as “scared” or “unsure” as Reactive Emotional responses and emotions that arise as a result of thinking such as,
“being excited that I solved it” or “confusion as a result of trying to solve the problem” as Cognitive Emotions. Thinking for my EAL students revolved around feelings of frustration or joy when completing various academic tasks and were mostly Reactive Emotional responses. The EAL support teacher and I found this very helpful because we wanted to ensure that all students, especially the EAL students were aware that it was the process and not necessarily the outcome that was most important. Making thinking visible was paramount for this group of students that often relied on visuals to fully grasp and then explain new vocabulary and content. Through visual representations such as diagrams they proved that the inability to communicate in English is not an indicator of a student’s ability to think and comprehend.

The Strategic responses correlated with the school-wide Thinking Maps initiative that was undertaken in mid-November (https://www.thinkingmaps.com/).

Many of the strategies included on the concept maps were directly related to the different thinking maps the students had completed in various classes such as circle maps, double-bubble maps, and flow maps. These responses only identified the maps but not the nature of thinking or the thinking processes involved in the completion of the maps. Through the Thinking Map initiative, teachers received professional development on how and when to use the different maps across the curriculum. Teachers were required to incorporate several thinking maps throughout their lessons and display the student made maps throughout their classrooms and school. Based on the responses it seemed that the students were able to identify the different strategies as physical actions of thinking but very few were able to further break them down into cognitive actions. The close
connection between the Thinking Maps used by all the other teachers and the Visible Thinking Strategies I was modeling in class created some confusion for the students and directly influenced the amount of strategic responses on the Thinking Concept Maps. The anticipated outcome was that following the treatment; the students’ responses would shift from more Associative and Emotional responses to more Strategic and Meta responses indicating that they had developed an awareness of thinking.

Students completed the second and final concept map at the end of the treatment (Figure 2).

![Final Thinking Concept Map](image)

*Figure 2. Final Concept Map, \(N=16\).*

There were 118 responses included on the final concept maps. Out of those responses 35% represented Associative responses, ideas that were associated with thinking but not descriptive of the act of thinking. These included responses such as, “focus”, “notes from my notebook”, “trying to think creatively in art” and “using a formula in math.” Associative responses still made up the largest group of responses but
significantly decreased from the initial concept map responses from 65% to 35%.

Emotional responses made up 15% of the responses and included, “be relaxed”, “will I be nervous in the presentation”, and “anxious because you are not prepared to answer the question.” Strategic responses were included in 32% of the responses. These included responses such as, “pictures/visual representations”, “creating mind maps”, “making connections” and “inferring/predicting.” Meta responses made up the remaining 18% of responses. These included, “look at the different perspectives to understand a problem completely and how it changes because they change all the time”, “making connections to yourself, to others or to the world helps you to understand more”, and “connecting things I already learned and add it to the new ideas to grow your learning.”

There was an equal amount of Emotional responses in the final concept maps as there were in the initial concept maps. In the initial concept map there were eighteen participants compared to sixteen participants in the final concept maps. Again many of the Emotional responses were from my EAL students. The student with the IEP included only Emotional responses in his completed concept map and all of the responses were Reactive Emotional responses, related to how he was feeling about completing and presenting his science night investigation. There were fewer Associative responses in comparison to the initial concept maps and the responses were more specific to school rather than general situations they would encounter outside of school. There were 37 Strategic responses in the final concept maps compared to the 15 responses given in the initial concept maps. I had expected that many of the students would name the Visual Thinking routines we completed in class in their concept maps but this was not the case.
After conferring with several students I realized that many of the students were not familiar with the actual names of the Thinking Strategies but the type of thinking involved in it and the desired result. The responses again included the names of the Thinking Maps they had completed in various classes as well as a list of higher order tasks associated with each Thinking Map like “compare and contrast”, “infer”, “evaluate” and “classify.” The overall results of the pre and post Thinking Maps are in keeping with the results of the study for grades 7-11 done by the COT research team at Bialik College in which there was a substantial decrease in the number of associative responses with a substantial increase in the strategic responses and a slight increase in the meta responses (Table 3). Unlike the results of the COT study where there was a fair decrease in emotional responses, there was no significant change in the emotional responses in my students. To get a better understanding of how the strategic responses had changed throughout the treatment I further categorized the responses to differentiate between strategies helpful for retention versus understanding. I used the four categories identified by the COT team. The four categories include, 1) memory and knowledge-based strategies, 2) general and non-specific strategies, 3) self-regulation and motivation strategies and 4) specific thinking strategies and processes. Following is a breakdown of the initial and final strategic responses by category (Figure 3).
Figure 3. Strategic responses by category, (Initial N=18, Final N=16).

Memory and knowledge based strategies focused on storing and recalling information like, “saying it over and over to myself”, “research it”, and “look at my notes.” The number of responses in this category increased from six to ten responses. General and non-specific responses identify good strategies but do not describe specific actions. These included “brainstorming” and “creating a flow chart.” This further emphasized the idea that students were aware of the specific strategies and could identify them but were unable to explain the cognitive actions related to these strategies. After identifying general strategies some students connected them to reflections on how these strategies were related to the nature of learning to construct Meta responses. It was these responses that I felt indicated an increase in students’ awareness of thinking because they were able to move beyond just identifying the strategy and explain how the strategy helped them think.

The Meta responses increased from two initial responses to twenty-one final responses. Nine out of the 16 students that completed concept maps included responses
that incorporated the general strategy of looking at information from different perspectives but connected it to deeper ideas about understanding. One student wrote, “thinking about issues from different perspectives helps you understand why you think like you do.” This was one of the thinking routines I spent the most amount of time modeling and doing in class as it easily lent itself to the subject matter and our issues based science curriculum. Through the Tug-of-War thinking routine the students were able to map out how beliefs can be shaped by personal, social, economic and political needs and how our own thinking can shift throughout time depending on our role in relation to the issue. This further emphasized the idea that understanding can be fluid and on going in its nature. Another example of Meta responses stemming from general strategies includes, “asking questions---even when you think you know, there can always be more.”

The data from the Concept Maps was compared with the data from the Student Evaluation of Thinking Survey to get a better idea of the student’s perceptions and awareness of the thinking process. The Concept Maps allowed the students to reflect on their own ideas about thinking while the Student Evaluation of Thinking Surveys allowed students to reflect on the thinking for understanding activities carried out in class and identify when and how often they thought they were engaged in each activity during class.

The Student Evaluation of Thinking was administered at the beginning of the treatment on November 2nd. In the survey the students were presented with a list of activities and asked if they participated in these activities almost always, sometimes or
almost never during science class. The responses served as baseline data to determine 1) how the students’ awareness of the process of thinking changed through the use of thinking routines, and 2) how the students’ conceptions of thinking change through the use of thinking routines. Nineteen students took the survey but only eighteen responses were received for questions one, nine and eleven. Figure 4 includes the initial Student Evaluation of Thinking Survey results.

![Initial Student Evaluation of Thinking Survey](chart.png)

*Figure 4. Initial student evaluation of thinking survey results, (N=19). Questions 1, 9 and 11, (N=18).*

The majority of the students indicated that they were almost always engaged in eight out of the fourteen activities. These activities are check marked in the list below, which presents each of the fourteen activities.

- [x] 1. Looking closely at things, describing them, noticing details, or detecting patterns.
- [ ] 2. Building our own explanations, theories, hypotheses, or interpretations.
3. Reasoning with evidence and supporting our ideas with facts and reasons.

☐ 4. Wondering, raising issues, and showing curiosity about what we are studying.

☐ 5. Making connections between different things, to the world, or to our own lives.

☐ 6. Looking at things from different perspectives & points of view to see things in a new way.

☑ 7. Identifying the central or core ideas, forming conclusions, or capturing the essence of things.

☑ 8. Digging deeply into a topic to uncovering mysteries, complexities, and challenges.

☑ 9. Organizing and pulling together ideas, information, notes, and experiences to make sense of them.

☑ 10. Reflecting on where we are at in our learning and understanding to determine where to go next.

☑ 11. Using and applying what we have been learning to solve new problems or create something original.

☐ 12. Reviewing and going over information from the readings or previous class work.

☑ 13. Reading, listening, or getting new information about the topic we are studying.

☐ 14. Practicing the skills and procedures the class has already learned.

A majority of students felt that they were engaged in five out of the fourteen activities only sometimes, including activities 2, 5, 7, 12 and 14. An equal number of students felt that they were almost always or only sometimes engaged in Activity 4. Five out of nineteen students indicated that they were almost never engaged in this activity.

Initially these five responses surprised me as wondering, raising issues and
showing curiosity about what they were studying was ranked as one of the most frequently used activity in the classroom and I felt that the students were almost always engaged in this activity during each class period. Tony Frontier and James Rickabaugh (2014) state,

The most profound questions that further learning are rarely asked on a test; they come from the learner. Metacognitive questions such as ‘What does this mean?’ ‘Why doesn’t this make sense?’ and ‘Why does this happen?’ are the most important questions asked of any learner. According to this principle, the most critical role a teacher can play is to empower students to honor these questions to guide their learning (p. 97).

Frontier and Rickabaugh state that too often students perceive asking questions as a sign of ignorance on their part instead of a pathway to understanding. I had been under the false impression that because I taught science my students were immune to this train of thought during class since asking questions is the basis for all scientific knowledge and investigation. My students could make the connection that in science, questions lead to investigations and experiments but were missing the connection between questions and understanding. This was further emphasized through an informal interview carried out during an investigation. When asked what they hoped to gain from carrying out the investigation, one of the students stated, “doing an experiment in class gives you the answer.” When asked if the answer led to a deeper understanding of the content, he commented “no, it just gives you the answer to the original question or sometimes leads you to another question.” This prompted me to model and encourage my students to ask more metacognitive questions throughout the learning process. I had already begun to incorporate “what makes you say that?” on a daily basis but I also added, “What does this mean?” “Why does this happen?”, “What is the purpose of doing this?” , “What’s going
on?” and “What do you see that makes you say that?” I encouraged my students to ask themselves these questions throughout the class to drive their thinking and gain a deeper level of understanding. I also hoped that the Chalk Talk, What Makes You say That? and Think, Puzzle, Explore strategies would show students how important wondering, raising issues and showing curiosity by asking questions is in developing a deeper level of understanding.

Figure 5 includes the results of the final Student Evaluation of Thinking Survey completed in early March.

Figure 5. Final student evaluation of thinking survey results, (N=16).

The majority of the students indicated that they had almost always been engaged in seven out of the fourteen activities. These activities are check marked in the list below, which presents each of the fourteen activities.
1. Looking closely at things, describing them, noticing details, or detecting patterns.

☐ 2. Building our own explanations, theories, hypotheses, or interpretations.

☑ 3. Reasoning with evidence and supporting our ideas with facts and reasons.

☑ 4. Wondering, raising issues, and showing curiosity about what we are studying.

☐ 5. Making connections between different things, to the world, or to our own lives.

☐ 6. Looking at things from different perspectives & points of view to see things in a new way.

☐ 7. Identifying the central or core ideas, forming conclusions, or capturing the essence of things.

☑ 8. Digging deeply into a topic to uncovering mysteries, complexities, and challenges.

☑ 9. Organizing and pulling together ideas, information, notes, and experiences to make sense of them.

☐ 10. Reflecting on where we are at in our learning and understanding to determine where to go next.

☑ 11. Using and applying what we have been learning to solve new problems or create something original.

☐ 12. Reviewing and going over information from the readings or previous class work.

☑ 13. Reading, listening, or getting new information about the topic we are studying.

☐ 14. Practicing the skills and procedures the class has already learned.

This number dropped by one from the initial survey and did not include Activities 7 and 10. In the final survey there was a shift in the number of students that thought they
were only sometimes engaged in wondering, raising issues, and showing curiosity about what they were studying from 37% to 44%. The number of students that thought they were almost always engaged in this shifted from 37% to 50%. Initially 26% or five of the students thought they were almost never engaged in this activity but that number dropped to 6% or one student in the final perception survey. Four out these five students from the initial survey shifted their answer from “almost never” to “almost always” and one student shifted her answer to “sometimes.” The one student who thought that they were almost never engaged in this activity on the final survey had previously thought she was initially engaged in it only sometimes.

Students felt that they were engaged in seven out of the fourteen activities only sometimes. This number increased by two from the initial survey. The seven categories included Activities 2, 5, 6, 7, 10, 12 and 14.

To further determine how my students thinking about thinking had changed throughout the treatment phase I gathered daily data that provided specific examples of the kinds of activities they were engaged in and the type of thinking involved. There were a total of 230 Daily Exit tickets submitted but only 195 of the surveys were fully completed at the end of class. I decided to only use the data from the exit tickets completed and submitted at the end of class for consistency. On average there were twelve students that completed Exit Tickets every day. The Daily Exit Ticket asked students to 1) identify what they had learned in class that day, 2) check off the activities they had engaged in to get a better understanding of the topic, 3) give an example of one thing they did that day to help them develop a deeper understanding of the topic and 4)
give one example of something they could have done that day to help them develop a deeper understanding of the topic. According to the students they engaged in the following activities in Figure 6 throughout the treatment to gain a better understanding of the topic being covered.

![Student Daily Exit Ticket Overall Results](chart)

*Figure 6. Daily Student Exit Ticket results, (N=195).*

Reasoning with evidence and supporting our ideas with facts and reasons, asking questions, wondering, raising issues, and showing curiosity about what we are studying and building our own explanations, theories, hypotheses, or interpretations emerged as the activities they thought they were most frequently involved in during class when seeking to understand. Students indicated that they were involved in these three activities 48% of the time or more. Examples of how reasoning with evidence and supporting our ideas with facts and reasons had helped them gain a better understanding
included, “Something that helped me was that I used numbers to help me support my data so that the reasoning would be more convincing”, “I analyzed and came up with evidence for the meteorological stuff”, “I observed the given sets of data carefully and matched up the graphs to find a connection” and “I looked at other’s graph and made a conclusion of do land and water absorb the heat in the same way, this thing helped me develop a deeper understanding.” Examples of how asking questions had helped them gain a better understanding included, “Today I asked question related to the groups presentations to clarify certain things”, “Said questions I thought without being shy”, “I raised my hand a lot because I was excited about this unit and so I could see how my previous knowledge related to the new concepts”, “I asked a question and got answers and it helped me”, “Today, I tried to help self understand on one particular question I got wrong I asked Ms. Isa to help me understand” and “I asked a couple questions to help [me understand] what was it they were talking about.” Examples of how building their own explanations, theories, hypotheses, or interpretations helped them gain a deeper level of understanding included, “I made a couple of hypothesis of why some areas that are next to each other have a huge difference in temperatures”, “I connected all the things I learned so far and put them all together into one big chunk of knowledge”, “I made as many hypothesis of who the person that carries the disease could be during the amount of time given”, “I came up with some ideas how the ocean temperature affects the climate of an area and discussed about it with my groups” and “I made explanation and summarized how the water has unequal heating in the ocean.”
Asking questions, coming up with hypothesis and reasoning with evidence or using facts to support claims is typical of an inquiry-based, science classroom that is focused on cultivating higher order thinking skills and application and transfer of knowledge as opposed to simple recall. Students indicated that they were engaged in making close observations paying attention to the details and describing them fully and making connections to what they were learning with previously gained knowledge, their own life, and the real world 40% or more of the time. These activities are also typical of an inquiry based science classroom where students make close observations and relate what they observe to past experiences or previously gained knowledge in an attempt to explain new phenomena. Activities that they were engaged 30% or less of the time were looking at different viewpoints and perspectives, summarizing notes in an attempt to capture the core of the concept and going below the surface to uncover complexities. In the Final Student Thinking Evaluation Survey students indicated that they were almost always engaged in looking at things from different perspectives and points of view to see things in a new way. I am inclined to think that this activity was included in the final survey and not as much in the daily exit tickets because the Thinking Routines designed for this were used toward the end of the unit, which coincided with the end of the treatment even though it had been included in the initial survey as an activity they were in engaged in only sometimes. Identifying the central or core ideas, forming conclusions, or capturing the essence of things and digging deeply into a topic to uncover mysteries, complexities, and challenges were both categorized by students as activities they were almost always engaged in on the initial Student Thinking Evaluation Survey. Unlike the
result of the Daily Exit Ticket, in the final Student Thinking Evaluation Survey, digging deeply into a topic to uncover mysteries, complexities, and challenges remained an activity the students considered they were engaged in almost always. The students considered they were only sometimes engaged in identifying the central or core ideas, forming conclusions, or capturing the essence of things, which the Daily Exit Ticket shows they were only engaged in 32% of the time.

**Effectiveness of Visible Thinking Routines**

I modeled and had the students engage in six of the Visible Thinking Routines for 14 weeks. The time frame was not long enough for each of the activities to become routines and the students were only given two to four opportunities to do each activity within the treatment period. As such it is impossible for me to really gauge the benefits of the Visible Thinking Routines as established classroom routines. Instead I will focus on the students initial perceptions of the Visible Thinking Routines and how they benefited from engaging in each one.

The students completed a survey on five of the six Visible Thinking Routines modeled in class. Students did not complete a survey on the “What Makes You Say That?” Visible Thinking Routine. The “What Makes You Say That?” routine was used daily throughout a lesson with both verbal and written responses. I incorporated the “What Makes You Say That?” routine into each of the surveys as follow up questions. The first survey question asked the students to determine if the Visible Thinking Routine pushed them to think 1) a lot, 2) some, 3) a little or 4) not at all (Figure 7).
Figure 7. Did this thinking routine push you to think?, (Chalk Talk N=12, I Used to Think N= 15, Tug-of-War N=15, Headlines N=13, Think, Puzzle, Explore N=15).

For the Tug-of-War Visible Thinking routine, ten out of the fifteen students surveyed thought the routine pushed them to think “a lot”. The remaining students thought the routine had only pushed them to think “some”. I modeled this activity twice throughout the treatment period and the class completed this activity twice on their own. Students’ responses when asked, “What makes you say that?” included, “I had to think a lot about all the evidence”, “It made me think a lot due to the multiple ideas we could think of not only in one perspective but multiple perspective too”, and “I was pushed to think because I had to come up with the opposite since I answered from each perspective.” An example of my students’ Tug-of-War Visible Thinking Routine can be found in Appendix S.

For the Headlines Visible Thinking Routine, seven out of the thirteen students
surveyed thought the routine pushed them to think “a lot”. Five of the remaining students thought the routine had pushed them to think “some” and one student felt that they had only been pushed to think “a little”. Students responses when asked, “What makes you say that?” for those that thought it had pushed them to think some or more included, “I have to review all the information I learned in my head, and then summarizing it into headline”, “Coming up with headline was making me think about how to make connections with the problem too come up with a good newsworthy headline”, and “I tried to think of a wrap up to summarize the whole topic.” The one student who thought the routine had only pushed him to think some stated, “I feel my brain is wired to make up not necessarily good names for topics.” Although many of the students stated that they enjoyed the activity, many of them expressed that it was more difficult than the other tasks. I modeled this routine twice and the students were engaged in this activity three times over the treatment phase. An example of my students’ Headlines Visible Thinking Routine can be found in Appendix T.

The majority of the students surveyed thought the Think, Puzzle, Explore and I used to Think Visible Thinking Routine pushed them to think “some”. Evidence provided for this choice included, “I was pushed to think what exactly puzzled me about the questions”, “The think and puzzle part were generally easy, but when I reached the explore part, I don't know what I want to explore yet because I don't know much about it yet. I would've rated it "not at all” if it wasn't for the "explore" part”, “I think this helped me think some because it pushed me to think deeply and reconcile everything I've learned” and “I say that this routine helped me to think, as it shows me the differences of
my thinking.” The Think, Puzzle, Explore routine was modeled twice and the students were engaged in this routine four times throughout the treatment phase. An example of my students’ Think, Puzzle, Explore Visible Thinking Routine can be found in Appendix U.

An equal number of students felt that the Chalk Talk Visible Thinking Routine pushed to them to think some or more. Evidence provided for this included, “I had to constantly think about what type of comments I have to make either to the original question or other's opinion”, “I find it helpful to help me with seeing how other people think and how my mind would differ on the same topic” and “We not only had to come up with our own explanations and support it with evidence, but also look at others and see if we agree with it.” I modeled the Chalk Talk thinking routine twice and the students were engaged in the activity three times throughout the treatment phase. An example of my students’ Chalk Talk Visible Thinking Routine can be found in Appendix V.

I think the Visible Thinking Routines were successful in their intent of getting students to think and create a visual for their thinking process as none of the students surveyed thought the routines did not push them to think at all. The Chalk Talk, Tug-of-War, Headlines and Think, Puzzle, Explore routines were completed as a class and everyone participated. These routines were also left on display for weeks at a time and the students were able to add to them throughout the week. These routines really helped the students’ process and keep track of their thinking on an individual basis and as a whole. I can see how having the time to establish these as regular classroom routines throughout a whole school year would be very beneficial in establishing a culture of
thinking within the classroom. Given the short amount of time I do not think the students were able to fully comprehend their overall usefulness in developing a deeper level of understanding. Despite the positive feedback on the first question, the majority of students did not think they would continue to use the routines on their own or in other classes. Question two of the Visible Thinking Routine surveys asked the students if they would use this strategy on their own and question three asked if they would use this strategy in another class (Figure 8 and 9).

![Bar Chart](chart.png)

**Figure 8.** Will you use this strategy on your own? (Chalk Talk N=12, I Used to Think N=15, Tug-of-War N=15, Headlines N=13, Think, Puzzle, Explore N=15).
Students indicated that they would use the Chalk Talk and Think, Puzzle, Explore Visible Thinking Routine “some” of the time and that they would use the other routines “a little” or “not at all”. Students felt that some of the routines could not be completed on their own but only in a group. For the Headlines routine, one student stated, “I think you have to do this activity in a group for it to actually work” and another wrote, “I haven't use it myself yet, but I might, however in my opinion, this activity work better with more people because you can see other's ideas.” For the Tug-of-War Visible Thinking Routine one student wrote, “I don't think I will use it because I like to work alone and I also don't like to oppose myself.” I thought this was an interesting comment because many students had expressed that they enjoyed working with others, feeding off of each other’s ideas and being challenged in their ideas. Sharing our own thoughts and putting them out there
for others to challenge can be difficult even for adults so I can understand why some students would be uncomfortable with making their thinking visible. I think this is why the routines are important in establishing a culture of thinking where everyone’s thoughts are valued and challenges to our point of view are seen as learning experiences and opportunities for growth. During the Tug-of-War idea I tried to emphasize to the kids that the most learning happens not from challenging other’s thought and opinions but from having your own challenged. I will address and elaborate more on these challenges in the following section.

Most students did not think they would use the routines in another class with many indicating that they would use it “a little” or “not at all”. One student commented that “not many subjects need it” in reference to the Headlines Visible Thinking Routine. Another student wrote, “I use it when I can, but not all classes require such deep thinking and looking at things through different perspectives” in reference to the Tug-of-War Visible Thinking Routine. Again I think that making these activities routine would help the students see the benefits of using them in other classes. I think this question in particular could have been worded differently as it put the focus on using the routine in another class and not necessarily on using the cognitive action in another class.

Establishing a culture of thinking needs to be a school wide endeavor. It is evident that the students thought the thinking routines were beneficial when used in science but many of them did not see the broader implications and benefits of using them outside the classroom.

The Thinking Routines Matrix in Table 4 lists the key thinking skills I wanted to
target with each of the six Visible Thinking Routines. I selected these six Visible Thinking Routines because they could be used at the beginning, middle and end of a unit but also because they focused on the type of thinking that is essential for higher order thinking and transfer of knowledge. Each Visible Thinking Routine Survey had four to five questions that asked students to rate how effective they thought the routine was at targeting those specific thinking skills. Following is a breakdown of the results by routine.

**Think, Puzzle, Explore**

The Think, Puzzle, Explore Visible Thinking Routine’s purpose is to get students to activate prior knowledge, direct students’ inquiry, identify each student’s current level of understanding and uncover misconceptions. Figure 10 includes the results of the Think, Puzzle, Explore Visible Thinking survey.

![Effectiveness of Think, Puzzle, Explore on Key Thinking Skills](image)

*Figure 10. Effectiveness of Think, Puzzle, Explore on key thinking skills. (N=15).*

Thirteen students found that this routine was effective some or a lot in helping them activate prior knowledge, identify their current level of understanding, plan for
learning and ask questions that lead to understanding. Students’ responses that support why they indicated that this routine helped them remember information they already knew about the topic included, “it pushed me to re-think what I knew/what I think I knew”, “There was some I forgot I learned or read a long time ago and the T, P, E helped me recall the information” and “It is good because we can connect the knowledge we have learned so it is useful.” Two students thought this routine only helped “a little” to activate prior knowledge. Their reasons included, “It was sort of useful because I already had unlocked known information in class last year. The problem was remembering it” and “I didn't know much about the topic in the 1st place.”

All but one student thought this routine was useful in identifying their current level of understanding. Reasons for this included, “The most important part of the Think, Puzzle, Explore to me isn't exactly seeing what you knew but mainly what you what to learn”, “I thought I knew a lot more about the topics which I didn’t”, “It makes me know where I'm at and what I'm going to learn” and “We could share what we know with everyone and everyone can learn something.” This last comment was interesting because it showed the value of establishing a common knowledge among a group of learners. From the comments shared in class while we gathered everyone’s ideas for the class Think, Puzzle, Explore poster it was evident that this routine made the students feel comfortable sharing not only what they knew but also what they didn’t know. Another comment that was reassuring and illustrated the importance of making our thinking visible was, “I thought that I had known more but then I actually didn't after writing it on paper.” One student thought this routine only helped them identify their current level of
understanding “a little”. This student had also thought the routine was not very effective at activating prior knowledge and supported his claim by stating, “I mention I have learned this already, the problem was remembering. Same applies here as well.”

Thirteen students thought the routine was useful in making a plan to learn the information they wanted to learn. Students stated, “the explore part gave us a plan of action that we hoped to complete”, “It makes me create a map in my brain of what I’m going to learn”, and “I had originally planned on simply paying attention to Ms. Isa's classes, but now I know how I can get extra information.” One student thought this routine was only “a little” useful because, “I brainstormed ways I can learn these information, but they are the things I would be doing anyways even with out the Think, Puzzle, and Explore.” The one student that thought this routine was “not at all” useful stated, “I do not understand the concept of wanting to learn things one cannot have known about. This is one reason why I couldn't do the "explore." Another is I need to remember the information from last year, but the time given was not enough.” I followed up with this student and asked if he could come up with ways to help him recall the information he had already learned and add that to the Explore section but he stated that he didn’t need to explore the topic because he had already learned it in his previous school but just couldn’t remember now. This particular student is a high achiever and does really well in all of his classes but he was very frustrated that he could not “fill in” more of the Think section of the routine.

Twelve out of the fifteen students surveyed felt the routine had helped them ask questions for understanding. Reasons for this included, “It pushed me to see what
questions should help me”, “When we did the activity, I realized how much I didn't know about our new unit and wanted to learn more”, and “Because I come up with the ones I am puzzled with, so I come up with multiple questions about the topic.” Three students found this routine “a little” helpful for asking questions that lead to understanding. Their reasons included, “It did help me ask questions indirectly because after answering the "think" it made me wonder about a few things”, “After I learned about the topic I didn't have any other questions and the questions I did have were already answered” and “personally, I just said something like Google it or ask the teacher so I didn’t try too hard of that one.” These responses were not very reliable because it seems that the students did not fully understand the question.

Chalk Talk

The Chalk Talk Visible Thinking Routine is designed to aid students in uncovering and identifying prior knowledge, ask questions and track changes in their thinking. Figure 11 includes the results of the Chalk Talk Visible Thinking survey.

![Figure 11. Effectiveness of Chalk Talk on key thinking skills, (N=12).](image)
Eleven out of twelve students found the Chalk Talk routine effective “some” or “a lot” at visualizing their level understanding. When asked what made them say that about the routine, their responses included, “yes, I compared my answers to the other answers and realized that some of the people might have been better than me”, “yes, I compared my answers to the other answers and realized that some of the people might have been better than me”, and “I originally thought I knew more but this lead me to multiple questions.” The one student that found the routine only “a little” effective at visualizing their level of understanding stated, “it helped a bit because we just had to write and there wasn’t much to visualize.”

All but one of the students thought the routine helped them get a better understanding of what they had learned in class through the ideas and questions posted by their classmates. Students stated, “It gives me time to see what I have bean missing out or haven’t remembered”, “I had to fully understand something in order for me to write it and support it”, “I could see my level of understandings the topics I learned in class by looking at different types of comments in different points of views”, and “Some questions lead to more questions, and I had to extend my thinking range for those questions.” The one student that thought the routine was only “a little” helpful stated, “Not really to be honest because it was an "after the fact thing.” The Chalk Talk routine was done after the introduction of a major topic and allowed students to explore their gained understanding in a collaborative way. This student felt that he had already achieved a good level of understanding on his own and did not gain anything by building understanding in a collaborative way. He felt that the ideas and questions posted by his fellow classmates
were topics he had already learned.

The majority of the students felt that the Chalk Talk routine helped them apply the concepts they had learned in class. Supporting statements for this included, “It helped me apply the concepts because we had to answer to the statements, and answer to others statements too”, “I basically needed the information I learned in class for the backups of my opinion” and “I had to apply the examples in the reading and in class to real-world questions.” One of my EAL students wrote the routine had “help me talk in class.” Since the Chalk Talk routine is an open-ended silent discussion where the students respond to the prompt and then to each other’s ideas or questions about their own posts she felt she more comfortable participating and “showing” what she knew.

Again eleven out of the twelve students found the routine helped them analyze what they had learned in class. One student wrote that the routine was helpful, “because all our answers had to be in relation to all the things we learned in class.” Other responses included, “It helped me gather information then help me form an answer” and “I had to break down some of the concepts, steps or theories I learned in class to reason my opinion based on evidences.” One student felt the routine was only “a little” useful, “since I only used some concepts, I only analyzed a couple of them.” Still this response shows that the student was analyzing some of what they had learned in class in regards to the open-ended discussion.

**Headlines**

The purpose of the Headlines Visible Thinking Routine is to help students summarize key points using a limited amount of words that effectively communicates the
core message. Figure 12 includes the results of the Headlines Visible Thinking survey.

![Figure 12. Effectiveness of Headlines on key thinking skills, (N=13).](image)

Twelve out of the thirteen students that took the survey felt the Headlines Visible Thinking Routine was effective “some” or “a lot” in helping them summarize what they had learned, and capture the core of a concept. One student found this routine to be “not at all” helpful in helping them summarize what they had learned, and capture the core of a concept. When asked to elaborate on why or how the routine had helped them summarize their learning students wrote, “I reviewed all the things I have learned to come up with one short head line”, “I had to summarize pages and pages of all the issues and good things to make headline of 5 words”, and “Because I don’t summarize often but really helps.” One statement that really stood out for me was, “In the headlines some explained a little about the topic so all of it showed a large amount of what we learned.”
The Headlines poster showed a collection of all the major topics we had covered within a unit and helped to illustrate all the important components. The completed poster really helped to illustrate all the pieces of the whole. The one student who did not find the routine significantly helpful stated that, “The "Headlines" activity was mainly just gathering ideas and catchy phrases for a certain subject, rather than summarizing anything.” This was true of some of the headlines generated by the students. This was one of the challenges of the routine and one that was important to assessment. I will address this issue in more detail in the next section. When asked how or why the routine had helped them capture the core of the topic some students stated, “I think it did help because we saw what some of the main ideas were” and “When summarizing something into one or less sentence, it requires you take only the most important part.” The one student who did not think the routine was effective felt this way, “Because sometimes headlines are suppose to attract people so I don't think you always capture the core concept.” One of the issues with this routine was that students competed with each other to come up with the most creative headline and in doing so sight of what was really important. This was a problem during the first attempt but not during the subsequent attempts.

Eleven out of the twelve students thought the routine was helpful “some’ or “a lot in applying and analyzing the concepts they had learned in class. When asked to elaborate on why or how the routine had helped them apply the concepts one student wrote, “In some instances, you would need to know that the headlines people had come up with were related to the concepts to visualize what the topic is and understand it
fully.” When asked to elaborate on why or how the routine had helped them analyze the concepts one student wrote, “I saw all of the things that I had learned before in the headlines.” Two students found this routine to be only a little helpful in applying and analyzing the concepts they had learned in class because, “it helps just not ALL the time.”

I Used to Think… Now I Think…

The I Used to Think… Now I Think… Visible Thinking Routine is a reflection and metacognition tool that helps students gauge how their thinking has shifted or changed over time. Figure 13 includes the results of the I Used to Think… Now I Think… Visible Thinking surveys.

![Effectiveness of I Used to Think..., Now I think... on Key Thinking Skills](image)

*Figure 13. Effectiveness of I Used to Think… Now I Think… on key thinking skills, (N=15).*
For this routine 80% of the students thought it was “some” or “a lot” useful in helping them reflect on their own thinking. These students stated that the routine was useful because, “This activity helped me reflect on how well I can think because it give me situations from what we have learned and see how well my answers were compared to the others”, “It was an easy way of comparing all the new information I learned” and “It helped me reflect because I had to try to remember what I used to believe and what I know now, and how I was wrong.” Fourteen out of the fifteen students thought the routine was “some” or “a lot” useful in helping them to identify shifts or changes in their thinking. When asked to elaborate on why or how the routine had helped them identify these changes, one student wrote, “Yes, it did, in fact it showed me that learning about weather in class helped me in my everyday life. It also showed me that my thinking skills got better over time because of the expansion of my knowledge.” The one student that found this routine only “a little” helpful did not elaborate or give a reason for his choice.

Only 60% of the students found this routine effective “some” or “a lot” in helping them synthesize their ideas. When asked to elaborate on why or how the routine had helped them synthesize their ideas, one student wrote, “I condensed weeks of learning and lectures into about two sentences and basically summarized it all up.” The other 40% found it “a little” effective. Reasons for this included, “I focused more on comparing what I thought rather than summarizing what I thought” and “Since it was only a couple of sentences it didn't really summarize too many ideas.”

Thirteen out of the fifteen students thought this routine was “some” or “a
lot” effective in helping them make connections between what they used to think and what they currently think. One student wrote that the routine, “made me think about the connections because I had some knowledge before learning.” Another student wrote, “I thought about the flaws and holes of my previous thinking and also how much I’d learned.” Many students were able to easily identify the misconceptions they had and their new learning but not very many were able to identify the gaps in their thinking and how they had filled these in throughout the unit.

**Tug-of-War**

The Tug-of-War Visible Thinking Routine is designed to help students gain perspective and reasoning by building both sides of an argument and to identify complexities by going beyond the surface. The results of Tug-of-War Visible Thinking surveys are in Figure 14.

![Effectiveness of Tug-of-War on Key Thinking Skill](image)

*Figure 14. Effectiveness of Tug-of-War on key thinking skills, (N=15).*
For this routine, 93% of the students thought it was effective at helping them explore different viewpoints and reason with evidence. When asked to elaborate on why or how the routine had helped them explore the arguments for both sides of a dilemma, the students wrote, “We can look at different viewpoints from other's sticky note, and change our understanding about it, so it is good for us look at a topic of different viewpoints”, “I could easily see the cons and pros of a certain topic”, and “As this routine is a visual representation, so it is easier for me to view the other sides.” The student that did not find this routine as effective for exploring different perspectives stated, “I say this because I was mainly stuck on one topic, unable to see anything good out of the other.” Statements explaining why and how this routine helped them find a cause, explanation or justification for an answer included, “I had to back up my perspective with specific reasons and evidence”, “In order to place a post it, I must have a cause, and evidence to post it”, and “It made me explain what I was thinking and why I chose this side over that side for this post.” The student that did not find this routine as effective for helping them to reason with evidence wrote, “I didn’t really think much I just put something random.”

Twelve out of the fifteen students thought the routine was effective in helping them identify complexities. Supporting statements for this included because, “we can understand it from another viewpoints so it is easy for me to go beyond the surface and identify the complexities in a dilemma”, “I had to think beyond the problem itself, but also how it will effect others”, “I had to think go deep below the surface in order to persuade others with my opinion” and “I realized a single problem had many
connections and you had to consider all those other connections to make up your mind.” Some of the reasons given by the three students that did not find this routine as effective in helping them identify dilemmas included, “because people had different answers so no need to go deep to prove they are not right” and “It helped a little because I was mainly stuck to a single side.”

All of the students surveyed found this routine to be effective at helping them gain a deeper level of understanding of the dilemmas connected to the topics learned in class. One student explained that this was achieved, “because they gave you a real world situation that could really happen.” Another student wrote, “It made me think the way an official would, looking at all the variables and possible results of making the final decision.”

Fourteen out of the fifteen students thought the Tug-of-War routine was effective at helping them evaluate the information learned in class. When asked to elaborate on why or how the routine had helped them accomplish this, the students wrote, “I had to balance what I learned with the problem”, “figuring out where to place the tugs was difficult because you had to think of everyone”, “the what if’s made it difficult for us all to agree”, and “I had to decide the "better" one and I had to judge based off the info.”

The one student who found this routine not as effective for evaluating the information learned in class stated, “I just based my opinions off of how I would feel I guess and not if it was important.”

Effect of the Visible Thinking Routines on the Teacher

Prior to starting the classroom action research project I completed a
Teacher Evaluation of Thinking survey to determine the primary focus of activities my students had been engaged in during the previous unit on Plate Tectonics. The teacher survey included the same fourteen categories from the Student Evaluation of Thinking survey. Below is a list of the activities the students were almost always engaged in:

2. Building our own explanations, theories, hypotheses, or interpretations.

3. Reasoning with evidence and supporting our ideas with facts and reasons.

4. Wondering, raising issues, and showing curiosity about what we are studying.

5. Making connections between different things, to the world, or to our own lives.

8. Digging deeply into a topic to uncover mysteries, complexities, and challenges.

Activities I felt the students were engaged in sometimes included:

1. Looking closely at things, describing them, noticing details, or detecting patterns.

6. Looking at things from different perspectives & points of view to see things in a new way.

7. Identifying the central or core ideas, forming conclusions, or capturing the essence of things.

9. Organizing and pulling together ideas, information, notes, and experiences to make sense of them.

12. Reviewing and going over information from the readings or previous class work.

13. Reading, listening, or getting new information about the topic we are studying.

Activities I felt the students were almost never engaged in included:
10. Reflecting on where we are at in our learning and understanding to determine where to go next.

11. Using and applying what we have been learning to solve new problems or create something original.

14. Practicing the skills and procedures the class has already learned.

As a teacher I was eager to see if the Visible Thinking Routines I had chosen to introduce to the students would give them more opportunities to engage in activities 1, 6, 7, 9 and 10. Specifically I wanted to encourage my students to look closely at things, describe them, notice details, and detect patterns through the Chalk Talk routine. I hoped to get students to look at things from different perspectives and points of view to see things in a new way through the Tug-of-War routine. I wanted the Headlines routine to provide my students more opportunities in identifying central or core ideas, forming conclusions, and capturing the essence of things. Through the Chalk Talk and Headlines routine I wanted the students to organize and pull together ideas, information, notes, and experiences to make sense of them. The I Used to Think…Now I Think… and Think, Puzzle, Explore routines were used to encourage students to reflect on where they were in their learning and understanding to help them determine where to go next. The “What Makes you Say That?” routine was used to address all the areas listed above.

Throughout the treatment I kept notes on my experience modeling and facilitating the various routines as part of the Teacher Visible Thinking Routine Questionnaire. The very first routine I introduced to my students was the Think, Puzzle, and Explore routine. This routine was fairly simple to teach and model as it required very little materials and engaged all students. As a teacher I found that this routine
provided a quick snapshot of the group’s common knowledge and misconceptions. This was very useful in planning out future lessons. The “Puzzle” part of the routine was useful in getting students to think creatively and helped me to quickly gauge student interest in the topic. The “Explore” part was challenging for the students and for me as the teacher as I had to really probe the students to go beyond “Google it”. I found that this routine helped me take a step back when new inquiries arose throughout the unit and throw it back at the students to make a plan for learning instead of just providing them with a quick answer. Of all the Visible Thinking Routine posters we created as a class or individually, I felt that these were the most productive and engaging because we could continue to add to them and use them as a reflective tool. As a teacher I found myself referring back to this poster after every class to mentally check off the ideas and misconceptions I had been able to address and to remind myself to not only focus on the standards but on the students’ interests. In my teacher reflection questionnaire I wrote, “use the responses to decide what is review, what needs to be addressed and what you can explore.”

The Chalk Talk and Headlines routine was very useful as an assessment tool because it helped me to see which students were making the deep connections and which ones were only making surface or tangential connections. Chalk Talk was also useful in “seeing” which students used the activity to build a deeper level of understanding by posting questions that extended the thinking beyond what we had addressed in class. As a teacher, I found these two routines to be great “check in” activities to help me make informed decisions about when to move on and where to go next. Displaying these
posters for several days and allowing students to revisit them and make additional posts also provided reflection and wait time for students. As the teacher, I was constantly worried about the amount of class time each activity took because there was so much content to cover in the unit but I realized that these activities were also useful in addressing activity 11,12 and 14.

The Headlines routine was difficult for the students to master at first and my EAL students really struggled to summarize their learning. In the Teacher Reflection questionnaire I wrote, “am I sending my EAL’s a mixed message- constantly pushing them to elaborate and now asking to summarize.” My apprehension about continuing to use this routine went away when I noticed that students began to refer to the headlines they had come up with in class before elaborating on an extended response question. In response to a question about the role of ocean currents in climate change, one student wrote, “ocean currents bringing more than just our garbage to distant shores” before going into detail about the effects of the gulf stream on the climate of European countries. This inspired me to reverse the routine and provide students with just a headline and ask them to write the story on one of their formative assessments. As the teacher this helped me gauge my students’ level of understanding and helped me identify gaps in their understanding.

Tug-of-War was by far the most enjoyable routine I introduced to the class. At first many students were focused on “getting their side of the issue to win” but it was easy to help them see that the activity was about gaining a deeper level of understanding. We actually had a good class discussion on the importance of understanding all sides of a
dilemma. All students were actively engaged in the routine and categorizing the responses and deciding where to place each response on the line led to interesting whole class discussions. The many “what if’s” that arose throughout the routine also led to extended class discussions on issues that extended far beyond the content and standards covered in class. As the teacher, I felt this routine was visually appealing and provided an effective visual of everything I had taught throughout the lesson. It was easy to see the strengths and weaknesses in my approach to the unit in the students’ arguments. Identifying these weaknesses helped me address them fairly quickly and provide context for the students as we added it to the board.

The feedback I received from teachers that stopped by my classroom during the treatment phase was the most validating. “There is a lot going on here” was one comment made by a colleague that stopped by to drop off a form. The head of school did an unannounced, quick walk through in late December when I had the Think, Puzzle, Explore, Headlines, Chalk Talk and Tug-of-War routine simultaneously displayed in the classroom and she came back that afternoon to tell me how impressed she had been by the level of higher order thinking displays of student work. She commented, “most classes have work by some students but I could see everyone’s input in these displays—they are truly ‘classwork’.”

As the teacher, the most effective thinking routine was the I Used to Think…, Now I Think…routine because it provided an opportunity for each student to reflect on their learning and in turn provided an opportunity for me to reflect on my teaching based on the individual student responses. I really liked the simplicity of this routine and that
all of my students could participate in it. One thing that I encouraged my students to do was to write little changes first and then move on to the bigger ideas. Little changes focused mainly on newly acquired vocabulary. An example from class is, “I used to think that meteorologist had something to do with meteors but now I think that meteorologist are scientists that study and track the conditions of the atmosphere to forecast the weather.” These changes were important building blocks for the bigger ideas. An example of a bigger idea from class is, “I used to think weather described only about temperature and precipitation, but now I think that weather describes various conditions in the earth’s atmosphere like temperature, precipitation, cloud cover, air pressure, wind speed and direction, etc.” This gave every student something to write about and helped him or her to better visualize their level of understanding by showing how they had built upon their basic knowledge to understand bigger ideas. I also liked that this routine could be used throughout the lesson and that the students could build on their answers. This routine is also an excellent exit ticket for students and teachers. For students it helps them evaluate and reflect on their level of understanding of the content covered in class. For the teacher this routine provided a quick formative assessment and served as a reflection tool to gauge if the goal of the lesson had been met. In addition, I used this routine in conjunction with our first Think, Puzzle, Explore poster. As I addressed the various misconceptions included in the “Think” column, I had students reflect on them and write I Used to Think…, Now I think….statements.

The “What Makes You Say That?” routine was very easy to turn into a habit and really helped me get more out of my students during whole class discussions. As a
teacher I found that incorporating it into tests after a multiple choice question is really effective in determining each student’s depth of understanding and provided concrete evidence to determine their level of understanding on a proficiency scale.

I completed the Teacher Evaluation of Thinking survey again at the end of the unit. Below is a list of the activities that I felt the students were almost always engaged in during the treatment phase because of the incorporated Visible Thinking Routines:

1. Looking closely at things, describing them, noticing details, or detecting patterns.
2. Building our own explanations, theories, hypotheses, or interpretations.
3. Reasoning with evidence and supporting our ideas with facts and reasons.
4. Wondering, raising issues, and showing curiosity about what we are studying.
6. Looking at things from different perspectives & points of view to see things in a new way.
7. Identifying the central or core ideas, forming conclusions, or capturing the essence of things.
8. Digging deeply into a topic to uncovering mysteries, complexities, and challenges.
9. Organizing and pulling together ideas, information, notes, and experiences to make sense of them.
10. Reflecting on where we are at in our learning and understanding to determine where to go next.
11. Using and applying what we have been learning to solve new problems or create something original.

Activities I felt the students were engaged in sometimes included:
5. Making connections between different things, to the world, or to our own lives.

13. Reading, listening, or getting new information about the topic we are studying.

Activities I felt the students were almost never engaged in included:

12. Reviewing and going over information from the readings or previous class work.

14. Practicing the skills and procedures the class has already learned.

The routines helped to shift activities 1, 6, 7, 9 and 10 from activities the students were only “sometimes” engaged in to “almost always”. Activity 13 remained in the same category. I felt that reviewing and going over information from the readings or previous class work (activity 12) was an activity the students were almost never engaged in the traditional sense. Instead I felt that the students were applying what they had previously learned and simultaneously reviewing it. This was also true for practicing the skills and procedures the class had already learned.

INTERPRETATION AND CONCLUSION

Primary Question: Effect on Awareness and Conceptions of Thinking and Understanding

In terms of how students’ awareness of the process of thinking changed through the use of thinking routines designed to make thinking more visible in the classroom, data showed that over time the students became more aware of the activities going on in the class and how they related to thinking for understanding. For example, students started to correlate any time spent reviewing for a test with identifying the central or core ideas, forming conclusions or capturing the essence of things. In the first exit ticket students completed after reviewing for an upcoming test many wrote, “we did not do anything
today but review our notes.” As the treatment phase progressed students also began to make connections between test review days with reflecting on where they were in their learning and understanding to determine where to go next. Some examples from the students include, “We went over the previous class’s formative test to see where we are and so we would have a study guide” and “We looked back into our last test and we looked over it and made more ideas of what we could have done.” Students also began to make the connection between writing answers on a test with reasoning with evidence and supporting our ideas with facts and reasons. Daily Exit tickets that were completed after a test included the following examples, “providing supporting evidence for answering questions”, “we had to reason with evidence while checking our tests”, and “During the test, we had reasoned with evidence to answer the questions.”

As part of the unit, the students gathered and graphed a lot of weather data. Initially, when asked what they had done that day to gain a better understanding of the topic many just wrote, “we made a graph.” Towards the end of the weather unit, many students indicated that they had used the graphs to reason with evidence or support their ideas with facts and reasons. Examples like these indicate that the students’ awareness and conceptions of thinking shifted from physical actions to more cognitive actions. The increase in metacognitive examples on the final Thinking Concept Maps also indicated that their awareness and conceptions of thinking had shifted from simply identifying physical actions to making connections between the physical actions and the cognitive actions. Like the results of the Thinking Maps used by the COT research team at Bialik College, my students’ Thinking Maps showed that their conceptions of thinking are
malleable and that they could measure the effect of the Visible Thinking Routines intervention.

**Secondary Question: Effectiveness of Routines on Key Thinking Skills**

Although the students Visible Thinking Routine survey results were positive for the most part, I felt that the treatment phase was not long enough for students to fully comprehend the effectiveness or value of the Visible Thinking Routines on their understanding. It seemed that students were able to determine that thinking for understanding was valued in the classroom through the use of thinking routines but were as of yet unable to find value in it for themselves or value in using them in other classes. The use of thinking routines and the emphasis on the thinking for understanding activities did however help to establish a common cognitive language to the classroom. Displaying the list of common thinking for understanding activities and referring to them throughout the weekly lessons really helped the students focus more on the cognitive actions and less on the physical actions as noted above. I believe this is one of the reasons Visible Thinking Routines were not identified by name in the final concept maps but by cognitive actions. Instead of writing “Tug-of-War” students wrote “looking at things from different perspectives” or “synthesizing information to capture the core” instead of Headlines. This was also evident in the shift from “giving an example” to “providing evidence” for their claims during class discussions and on their assessments.

**Secondary Question: How This Affected Me as the Classroom Teacher**

My main goal in introducing the Visible Thinking Routines was to get my students to think and to develop an awareness of thinking for understanding on an individual basis. I feel I was successful at this and that I also established a unique culture
of thinking in the class. The best example of this came from the students’ reflections on
the thinking routines. One student wrote, “To be honest it really feels that anything I do
in this class, I've never done outside of it.” Another student wrote on multiple
reflections, “As I say in every one of these I've never seen these methods of learning
anywhere.”

As the classroom teacher, this classroom action research project made me reflect
on what I thought was important in the classroom and how I could communicate that to
my students. I knew that I wanted to get my students to focus more on thinking and that
in fact I needed to get them to focus more on thinking for understanding if I was to help
them make the shift from just recalling content to demonstrating a deeper level of
understanding of the content. The problem was that I valued something that was
invisible to my students. The Visible Thinking Routines really helped me to begin to
understand how I could make the invisible, visible. Through these routines I not only
made my own thinking visible for the students, but I was also able to get a better
understanding of my own students’ thinking ability and processes.

Witnessing my students make the shift from physical actions associated with
thinking to cognitive actions that emphasize the nature of thinking was really inspiring.
It made me realize that in the past I had put too much emphasis on the strategy and not
enough emphasis on the cognitive processes. I also noted that there was a shift not only in
the language that I used in class but during lesson planning sessions as I tried to
emphasize and model thinking for understanding. Instead of saying, “let’s review” or
“let’s go over our notes”, I found myself saying, “let’s make connections” or “let’s build
on our explanations and interpretations.” Instead of telling the class that the goal of today’s lesson was to make a concept map, I would state that the goal was to “make connections by describing things fully and in detail.”

Of course not all students benefited in the same way and most of my EAL students struggled to make the leap but I now have a better understanding of where they are and I can begin to address the emotional side of thinking for understanding. This also prompted me to research how the Visible Thinking Routines can be used in EAL classrooms.

Making time to incorporate the Visible Thinking Routines in an already tight schedule showed me the importance of creating a culture of thinking in the classroom that leads to a culture of learning and understanding where students are aware of when and how they are engaged in thinking throughout the class. As valuable as this was, integrating the Visible Thinking Routines was time consuming. Having the students become more aware of their conceptions of thinking and understanding far outweighed the amount of time it took but it was still frustrating not to get as much done as I had originally planned. I believe that the amount of time each routine takes to complete would be less and less as they become more routine and fully integrated into the curriculum. The first Headlines routine took the students two days to complete so that all the students had an opportunity to participate. In the last Headlines routine, all students participated within the 90-minute class period.
As stated above, incorporating Visible Thinking Routines to get my students to become more aware of their conceptions of thinking and understanding into my science classroom was of great value to me but I believe the integration of the routines would be valuable in any educational setting. The most important aspect of integrating these routines into the curriculum was making a conscious effort to make time for thinking and thus showing students that I valued thinking. I was only able to introduce six Visible Thinking Routines to my students during the classroom action research project, but I hope to be able to integrate more in the future and to use them frequently enough that they become indispensable classroom routines. The ultimate goal would be to create a classroom environment where thinking for understanding is at the forefront and individual and collective thinking is valued, encouraged and easily visible.

Fostering these thinking dispositions in our students become more and more necessary as we shift learning from memorization and recall to deeper levels of understanding. The NGSS is already focused on shifting science education away from a long list of concepts that can only be taught at a surface level in order to cover them all within one school year to performance expectations where the science and engineering practices are at the forefront.

As educators we all value learning and learning is a product of thinking. Therefore if we truly want our students to learn and to develop deep levels of understanding we must allow them time to think. The Visible Thinking Routines allow us
to model thinking and to make it a visual process that the kids can join in while developing their own thinking dispositions.

The Visible Thinking Routines are an important component of establishing a Culture of Thinking in a classroom but it is not the only component. In researching the routines and Ron Ritchhart’s work, I learned that there are eight cultural forces that define a Cultures of Thinking classroom. These cultural forces are outlined in Figure 15.

Figure 15. Eight cultural forces that define our classroom. (Sourced from: The Cultures of Thinking project at Project Zero, Harvard Graduate School of Education, www.rcsthinkfromthemiddle.com)

The results of this classroom research project made me realize that creating a classroom where thinking is encouraged, visible and valued by all is something that I
want to establish in my future learning environment. In addition to modeling and using
the routines with my students next year I will be focusing on creating a learning space
that facilitates thoughtful interactions by displaying the thinking routines to target the
Environment component. I also want to focus on modeling and using the language of
thinking with my students to target the Language component.
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http://www.rcsthinkfromthemiddle.com/thinking-routines.html


APPENDICES
APPENDIX A:

THINK, PUZZLE, EXPLORE VISIBLE THINKING ROUTINE
THINK / PUZZLE / EXPLORE
A routine that sets the stage for deeper inquiry

1. What do you think you know about this topic?
2. What questions or puzzles do you have?
3. What does the topic make you want to explore?

Purpose: What kind of thinking does this routine encourage?
This routine activates prior knowledge, generates ideas and curiosity and sets the stage for deeper inquiry.

Application: When and where can it be used?
This routine works especially well when introducing a new topic, concept or theme in the classroom. It helps students take stock of what they already know and then pushes students to identify puzzling questions or areas of interest to pursue. Teachers can get a good sense of where students are on a conceptual level and, by returning to the routine over the course of study, they can identify development and progress. The third question is useful in helping students lay the groundwork for independent inquiry.

Launch: What are some tips for starting and using this routine?
With the introduction of a new topic—for example, earth, leaves, fractions, Buddhism—the class can engage in the routine together to create a group list of ideas. Between each phase of the routine, that is with each question, adequate time needs to be given for individuals to think and identify their ideas. You may even want to have students write down their individual ideas before sharing them out as a class. In some cases, you may want to have students carry out the routine individually on paper or in their heads before working on a new area.

Keep a visible record of students’ ideas. If you are working in a group, ask students to share some of their thoughts and collect a broad list of ideas about the topic on chart paper. Or students can write their individual responses on post-it notes and later add them to a class list of ideas.

Note that it is common for students to have misconceptions at this point—include them on the list so all ideas are available for consideration after further study. Students may at first list seemingly simplistic ideas and questions. Include these on the whole class list but push students to think about things that are truly puzzling or interesting to them.

Visible Thinking © Harvard Project Zero
(http://visiblethinkingpz.org/VisibleThinking_html_files/03_ThinkingRoutines/03d_UnderstandingRoutines/Understand_pdfs/VT_ThinkPuzzleExplore.pdf)
APPENDIX B:

CHALK TALK VISIBLE THINKING ROUTINE
Chalk Talk

A routine that facilitates the nonlinear exploration of ideas

1. What ideas come to mind when you consider this idea, question or problem?
2. What connections can you make to others’ responses?
3. What questions arise as you think about the ideas and consider the responses and comments of others?

Steps

1. **Set up.** Write each prompt on a large sheet of chart paper or butcher’s paper and place on tables around the room. Place markers at each table or pass them out to individuals. Decide whether you want to assign students to groups for the purposes of the Chalk Talk or you want them to freely move about the room. If students will stay together as a group, decide how much time you will give for the first round of the Chalk Talk.

2. **Present the Chalk Talk prompt.** Invite learners to think about their reactions to the prompt and record their ideas and questions. Encourage learners to read and add to each other’s responses with additional comments and questions.

3. **Circulate.** Provide time for learners to circulate around the Chalk Talk paper, reading and adding to the prompts and responses as they build. If learners have been assigned to work in groups, you may want to have groups stay with one recording sheet for 5 minutes to allow time for the conversation to develop. You can then have groups rotate en masse to another group’s paper, silently read what has been written there, and add their reactions and questions to the paper. This rotation often helps infuse new ideas into the “conversation” of a group who might be stuck.

4. **Facilitate.** You may need to prompt the group about types of responses they can make as they read: connecting ideas, elaborating on others ideas, commenting on what others have written, asking others to respond with more detail, and so on. There is no reason why you cannot be an active participant and model responding to comments and questions and posing new insights and wonderings. Toward the end of the session, indicate how much more time there is for responding.

5. **Share the thinking.** If people have rotated as a group, allow them to return to their original starting places to read what others have written on “their” Chalk Talk paper. Allow time for the group to review the various Chalk Talks if there is more than one. Ask the group what themes they noticed emerging. Where did they see common issues and reactions? What questions surprised them? Debrief the process itself, asking the group how their thinking developed during the Chalk Talk.

Source: Ritchhart, R., Church, M., & Morrison, K. (2011). *p.79*
APPENDIX C

HEADLINES VISIBLE THINKING ROUTINE
**HEADLINES ROUTINE**
*A routine for capturing essence*

This routine draws on the idea of newspaper-type headlines as a vehicle for summing up and capturing the essence of an event, idea, concept, topic, etc. The routine asks a core question:

1. If you were to write a headline for this topic or issue right now that captured the most important aspect that should be remembered, what would that headline be?

A second question involves probing how students’ ideas of what is most important and central to the topic being explored have changed over time:

2. How has your headline changed based on today’s discussion? How does it differ from what you would have said yesterday?

**Purpose: What kind of thinking does this routine encourage?**

This routine helps students capture the core or heart of the matter being studied or discussed. It also can involve them in summing things up and coming to some tentative conclusions.

**Application: When and where can it be used?**

This routine works especially well at the end of a class discussion or session in which students have explored a topic and gathered a fair amount of new information or opinions about it.

**Launch: What are some tips for starting and using this routine?**

The routine can be used quite effectively with think-pair-share. For example, at the end of a class the teachers can ask the class, “Think about all that we have been talking about today in class. If you were to write a headline for this topic or issue right now that captured the most important aspect that should be remembered, what would that headline be?” Next, the teacher tells students, “Share your headline with your neighbor.” The teacher might close the class by asking, “Who heard a headline from someone else that they thought was particularly good at getting to the core of things?”

Student responses to the routine can be written down and recorded so that a class list of headlines is created. These could be reviewed and updated from time to time as the class learns more about the topic. The follow-up question, “how has your headline changed or how does it differ from what you would have said?” can be used to help students reflect on changes in their thinking.

Visible Thinking © Harvard Project Zero
(http://visiblethinkingpz.org/VisibleThinking_html_files/03_ThinkingRoutines/03d_UnderstandingRoutines/Understand_pdf/VT_Headlines.pdf)
APPENDIX D

I USED TO THINK…, NOW I THINK… VISIBLE THINKING ROUTINE
I USED TO THINK…, BUT NOW I THINK…

A routine for reflecting on how and why our thinking has changed

Remind students of the topic you want them to consider. It could be the ideal itself—fairness, truth, understanding, or creativity—or it could be the unit you are studying. Have students write a response using each of the sentence stems:

- I used to think…
- But now, I think…

**Purpose: What kind of thinking does this routine encourage?**

This routine helps students to reflect on their thinking about a topic or issue and explore how and why that thinking has changed. It can be useful in consolidating new learning as students identify their new understandings, opinions, and beliefs. By examining and explaining how and why their thinking has changed, students are developing their reasoning abilities and recognizing cause and effect relationships.

**Application: When and where can it be used?**

This routine can be used whenever students’ initial thoughts, opinions, or beliefs are likely to have changed as a result of instruction or experience. For instance, after reading new information, watching a film, listening to a speaker, experiencing something new, having a class discussion, at the end of a unit of study, and so on.

**Launch: What are some tips for starting and using this routine?**

Explain to students that the purpose of this activity is to help them reflect on their thinking about the topic and to identify how their ideas have changed over time. For instance:

*When we began this study of ____________, you all had some initial ideas about it and what it was all about. In just a few sentences, I want to write what it is that you used to think about ____________. Take a minute to think back and then write down your response to “I used to think…”*

*Now, I want you to think about how your ideas about ____________ have changed as a result of what we’ve been studying/doing/discussing. Again in just a few sentences write down what you now think about ____________. Start your sentences with, “But now, I think…”*

Have students share and explain their shifts in thinking. Initially it is good to do this as a whole group so that you can probe students’ thinking and push them to explain. Once students become accustomed to explaining their thinking, students can share with one another in small groups or pairs.
APPENDIX E

TUG-OF-WAR VISIBLE THINKING ROUTINE
**TUG OF WAR**

*A routine for exploring the complexity of fairness dilemmas*

1. Present a fairness dilemma.

2. Identify the factors that “pull” at each side of the dilemma. These are the two sides of the tug of war.

3. Ask students to think of “tugs”, or reasons why they support a certain side of the dilemma. Ask them to try to think of reasons on the other side of the dilemma as well.

4. Generate “what if?” questions to explore the topic further.

**Purpose: What kind of thinking does this routine encourage?**

This routine builds on children’s familiarity with the game of tug of war to help them understand the complex forces that “tug” at either side of a fairness dilemma. It encourages students to reason carefully about the “pull” of various factors that are relevant to a dilemma of fairness. It also helps them appreciate the deeper complexity of fairness situations that can appear black and white on the surface.

**Application: When and where can it be used?**

This routine can be used in any situation where the fairness dilemma seems to have two obvious and contrasting ways of being resolved. Dilemmas can come from school subjects or everyday life: testing of medicine on animals, adding people to a game once it has started, censoring a book in a library, and so on.

**Launch: What are some tips for starting and using this routine?**

The routine works well as a whole class activity. Present the dilemma to the class. Draw or place a rope with the two ends representing the opposing sides of the dilemma and ask students to think about what side of the dilemma they would be on and why. Students can write their justifications on post-it notes. Encourage students to think of other reasons or “tugs” for both sides of the dilemma, and then have students add their post-it notes to the rope. Stand back and ask students to generate “What if’s?” questions, issues, factors or concerns that might need to be explored further to resolve the issue. Write and post these above the rope. Finish the lesson by asking students to reflect on the activity. What new ideas they have about the dilemma? Do they still feel the same way about it? Have they made up minds or changed their minds?

The display of the tugs and What if’s? on the rope helps to make students’ thinking visible. Most importantly, their ideas are displayed in a way that shows their interconnectedness. The collaborative thinking process of the group as a whole is represented through the “action” of the tug of war. This is a key point about making thinking visible: It shows the dynamic interaction of people’s thoughts in a context of a shared inquiry. Documenting thinking and making it visible in the classroom can facilitate this interaction in order to make the inquiry richer.

([http://visiblethinkingpz.org/VisibleThinking_html_files/03_ThinkingRoutines/03e_FairnessRoutines/Fairness_pdfs/VT_TugofWar.pdf](http://visiblethinkingpz.org/VisibleThinking_html_files/03_ThinkingRoutines/03e_FairnessRoutines/Fairness_pdfs/VT_TugofWar.pdf))
APPENDIX F

WHAT MAKES YOU SAY THAT? VISIBLE THINKING ROUTINE
WHAT MAKES YOU SAY THAT?
Interpretation with Justification Routine

1. What’s going on?
2. What do you see that makes you say that?

**Purpose: What kind of thinking does this routine encourage?**
This routine helps students describe what they see or know and asks them to build explanations. It promotes evidential reasoning (evidence-based reasoning) and because it invites students to share their interpretations, it encourages students to understand alternatives and multiple perspectives.

**Application: When and where can it be used?**
This is a thinking routine that asks students to describe something, such as an object or concept, and then support their interpretation with evidence. Because the basic questions in this routine are flexible, it is useful when looking at objects such as works of art or historical artifacts, but it can also be used to explore a poem, make scientific observations and hypothesis, or investigate more conceptual ideas (i.e., democracy). The routine can be adapted for use with almost any subject and may also be useful for gathering information on students’ general concepts when introducing a new topic.

**Launch: What are some tips for starting and using this routine?**
In most cases, the routine takes the shape of a whole class or group conversation around an object or topic, but can also be used in small groups or by individuals. When first introducing the routine, the teacher may scaffold students by continually asking the follow-up questions after a student gives an interpretation. Over time students may begin to automatically support their interpretations with evidence with out even being asked, and eventually students will begin to internalize the routine.

The two core questions for this routine can be varied in a number of ways depending on the context: What do you know? What do you see or know that makes you say that? Sometimes you may want to preceded students’ interpretation by using a question of description: What do you see? or What do you know?

When using this routine in a group conversation it may be necessary to think of alternative forms of documentation that do not interfere with the flow of the discussion. One option is to record class discussions using video or audio. Listening and noting students’ use of language of thinking can help you see their development. Students words and language can serve as a form of documentation that helps create a rubric for what makes a good interpretation or for what constitutes good reasoning.

Another option is to make a chart or keep an ongoing list of explanations posted in the classroom. As interpretations develop, note changes and have further discussion about these new explanations. These lists can also invite further inquiry and searches for evidence. Other options for both group and individual work include students documenting their own interpretations through sketches, drawings, models and writing, all of which can be displayed and revisited in the classroom.

(https://www.rcstinthekomiddle.com/what-makes-you-say-that.html)
APPENDIX G

STUDENT EVALUATION OF THINKING SURVEY
Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

1. In this class we spend time looking closely at things, describing them, noticing details, or detecting patterns.
   - almost never
   - sometimes
   - almost always
   Other (please specify) 

2. In this class we spend time building our own explanations, theories, hypotheses, or interpretations.
   - almost never
   - sometimes
   - almost always
   Other (please specify) 

3. In this class we spend time reasoning with evidence and supporting our ideas with facts and reasons.
   - almost never
   - sometimes
   - almost always
   Other (please specify) 

4. In this class we spend time wondering, raising issues, and showing curiosity about what we are studying.
   - almost never
   - sometimes
   - almost always
   Other (please specify) 

5. In this class we spend time **making connections between different things, to the world, or to our own lives.**

- [ ] almost never
- [ ] sometimes
- [ ] almost always
- Other (please specify)

6. In this class we spend time **looking at things from different perspectives & points of view to see things in a new way.**

- [ ] almost never
- [ ] sometimes
- [ ] almost always
- Other (please specify)

7. In this class we spend time **identifying the central or core ideas, forming conclusions, or capturing the essence of things.**

- [ ] almost never
- [ ] sometimes
- [ ] almost always
- Other (please specify)

8. In this class we spend time **digging deeply into a topic to uncover mysteries, complexities, and challenges.**

- [ ] almost never
- [ ] sometimes
- [ ] almost always
- Other (please specify)
9. In this class we spend time organizing and pulling together ideas, information, notes, and experiences to make sense of them.

- almost never
- sometimes
- almost always

Other (please specify) 

<table>
<thead>
<tr>
<th>Option</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>almost never</td>
<td></td>
</tr>
<tr>
<td>sometimes</td>
<td></td>
</tr>
<tr>
<td>almost always</td>
<td></td>
</tr>
</tbody>
</table>

10. In this class we spend time reflecting on where we are at in our learning and understanding to determine where to go next.

- almost never
- sometimes
- almost always

Other (please specify) 

<table>
<thead>
<tr>
<th>Option</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>almost never</td>
<td></td>
</tr>
<tr>
<td>sometimes</td>
<td></td>
</tr>
<tr>
<td>almost always</td>
<td></td>
</tr>
</tbody>
</table>

11. In this class we spend time using and applying what we have been learning to solve new problems or create something original.

- almost never
- sometimes
- almost always

Other (please specify) 

<table>
<thead>
<tr>
<th>Option</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>almost never</td>
<td></td>
</tr>
<tr>
<td>sometimes</td>
<td></td>
</tr>
<tr>
<td>almost always</td>
<td></td>
</tr>
</tbody>
</table>

12. In this class we spend time reviewing and going over information from the readings or previous class work.

- almost never
- sometimes
- almost always

Other (please specify) 

<table>
<thead>
<tr>
<th>Option</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>almost never</td>
<td></td>
</tr>
<tr>
<td>sometimes</td>
<td></td>
</tr>
<tr>
<td>almost always</td>
<td></td>
</tr>
</tbody>
</table>
13. In this class we spend time reading, listening, or getting new information about the topic we are studying.

- [ ] almost never
- [ ] sometimes
- [ ] almost always

Other (please specify):

---

14. In this class we spend time practicing the skills and procedures the class has already learned.

- [ ] almost never
- [ ] sometimes
- [ ] almost always

Other (please specify):

---

* 15. Name:
APPENDIX H

THINKING CONCEPT MAP
What is thinking?
When you tell someone you are thinking, what kinds of things might be going on in your head?
For instance, you might be making a mental picture of things, or you might be comparing one thing with another.
What other things might be going on in your head when you are thinking? Make a map or list of your ideas.
What additional ideas about thinking might you add to your map? To help you come up with more ideas about what thinking is and what is involved in thinking:

1. Think of a time when it was difficult or hard for you to think. What kinds of things did you do then? Add your new ideas on your map.

2. Think about times when you knew you were doing some good thinking. What were you doing then? Add your new ideas on your map.

3. Think of someone you consider to be a good thinker. What kinds of things does this person do that makes him or her a good thinker? Add your new ideas on your map.
APPENDIX I

THINK, PUZZLE, EXPLORE VISIBLE THINKING ROUTINES SURVEY

Source: http://www.pz.harvard.edu/resources/cultures-of-thinking-student-recording-sheet
Participation in this research is voluntary and participation or non-participation will not affect a student’s grades or class standing in any way.

* 1. The Think, Puzzle, Explore thinking routine pushed me to think.
   - not at all
   - a little
   - some
   - a lot

* 2. What makes you say that about the Think, Puzzle, Explore thinking routine?

* 3. The Think, Puzzle, Explore thinking routine was useful in helping me activate prior knowledge (remember information I already knew about the topic).
   - not at all
   - a little
   - some
   - a lot

* 4. What makes you say that about question 3?
* 5. The **Think, Puzzle, Explore** thinking routine was useful in helping me identify my current level of understanding.
   - [ ] not at all
   - [ ] a little
   - [ ] some
   - [ ] a lot

* 6. What makes you say that about question 5?

* 7. The **Think, Puzzle, Explore** thinking routine was useful in helping me make a plan to learn the information I want to learn but did not know yet.
   - [ ] not at all
   - [ ] a little
   - [ ] some
   - [ ] a lot

* 8. What makes you say that about question 7?

* 9. The **Think, Puzzle, Explore** thinking routine helped me ask questions that would lead me to understand the topic better.
   - [ ] not at all
   - [ ] a little
   - [ ] some
   - [ ] a lot

* 10. What makes you say that about question 9?
11. I will use the Think, Puzzle, Explore thinking routine on my own to help me gain a deeper understanding of new topic.

- not at all
- a little
- some
- a lot

* 12. What makes you say that about question 11?

13. I will use/have used the Think, Puzzle, Explore thinking routine in another class

- not at all
- a little
- some
- a lot

* 14. What makes you say that about question 13?

15. The Think, Puzzle, Explore thinking routine affected/influenced my performance on higher order thinking questions.

- not at all
- a little
- some
- a lot

* 16. What makes you say that about question 15?

17. Name:
APPENDIX J

CHALK TALK VISIBLE THINKING ROUTINES SURVEY
Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

* 1. The Chalk Talk thinking routine pushed me to think
   - not at all
   - a little
   - some
   - a lot

* 2. What makes you say that about the Headlines thinking routine?

* 3. The Chalk Talk thinking routine helped me to visualize my level of understanding of what I had learned in class.
   - not at all
   - a little
   - some
   - a lot

* 4. What makes you say that about question 3?
5. The Chalk Talk thinking routine helped me get a better understanding of what we had learned in class through the ideas and questions posted by my classmates.
   - not at all
   - a little
   - some
   - a lot

6. What makes you say that about question 5?

7. The Chalk Talk thinking routine helped me apply the concepts I had learned in class.
   - not at all
   - a little
   - some
   - a lot

8. What makes you say that about question 7?

9. The Chalk Talk thinking routine helped me to analyze the concepts I had learned in class.
   - not at all
   - a little
   - some
   - a lot

10. What makes you say that about question 9?

11. I will use the Chalk Talk thinking routine on my own to help me summarize (synthesize) my ideas.
   - not at all
   - a little
   - some
   - a lot
* 12. What makes you say that about question 11?

* 13. I will use/have used the Chalk Talk thinking routine in another class.
   - not at all
   - a little
   - some
   - a lot

* 14. What makes you say that about question 13?

* 15. The Chalk Talk thinking routine affected/influenced my performance on higher order thinking questions.
   - not at all
   - a little
   - some
   - a lot

* 16. What makes you say that about question 15?

* 17. Name:
APPENDIX K

HEADLINES VISIBLE THINKING ROUTINES SURVEY
Participation in this research is voluntary and participation or non-participation will not affect a student’s grades or class standing in any way.

* 1. The Headlines thinking routine pushed me to think
   - not at all
   - a little
   - some
   - a lot

* 2. What makes you say that about the Headlines thinking routine?

* 3. The Headlines thinking routine helped me summarize what I had learned.
   - not at all
   - a little
   - some
   - a lot

* 4. What makes you say that about question 3?
5. The Headlines thinking routine helped me capture the core of a concept I had learned in class.
   - not at all
   - a little
   - some
   - a lot

6. What makes you say that about question 5?

7. The Headlines thinking routine helped me apply the concepts I had learned in class.
   - not at all
   - a little
   - some
   - a lot

8. What makes you say that about question 7?

9. The Headlines thinking routine helped me analyze the concepts I had learned in class.
   - not at all
   - a little
   - some
   - a lot

10. What makes you say that about question 9?

11. I will use the Headlines thinking routine on my own to help me summarize (synthesize) my ideas.
   - not at all
   - a little
   - some
   - a lot
12. What makes you say that about question 11?

13. I will use/have used the Headlines thinking routine in another class.
   - not at all
   - a little
   - some
   - a lot

14. What makes you say that about question 13?

15. The Headlines thinking routine affected/influenced my performance on higher order thinking questions.
   - not at all
   - a little
   - some
   - a lot

16. What makes you say that about question 15?

17. Name:
APPENDIX L

I USED TO THINK…, NOW I THINK… VISIBLE THINKING ROUTINES SURVEY
Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

* 1. The I Used To Think….But Now I Think….. thinking routine pushed me to think
   - not at all
   - a little
   - some
   - a lot

* 2. What makes you say that about the I Used To Think….But Now I Think….. thinking routine?

* 3. The I Used To Think….But Now I Think….. thinking routine was useful in helping me reflect on my own thinking.
   - not at all
   - a little
   - some
   - a lot

* 4. What makes you say that about question 3?
5. The I Used To Think... But Now I Think..... thinking routine was useful in helping me identify how my thinking shifted or changed over time.

- not at all
- a little
- some
- a lot

6. What makes you say that about question 5?

- not at all
- a little
- some
- a lot

7. The I Used To Think... But Now I Think..... thinking routine helped me synthesize (summarize) my ideas.

- not at all
- a little
- some
- a lot

8. What makes you say that about question 7?

9. The I Used To Think... But Now I Think..... thinking routine helped me to make connections between what I used to think and what I think now.

- not at all
- a little
- some
- a lot

10. What makes you say that about question 9?
11. I will use the I Used To Think... But Now I Think... thinking routine on my own to help me understand how my own thinking has changed over time.
- not at all
- a little
- some
- a lot

* 12. What makes you say that about question 11?

13. I will use/have used the I Used To Think... But Now I Think... thinking routine in another class.
- not at all
- a little
- some
- a lot

* 14. What makes you say that about question 13?

15. The I Used to Think... But Now I Think... thinking routine affected/influenced my performance on higher order thinking questions.
- not at all
- a little
- some
- a lot

* 16. What makes you say that about question 15?

17. Name:

*
APPENDIX M

TUG_OF_WAR VISIBLE THINKING ROUTINES SURVEY
Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

* 1. The Tug-of-War thinking routine pushed me to think.
   - not at all
   - a little
   - some
   - a lot

* 2. What makes you say that about the Tug-of-War thinking routine?

* 3. The Tug-of-War thinking routine was useful in helping me explore the arguments for both sides of a dilemma (look at different viewpoints and perspectives).
   - not at all
   - a little
   - some
   - a lot

* 4. What makes you say that about question 3?

* 5. The Tug-of-War thinking routine was useful in helping me reason with evidence (find a cause, explanation, or justification for an action).
   - not at all
   - a little
   - some
   - a lot
6. What makes you say that about question 5?

* 7. The Tug-of-War thinking routine helped me go beyond the surface and identify the complexities in a
dilemma.
- not at all
- a little
- some
- a lot

* 8. What makes you say that about question 7?

* 9. The Tug-of-War thinking routine helped me gain a deeper level of understanding of the dilemmas
connected to the topics learned in class.
- not at all
- a little
- some
- a lot

* 10. What makes you say that about question 9?

* 11. The Tug-of-War thinking routine helped me evaluate (judge) the information learned in class.
- not at all
- a little
- some
- a lot

* 12. What makes you say that about question 11?
13. I will use the **Tug-of-War** thinking routine on my own to help me identify complexities and evaluate information.

- [ ] not at all
- [ ] a little
- [ ] some
- [ ] a lot

14. What makes you say that about question 13?

15. I will use/have used the **Tug-Of-War** thinking routine in another class.

- [ ] not at all
- [ ] a little
- [ ] some
- [ ] a lot

16. What makes you say that about question 15?

17. The **Tug-Of-War** thinking routine affected/influenced my performance on higher order thinking questions.

- [ ] not at all
- [ ] a little
- [ ] some
- [ ] a lot

18. What makes you say that about question 17?

19. Name:
Daily Exit Ticket

1. Student Information
   Name

2. Today in class I learned about:

3. To understand the topic covered in class today I...  
   - asked questions about the topic
   - made close observations paying attention to the details and describing them fully
   - came up with explanations and/or interpretations for the concepts covered in class
   - reasoned with evidence
   - made connections to what I was learning with previously gained knowledge, my own life, the real world, etc
   - looked at different viewpoints and perspectives
   - summarized my notes in an attempt to capture the core of the concept
   - went below the surface to uncover complexities

   Other (please specify)

4. Give specific examples of one thing you did today that helped you develop a deeper understanding for the topic.

5. What is one thing you could have done today to help you develop a deeper level of understanding?
APPENDIX O

DAILY TEACHER REFLECTION SURVEY
<table>
<thead>
<tr>
<th>Daily Teacher Reflection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Name</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>2. Today’s topic was...</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>* 3. During today’s lesson, students were given the opportunity to</td>
</tr>
<tr>
<td>[ ] ask questions about the topic</td>
</tr>
<tr>
<td>[ ] make close observations paying attention to the details and describing them fully</td>
</tr>
<tr>
<td>[ ] come up with explanations and/or interpretations for the concepts covered in class</td>
</tr>
<tr>
<td>[ ] reason with evidence</td>
</tr>
<tr>
<td>[ ] make connections to what they were learning with previously gained knowledge, their own life, the real world, etc</td>
</tr>
<tr>
<td>[ ] look at different viewpoints and perspectives</td>
</tr>
<tr>
<td>[ ] summarize notes in an attempt to capture the core of the concept</td>
</tr>
<tr>
<td>[ ] go below the surface to uncover complexities</td>
</tr>
<tr>
<td>Other (please specify)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>4. Give a specific example of one thing that you thought helped the students develop a deeper understanding for the topic.</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>5. What is one thing that could have been done today to help the students develop a deeper level of understanding?</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
APPENDIX P

TEACHER PERCEPTION SURVEY
Teacher Classroom Perception Survey

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

1. In this class we spend time **looking closely at things, describing them, noticing details, or detecting patterns.**

   - [ ] almost never
   - [ ] sometimes
   - [ ] almost always

   Other (please specify)

2. In this class we spend time **building our own explanations, theories, hypotheses, or interpretations.**

   - [ ] almost never
   - [ ] sometimes
   - [ ] almost always

   Other (please specify)

3. In this class we spend time **reasoning with evidence and supporting our ideas with facts and reasons.**

   - [ ] almost never
   - [ ] sometimes
   - [ ] almost always

   Other (please specify)

4. In this class we spend time **wondering, raising issues, and showing curiosity about what we are studying.**

   - [ ] almost never
   - [ ] sometimes
   - [ ] almost always

   Other (please specify)
* 5. In this class we spend time making connections between different things, to the world, or to our own lives.
   - almost never
   - sometimes
   - almost always
   Other (please specify)

* 6. In this class we spend time looking at things from different perspectives & points of view to see things in a new way.
   - almost never
   - sometimes
   - almost always
   Other (please specify)

* 7. In this class we spend time identifying the central or core ideas, forming conclusions, or capturing the essence of things.
   - almost never
   - sometimes
   - almost always
   Other (please specify)

* 8. In this class we spend time digging deeply into a topic to uncover mysteries, complexities, and challenges.
   - almost never
   - sometimes
   - almost always
   Other (please specify)
9. In this class we spend time organizing and pulling together ideas, information, notes, and experiences to make sense of them.
- almost never
- sometimes
- almost always
Other (please specify)

10. In this class we spend time reflecting on where we are at in our learning and understanding to determine where to go next.
- almost never
- sometimes
- almost always
Other (please specify)

11. In this class we spend time using and applying what we have been learning to solve new problems or create something original.
- almost never
- sometimes
- almost always
Other (please specify)

12. In this class we spend time reviewing and going over information from the readings or previous class work.
- almost never
- sometimes
- almost always
Other (please specify)
* 13. In this class we spend time **reading, listening, or getting new information about the topic we are studying.**

- [ ] almost never
- [ ] sometimes
- [ ] almost always
- Other (please specify)

* 14. In this class we spend time **practicing the skills and procedures the class has already learned.**

- [ ] almost never
- [ ] sometimes
- [ ] almost always
- Other (please specify)

* 15. Name:
APPENDIX Q

TEACHER VISIBLE THINKING ROUTINE REFLECTION SAMPLE
<table>
<thead>
<tr>
<th>Routine:</th>
<th>Think, Puzzle, Explore</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesson Planning:</td>
<td>- How easy was it to incorporate into the day’s lesson plan?</td>
<td>- Easy fit into the 6E’s.</td>
<td>- Can be used as a grounding activity.</td>
<td></td>
</tr>
<tr>
<td>Prep Needed:</td>
<td>- What materials were needed?</td>
<td>- Large butcher paper</td>
<td>- A3 paper for each pair of students</td>
<td></td>
</tr>
<tr>
<td>Modeling:</td>
<td>- What did you need to set up?</td>
<td>- Markers</td>
<td>- A3 paper for each student</td>
<td></td>
</tr>
<tr>
<td>Modeling:</td>
<td>- How much space was needed?</td>
<td>- Student copies of template</td>
<td>- Students kept in their folders</td>
<td></td>
</tr>
<tr>
<td>Time Commitment:</td>
<td>- Time commitment</td>
<td>- Writing out the ideas takes a long time. Better to type them up on a word doc and project.</td>
<td>- Having a set of questions already on hand to move students along made it quicker</td>
<td></td>
</tr>
<tr>
<td>Time Commitment:</td>
<td>- How long did it take to prep?</td>
<td>- Prep time was minimal.</td>
<td>- No prep</td>
<td></td>
</tr>
<tr>
<td>Time Commitment:</td>
<td>- How much class time did it take?</td>
<td>- Actual activity took 40 minutes</td>
<td>- 30+ minutes to complete</td>
<td></td>
</tr>
<tr>
<td>Participation/Classroom Culture:</td>
<td>- Students jumped right into sharing ideas for the “think” column</td>
<td>- All participated</td>
<td>- Only 1 EAL student needed extra support</td>
<td></td>
</tr>
<tr>
<td>Troubleshooting:</td>
<td>- Who participated?</td>
<td>- EAL students completed it with support teacher</td>
<td>- All participated</td>
<td></td>
</tr>
<tr>
<td>Assessment:</td>
<td>- What were the Pros and Cons?</td>
<td>- Kids excited about what they wanted to explore and how</td>
<td>- Required less prompting on my part</td>
<td></td>
</tr>
<tr>
<td>Assessment:</td>
<td>- What did you notice?</td>
<td>- The “think” column was important to on</td>
<td>- Students helped each other out when stuck</td>
<td></td>
</tr>
<tr>
<td>Reflection:</td>
<td>- What would you change?</td>
<td>- Used post-it notes for students to add to class poster to cut down on time.</td>
<td>- Complete in pairs</td>
<td></td>
</tr>
<tr>
<td>Reflection:</td>
<td>- What would you keep?</td>
<td></td>
<td>- Limit discussions when sharing out and save for later</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX R

IRB EXEMPTION LETTER
INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 00000165

MEMORANDUM

TO: Isabel Heredia and Walter Woolbaugh
FROM: Mark Quinn
DATE: November 4, 2016
SUBJECT: “Effect of Thinking Routines Used to Make Thinking Visible on Student Awareness, Attitudes and Conceptions on Thinking in a Science Classroom” [H110416-EX]

The above research, described in your submission of November 4, 2016, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

_X_ (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

_X_ (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects’ responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects’ financial standing, employability, or reputation.

(b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

(b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.

(b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

(b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.
APPENDIX S

TUG-OF-WAR VISIBLE THINKING ROUTINE CLASSROOM EXAMPLE
Tug-of-War

Should the family members + close friends of all infected individuals (including student, teachers and bus drivers), stay home until everyone with symptoms get better?
APPENDIX T

HEADLINES VISIBLE THINKING ROUTINE CLASSROOM EXAMPLE
HEADLINES

Population goes up, water goes down

- Sunbeam City
- Solar power startup
- Green energy
- Rainy spell

New changes in Sunbeam City's weather and water.

Rising population leading to Sunbeam's doomday?

Sunbeam City is in chaos!

- Water crisis
- Air pollution
- Traffic congestion
- Crime increase

Guess what you are inhaling!

The end of Sunbeam City?

Sunbeam City is harmless!

- Pollution
- Overpopulation
- Climate change
- Economic downturn

Learn? Destroying the water source

Sunbeam City, more people, more problems.
APPENDIX U

THINK, PUZZLE, EXPLORE VISIBLE THINKING ROUTINE CLASSROOM EXAMPLES
Feb 27th

- Cells are many different parts
- Some may be harmful to humans
- Some living organisms are made of cells
- There are different types of cells
- Different organisms have different types of cells
- Plants and animals cells are different

P

- Where does a cloud cell go?
- These cells are called
- How do different cells form (including human cells)
- Can you distinguish between live and non-live cells?
- One cell?
- What are the structures like?
- If we broke apart into dust, still cells stay alive?
- What all matter of cells, why don’t we breathe.

E

- Be good kids in science class
- Examine cells with microscopes
- Search for other organisms in the Internet
- Use the mouse
- Look at diagrams of cells

C

- Small
- Can’t be seen by naked eye
- In many things
- Has 2 meanings
- Is in blood
- DNA related
- Pyramids & pyramids

P

- Are they smaller than air?
- Are big ice cells?
- Why are they important?
- Which are pyramids?
- How are they made?
- How many are there per day?
- What colors are they?
- Do they change?
APPENDIX V

CHALK TALK VISIBLE THINKING ROUTINE CLASSROOM EXAMPLE
Understanding the factors that contribute to weather conditions is important for everyone to know.