IMPLEMENTING AN IMAGINATIVE UNIT

Wonders of the Water Cycle

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My Curricular Problem

The grade three curriculum set out by the British Columbia Ministry of Education has four categories for science: Processes of Science, Life Science, Physical Science, and Earth and Space Science. Within each of these categories there are numerous topics to teach. For example, the physical science curriculum requires students to learn about magnetism, energy, matter, and sound. In addition, students are expected to be able to classify, demonstrate, describe, create, distinguish, identify, evaluate, classify, compare, and infer different aspects of each of these topics as needed. This is an overwhelming task and covering all the material in a meaningful way, so that every child develops and expands their concepts, is a challenge, to say the least.

In the Integrated Resource Package that outlines the curriculum for life science, students are to learn about the life cycles of different plants and animals and compare them. Students are to learn what each needs for survival, discuss the environment, fossils, endangerment, and extinction. In an effort to tie these topics together I decided to introduce the water cycle as a basis for understanding what students are required to learn about plants and animals.

The following unit is based on Kieran Egan's *mythic* framework. My aim is to introduce the students to how plants and animals (including humans) are connected to the water cycle and explore these topics in depth in later units. As future science units will explore these topics in greater detail, this unit will provide a basis for future learning. Interconnectedness is the main concept to be developed in this unit.

1. Identifying Importance

It is important for children to realize how necessary and precious water is. It is essential that children understand how water connects plants, animals, and humans to each other. It is fascinating that the water we use everyday has been around since the beginning of Earth. The very same water we drink, that composes 70% of our bodies, is the very same water that dinosaurs, cavemen, and your great-great grandparents drank and used daily. The only way new water enters the cycle is from icy comets entering our atmosphere.

Emotional Engagement: The incredible fact that the water we have on Earth today is the same water that existed when the Earth was formed.

2.1 Finding Binary Opposites

Movement (motion) and stagnation (stillness) embody the essential elements of the water cycle. Water is in constant motion. Whether it is solid, liquid, or gas, the molecules vibrate and move depending on how much energy they possess. The continuous motion of the water cycle ensures that water is cleaned and used where it is needed. Water molecules are never still, but water is sometimes trapped within rock beds or glaciers or even within a loop between evaporation and precipitation. The water cycle is not a predictable and perfect cycle; sometimes water stagnates in oceans, glaciers, and rock layers for thousands of years or more. Although the water seems still in these places it is really in motion as the molecules gain and lose energy.

As water moves it rejuvenates itself and nourishes life; however stagnating water can bring disease and danger. If water does not flow to plants and animals they will die. The constant movement of the water cycle is essential for life on this planet.

2.2 Finding Images and Drama

I have created the character of Walter the water molecule to help highlight the interconnectedness of the water cycle. The unit illustrates how the movement of water enables life on our planet.

The water molecule (Walter) has been around since the beginning of Earth's life exploring every corner or the planet. This reflects the binaries of motion and stillness. Walter moves throughout the cycle changing forms yet he can become trapped, and it may seem like he is still. Walter's movement (along with his water molecule friends) is a necessary part of the health of plants and animals. Considering that only 3% of the water on Earth is fresh (drinkable) water and of that 2% is trapped in ice, only 1% of the water on Earth is accessible to drink. This stagnation (trapping) of the majority of the water (within oceans and ice) creates an environmental problem. If we are not responsible with our water use then there will not be enough water for all the plants and animals, including humans, to survive.

2.3. Organizing Content into Story Form: An Overview

Once Walter is introduced he is referred to throughout the lessons. It is important for students to see Walter as a character as we discuss how he changes (gains and loses energy). Students will understand that as Walter loses energy he moves closer to other molecule friends and as he gains energy he runs around and bounces off other molecules as they all spread apart. Discovering that Walter needs to evaporate, condense, melt, freeze and precipitate to travel around the globe helps students understand the movement of water throughout the cycle.

Unit two continues the story as students learn how Walter is connected to all aspects of the environment. Students will under-

stand all the places water travels to and see how it can get trapped and become unusable to plants, animals, and humans. Students will see the essential interconnectedness of water and appreciate that the movement of water is necessary for the health of our planet.

Unit 1

LESSON 1: THE INTRODUCTION OF WALTER THE WATER MOLECULE

A long time ago, before you were born, before your parents, grandparents, great, great, great, great grandparents were born; in fact, before there were any people on Earth, there was water. Water was on Earth before the dinosaurs, before the trees and even before the oceans. When the earth was born it was made of layers upon layers of rock. (At the very centre of the earth the rocks were so hot that they were liquid. This is called magma. The core of the earth is still molten rock, and we sometimes see this when it erupts out of volcanoes as lava.) As these layers formed, volcanoes grew and started to erupt. As the lava, rocks, gases, and water exploded out of the volcanoes water began to collect and formed the oceans we have today along with lakes and rivers. The presence of water allowed life to begin growing on our planet. If we did not have water then we would not be here today.

Walter had been around watching all of this happen. He remembers being shot out of the mouth of a red-hot volcano and falling gently into the oceans that were beginning to form. His ride had been better than any ride at Playland! Walter had been there at the beginning because he is a water molecule, and he has been exploring the world forever. Walter usually travelled with friends as he moved around the globe, and today is no different. Today Walter is moving around wherever the ocean tides take him. He enjoys the ocean because it is so big, and he always discovers something new with every trip.

Activity:

Why is the Earth called the Blue Planet?

The oceans cover 71% of the earth's surface. In fact there is so much water on our planet that it is called the blue planet. Let's find out why Earth has this name.

Students will observe the earth from space as it rotates. NASA has a web site that nicely illustrates how blue the earth is and how much of the earth is water. The class will then discuss what they saw.

Conclusion:

The earth is called the blue planet because from space you can see more ocean than land. From space Earth looks mostly blue. Like Walter, the water that moves around our planet today is the same water that has always been here. The water never leaves our planet and it never dies or goes away. Sometimes new water is added to our supply, for example when icy comets hit the earth, but most of our water has been here since the beginning of Earth. It is amazing to think about where the water we drink everyday has been. The last glass of water you drank may have been the same water that dinosaurs drank, or maybe it was trapped in a glacier for millions of years, or maybe it had been inside a great white shark. The possibilities are endless.

Activity:

Where has water been?

Students will sit in groups of four and brainstorm a list of all the places the water they drank earlier today could have been. This brainstorming activity is called a place mat brainstorm. Students are given a large piece of paper (11x14) and divide it into four parts. Each student writes their ideas down as they share them aloud. It means that everyone is involved in the activity and everyone shares ideas. Once students are done they will share their ideas with the class.

Conclusion:

Water is an essential part of our planet and the lives of animals and plants are deeply connected to it. The water cycle is what we call the movement of water throughout our environment.

LESSON 2: MOLECULE

Discussion: What is a molecule?

Everything in the whole wide world is made up of atoms—your chair, your desk, your hair, your bed, your pencil, the smallest bug, and the biggest whale. Even Walter is made of tiny particles or pieces called atoms. Atoms are not normally found by themselves. Usually, atoms bond or attach together. When atoms bond together they form a molecule. (An atom is like a baseball player all by herself. When all the players are together then they form a team. When atoms are together they form a molecule.) Molecules are also incredibly tiny. They are smaller than one grain of sand. In fact they are so tiny you can't even see them! For example, one droplet of water has 10 billion molecules in it!!

Demonstration:

Using an eye dropper, show students one drop of water and inform them that it has ten billion water molecules in it.

One water molecule, like Walter, is made up of two hydrogen atoms and one oxygen atom. When the two hydrogen atoms and one oxygen atom get together they make a water molecule. So this team has three players (two hydrogen and one oxygen) and when they all come together they form a team called a water molecule. Draw this image so students have a picture of it in their minds.

Activity:

What does Walter look like?

Give students three circles—two smaller (same size) and one larger. Students then label these circles hydrogen and oxygen. Students will then glue these circles together to form a water molecule like

Walter. Once the molecule is glued together students will fill in the sentences below with their new information about water molecules.

LESSON 3: ENERGY

Discussion:

I hope you remember where Walter was when we left him. That's right he was in the ocean with billions of friends. Walter isn't always with his friends. Sometimes he is all by himself floating through the air without a care in the world. When he is by himself he has so much energy he bounces around doing whatever he wants. Other times Walter doesn't have as much energy, and he likes to hang out with his friends, like he is now in the ocean. There are also times when Walter has very little energy, and he sticks really close to his friends.

Walter, like all water molecules, can transform into three states (forms). I know that Pokemon can change and become different characters but water molecules can become three different things! "What makes Walter and his friends change states?" you ask. Good question. Water molecules change states depending on how much or how little energy they have, and they get energy from heat, like the sun or an oven.

Sometimes Walter has lots of energy, and he bounces around just like you do when you run around the playground. At other times Walter has very little energy, like when you don't get enough sleep or enough to eat. What do you do when you have little energy? Like you, when Walter has little energy he moves slowly.

Prediction/Demonstration/Observation Activity:

Students will discuss and then predict what will happen to water molecules as they gain energy and lose energy. Students will record their thinking on a prediction/observation sheet.

Prediction.

Let's think about all the molecules that are in this bowl of water. Remember that one drop has ten billion molecules. What do you predict would happen if this water was heated up? Class discusses.

Now we are going to think about what will happen to the water molecules as the water is heated up. Talk with people at your desk about what you predict will happen to the water molecules. Write your predictions down.

What do you think will happen if this water is cooled down? Discuss your predictions.

Now we are going to think about what will happen to the molecules as the water cools down. Talk with your desk partners and write down your predictions.

Demonstration.

Discuss the predictions students made about water molecules as they heat up.

Students will now observe a kettle boiling. Pour the water into a glass bowl so students can observe the water. Discuss what is happening with the class. Tell me what you notice.

We see steam and this is called water vapor. This is a gas. The water began as a liquid and now it is turning into a gas. The water molecules are gaining energy as they are heated. As they gain energy they begin moving further and further apart, bounce off each other, and become a gas. Heat gives water molecules more energy so they move faster and are able to escape from each other and move freely in the air. When water molecules are heated at or above one hundred degrees celsius they move apart and become a gas. Students record observations.

Demonstration.

Discuss the predictions students made about water molecules as they cool down.

Students will observe ice and discuss what they notice.

We see ice and the water is frozen. When water turns into ice this is called a solid. As molecules cool they loose energy and move closer together, thus forming a solid. When water molecules are put in a cold place (where they don't get enough heat) they lose energy and move towards each other. When water molecules are cooled below zero degrees Celsius, they reach the freezing point and form a solid. Students record their observations.

Conclusion:

We observed that when water molecules are heated up they move apart from each other, and when they are cooled they move closer together. As molecules gain energy and lose energy they change states.

LESSON 4: MOLECULES CHANGING STATES

Activity:

Students pretend that they are a water molecule. They are reminded that two are hydrogen atoms and one is oxygen. Together, they make up one water molecule. As a class we will pretend to be a liquid, a solid, and a gas and move around the room accordingly.

Show me what you would do if you were to heat up and gain energy.

Now show me what you would do if you cooled down and lost energy.

What would you do if you had lots of energy, and what would you do if you only had a little energy? What would you do if your energy was medium?

Conclusion:

Heat affects water molecules and the energy of these molecules determines its state. Water is the only substance on earth that exists in three forms.

Discussion:

Molecules always have some energy, therefore they are always moving, even if it is only a little bit. When they are a gas their energy is high and they move a lot and take up a lot of room. When they are a solid their energy is low and they only move slightly. If the molecules are heated (maybe by the sun or an oven) they gain energy, and as molecules lose heat they lose energy.

It is easy to think that molecules stop moving when they are in a solid form but this is not true. Although they don't move very much they continue to vibrate slightly even when in a solid state. A solid is like you when you're sleeping. Even though you are still (not moving) your lungs are moving, your blood is pumping and many other parts of you are in motion. A molecule is the same. Even though it may seem still, it actually has energy and is moving.

Conclusion: Molecules have energy therefore they are continuously moving. Although water molecules change forms they continue to move.

LESSON 5: PICTURE IT

Begin the lesson with a brief discussion reviewing how molecules change states and what three states they become.

Activity:

Students will draw what water molecules look like in each state. Discuss that when water molecules heat up to or beyond one hundred degrees celsius they become a gas. These molecules gain so much energy that they move far apart and change into a gas. They float in the air bouncing into each other and anything else in their way. Discuss what gives molecules energy. Think of some examples of a gas.

When water molecules cool down below zero degrees celsius they become a solid. They lose so much energy that they move close to each other and turn into a solid. Discuss when molecules would lose energy. Think of some examples of a solid.

When water molecules are between a solid and a gas they are a liquid, like the water we drink. They are warmer than zero degrees celsius and cooler than one hundred degrees celsius. The molecules are close together but not too close. Think of when molecules would be in a liquid state and discuss some examples.

LESSON 6: MOVING WATER

Read The Snowflake, A Water Cycle Story by Neil Waldman.

Activity:

Now let's think about where we would find water in a liquid, solid, and gaseous state. Let's brainstorm some ideas. Write down student's ideas on chart paper and label each column as a solid, liquid, or gas. Label the following main ideas on the chart.

Discuss:

To change states the molecules would need to gain energy or lose energy. How do they gain energy (heated)? How do they lose energy (cooled)?

Let's think about Walter, our water molecule. As he sits in the ocean what form is he in? (Liquid) Now let's pretend the ocean Walter finds himself in is the Arctic Ocean in the dead of winter. What might happen to Walter and his molecule buddies? (Freeze – as they cool they lose energy and huddle close together therefore forming a solid – ice) Have some students stand up and act this change out for the class. (Begin by holding hands as they loose energy the molecules huddle together and lock arms.)

- Water molecules become a solid when the temperature is zero degrees celsius or below. This is called the **freezing point** and the molecules form ice.

Walter and his molecules friends float around the freezing waters of the Arctic as ice. Show some pictures. They begin to drift southward. As they float the sun shines brightly, and they start to warm up (gain energy!) What will happen now? (Turn back into a liquid – gain some energy so they separate from each other more but still remain connected.) Have some students act out this change for the class. (Begin by huddling together with arms locked together. As they gain energy they loosen their grip on other molecules and just hold hands.)

- **Melting point**: when a solid is heated, the temperature rises and the molecules gain energy and move apart and the solid melts into a liquid form.

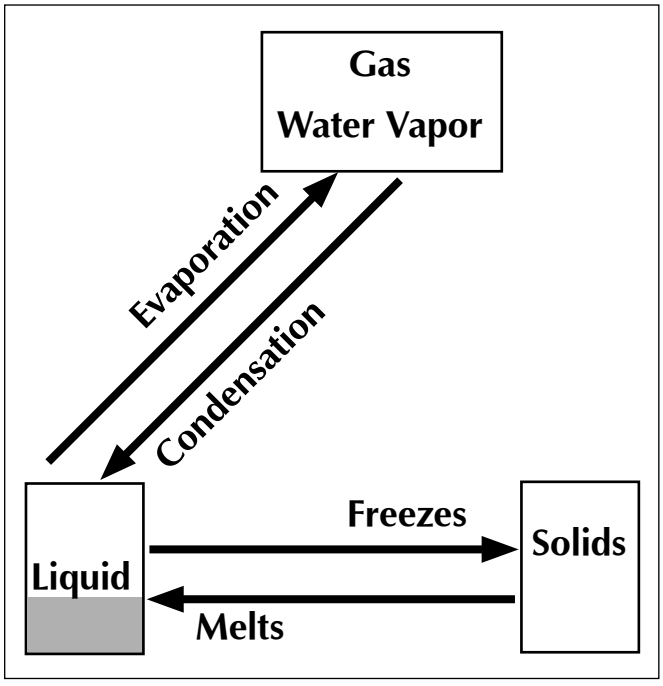
The sun continues to shine and Walter begins to heat up even more. What will happen to Walter as he continues to gain energy? (Turn into a gas – evaporate - break the bonds with other molecules and rise out of the ocean and float upward on his own.) Have some students act out this change for the class. (Begin by holding hands then drop hands and move freely around the room.)

- **Evaporation**: as a liquid heats up the molecules gain energy and escape into the air as gas—molecules on the water's surface have the energy to evaporate and form water vapor.
- **Water vapor** is water that becomes a gas when heated.

As Walter floats higher and higher above the ocean the air begins to get cooler. When Walter and the other molecules lose energy they start to move together again and form a liquid. (After the gas has risen, it may lose energy. If the water vapor loses energy, it will turn back into a liquid.) This is called condensation. **Condensation** happens when water molecules, like Walter, turn from a gas into a liquid.

LESSON 7: THE THREE STATES OF WATER

Review the chart the class created in the last lesson and discuss the main ideas again. Draw a chart for the class showing this information.



Activity:

Students create their own poster of this cycle for their science book.

Drama Activity:

Students will be put into groups of five and will act as water molecules changing states. Students will perform these in front of the class and will tell us what happens as they change from state to state (i.e.: we are in a glass of water, now the water is being put in the freezer, then put on a table and then the sun shines on the water all day long).

LESSON 8: CONDENSATION AND CLOUDS

When Walter sits on the ocean's surface with his friends they are heated by the sun. As the temperature increases Walter gains energy and breaks his bonds/attachment with other molecules. He begins floating above the ocean as a gas called **water vapor**. Once Walter is water vapor he is a molecule on his own.

The higher Walter goes the colder the air gets, and he starts to lose some of his energy. The same thing happens to other molecules, and they can't stay apart so Walter and the other water vapor molecules begin attaching to each other and to particles/pieces of dust, dirt, pollen, salt, or anything else in the air. As they attach, these molecules change from a gas back into a liquid (droplet) and start to form a cloud. This process is called **condensation**. A cloud, therefore, is a liquid, not a gas.

As Walter and his molecule friends sit in the cloud, the cloud continues to slowly rise. The higher the cloud gets the colder the air is and more condensation occurs. The cloud starts to get full of water! Once the droplets cannot hold any more water they are too heavy to sit in the cloud so they fall out of the cloud as rain. Walter and his friends fall to the Earth and this is called **precipitation.** Rain, snow, hail, and sleet are all types of precipitation.

If the cloud's temperature is zero degrees celsius or below, the vapor condenses as ice crystals not water droplets. When this happens it will not rain it will snow, hail, or sleet (liquid or solid, rain or snow). Eighty percent of precipitation falls into oceans. A water molecule spends eight to ten days in the air between evaporation and precipitation.

Discuss:

As a class, discuss how a cloud is formed and what precipitation is. Create a drawing of the process and discuss.

LESSON 9: CONDENSATION AND CLOUDS CONTINUED…

Demonstration:

Do some experiments with water to show evaporation, water vapor, condensation, and precipitation.

- Boil some water and watch the water vapor rise up from the water. This is evaporation. **Boiling point**: when a liquid is heated the temperature rises, the molecules gain more energy and break free of each other, thus turning the liquid into a gas. By putting a boiling kettle in front of a blackboard students can see the water vapor. If the kettle is close enough to the blackboard the water vapor will condense on the board, and if there is enough water vapor present the condensed water will join together and create droplets of water that look like it's raining down the blackboard.
- Some things will make water evaporate faster.
- Example 1: The wind. When we hang laundry outside to dry, the sun and wind both help to make the water evaporate. The wind blows the water vapor away from above the liquid.
- Example 2: Surface area. A liquid in a cup will evaporate much more slowly than water that is spilled on a table and covers more area. We can see this when we put water on the chalkboard. It magically disappears but we know that the water is turning into water vapor and evaporating. Once the water condenses on the blackboard, wave a fan/book at the liquid and students can watch it turn back into a gas and evaporate quite rapidly.
- Put ice cubes into a glass and leave it out for a while. Watch as water vapor condenses on the side of a glass. As the ice cools the water vapor (gas) in the air, water molecules begin to move together and as they attach they form a liquid that condenses on the side of the glass. We can also see condensation happening on windows or on the bathroom mirror after a shower.

Activity: Students will create their own picture of how a cloud is formed and label it accordingly. Students should show where

evaporation, condensation, and precipitation occur. They should show an energy source and label the water vapor. To show the molecules changing states students should show what molecules look like as they go through the various states.

LESSON 10: ASSESSMENT

Activity:

Students will complete the "Tell me what you know" assignment. This assignment asks students to define melting, freezing, evaporation, and condensation, and then to draw the process.

Conclusion:

The same water we still have on Earth today has been here forever. The water molecules don't go away instead they get recycled through the environment. In the next unit student will explore how water is connected to the oceans, plants, animals, and humans. As a concluding activity we will watch Bill Nye the Science Guy's video on the water cycle.

Conclusion:

To conclude this unit it is important for students to recognize how water moves. We have mediated the binary opposites of motion and stillness and discovered that molecules do not simply move and stay still, but are in constant motion throughout the water cycle. Students learned that as a gas water molecules are moving more than when they are in the form of a solid. Students used these two ideas to understand that medium-energy molecules exist as a liquid. After learning this students will then apply this knowledge in an example. Understanding how the processes of evaporation and condensation create clouds will help students to see how water moves throughout our environment.

Evaluation

This final assignment will provide me with an insight as to how well each student understands the concept of a water molecule and its changing states. Having students both write and draw about the concepts allows students to fully show their understanding despite any difficulties they may have with language and writing.

Conclusion

Overall I was extremely pleased with my unit on the water cycle. I thoroughly enjoyed the lessons and my students were successfully engaged. They speak about water with a new level of confidence and understanding. My students seem to have a better appreciation of the world around them, and they see how their new knowledge connects them to the earth. They understand that the water we drink has been around since the beginning of the earth and that it cycles throughout the globe. The enthusiasm and excitement of my students has invigorated me and motivated me to further engage and nourish their imaginations.

Having students understand the scientific aspects of a concept is important. In the past I have taught about the water cycle but have not stressed the need to understand molecules or where water came from. I would briefly teach what molecules were and then moved on to what they look like as a solid, liquid or gas. In this unit, however, I took the time to discuss how water became a part of our Earth and how interconnected it is to everything on the planet. Students learned what molecules were and how they worked in regard to energy. I feel that I have been able to establish why water is an important concept and have built a stronger understanding of how and why molecules change forms. Prior to this I think my students were missing the notion of why it is important and how this information connects to other things they know. Inviting students to discover things they don't know requires a sense of purpose: "Why should I learn this?"

Imaginative education showed the relevance of subject and engaged my students in a meaningful way. It is important for students to understand how precious and necessary water is because it is essential to our survival. By engaging my students emotionally in the topic I was able to arouse their sense of wonder and motivation for learning. I agree with Kieran Egan's view that "a sense of wonder and an emotional response to material are important in engaging students' imaginations" (2004, p. 35). I feel that once I located the wonder in my topic, not only was I excited, but so too were my students.

This unit reflects Egan's mythic framework and many of the cognitive tools associated with this stage where incorporated into the lessons. Binary structures were used to help students mediate their understanding of water. In order to make sense of the fact that water molecules are in constant motion students began lesson three by predicting what would happen to water molecules when the water was heated up and cooled down. Many students predicted that molecules in frozen water would not move and molecules in boiling water would move really fast. Beginning with the students' intuitions I was able to introduce the idea that water molecules are always moving even if it is very slowly. Students were introduced to the scientific concept that as water molecules lose energy they move closer together and as they gain energy they spread farther apart. Students could then determine that molecules with less energy move less and molecules with more energy move more, but water molecules are never perfectly still.

Metaphor also helped to develop the scientific concept of water. For example, in lesson three, as I introduced energy, I compared the energy of a student to that of a water molecule. I feel that metaphor helped my students better understand the content I was teaching. Students also used metaphor to explain their thinking, for example one of the students compared molecules gaining energy to a war.

The tools of imagery and narrative were also used in this unit. Although I introduced the lesson with a story of how water came to be on the earth, the image of Walter the water molecule became a more powerful tool for my students. For example, when students drew water molecules, they showed three atoms. This showed me that they had truly internalized the concept of what made up a water molecule. As we discussed the changes that water went through as solid, liquid, and gas students could invoke the image of Walter and

his water molecule friends to understand how water changed forms. This proved to be an invaluable tool as students could easily act out what molecules did during evaporation, condensation, melting, and freezing. This image continued to be powerful as some students drew molecules talking to each other as they changed states.

Imagery enabled my students to show something they could not see and thus encouraged them to think abstractly. Vygotsky believes that "from the point of view of development, creating an imaginary situation can be regarded as a means of developing abstract thought" (1978, pg. 103). Because my students had an image of a water molecule, they could picture the abstract processes involved as water changes states. In the past having students understand these processes was extremely difficult, however this year I felt my students had much more success and developed a deeper understanding of the processes. Students, for example, were able to think of situations where condensation and evaporation may occur.

Stories were used to introduce my unit and were continued throughout. Although the beginning story and the image of Walter engaged my students in a powerful way, I would like to develop this story in a more substantial way. Picture books furthered the ideas we were developing, helped students make meaningful connections, and offered new perspectives. In the future, when I end unit two, I intend to have students write their own adventure story of water. I feel that this will be an excellent way for students to show their understanding of how water moves and is connected to the environment.

Rhyme also proved to be an excellent tool to aid the memory of my students. Many of the terms used in the water cycle were a challenge for my students. To improve their memory of the difficult and complex words I found a song on the Internet (www.proteacher.net/archive/posts/2001/03/24/12048.html). My students love it and are now able to pronounce these words correctly.

Many of these tools allowed everyone in my class, regardless of ability, to develop their understanding of water. The image of Walter, for example enabled them to understand what molecules do as they gain and lose energy. The rhyme of the song helped all students figure out how to pronounce difficult words and remember the processes involved in how clouds are formed. The tools suggested by Egan for developing *mythic* understanding have been very successful, and I feel satisfied that these tools lead to an improvement in my curriculum and instruction, as well as the learning of my students. The notion of concept development empowered me to be more purposeful and directive in my teaching. Conversation provided the opportunity to mediate my students' understandings. Concept development, imagination, and wonder have become the starting point of my practice, and I look forward to developing this into more units in the future.

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