

The nose knows...or does it?

Using the learning cycle and questioning in a lesson about the sense of smell

by

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Teachers can always sniff out a passing trend in education. They get a whiff of the old, “We’ve done this before” and before you know it, science education reform goes the way of stinky sneakers. Currently, constructivism provides the philosophical foundation for reform in science education (National Research Council, 1996). Constructivism “baffles, scares, and annoys large portions of educators – it requires new behaviors for many teachers who learned to teach in conventional ways” (Loucks-Horsley, et al., 1993). As a theory of learning, constructivism provides educators with an understanding of how students learn, but as with most theories, does not itself provide strategies for classroom use.

Descriptors of teaching practices that support students’ construction of knowledge can be found in the literature including: Inquiring about students’ understandings of concepts before sharing the teacher’s own understandings of the concepts; Encouraging students to engage in dialogue, both with the teacher and with one another; Encouraging inquiry by asking open-ended questions of students and encouraging students to ask questions of others; Seeking elaboration of students’ initial responses; Nurturing students’ natural curiosity through frequent use of the learning cycle model (Brooks & Brooks, 1997; NRC, 1996). The learning cycle is an approach to teaching and learning that increases the likelihood that students are engaged in the type of thinking that constructivists argue is necessary for productive thinking (Renner & Marek, 1998).

To maximize the use of the learning cycle, it is essential for teachers to think about – and plan for – the use of questions within a lesson. All teachers ask questions. However, when teachers are not encouraged to consider or script questions before a lesson, they tend to revert to basic levels of recall questions when actually teaching the lesson (Ittigson, 2000). Planning for questions is not meant to limit the teacher. Instead, having questions organized and structured by their place and purpose within the lesson helps the teacher skillfully guide students to construct understanding of a concept. Asking a series of carefully sequenced questions and revisiting earlier questions can lead students to new insights, as well as encourage them to ask their own questions. The questions in the plan serve as a “road map” to a destination of understanding. A map does not preclude the traveler from taking a side road to an interesting or unplanned destination, but it does mean that if the journey starts to wander, the map is available to get the traveler back on course. Having a plan for questions allows for flexibility to go with the teachable moments, like taking a slight detour, but provides the safety of knowing you can still get to your destination because you have a course or route outlined on your map.

Closer examination of constructivist teaching practices reveal that questioning is a critical element of facilitating student construction of knowledge. Questioning by the teacher serves several purposes. First, questions elicit students' ideas so the teacher can gain insight into student thinking and subsequently plan for experiences that clarify and deepen student understanding. In order for the teacher to "inquire about" or "seek elaboration" of students' ideas, the teacher must be able to effectively use questions. Second, the use of questions generates discourse between students and between the students and the teacher. General agreement among constructivists posits that discourse is especially important to negotiate meaning and develop socially agreeable constructs. Therefore, the use of questioning to generate discussion is important before, during, and after engaging students in learning experiences. Third, teachers' questions heavily influence the kinds of question patterns students develop. Pursuit of students' questions addresses the personal nature of learning central to a constructivist model. While teachers are often told that students should raise their own questions and be given opportunities to answer them, professional development does not often address the impact of the teacher's use of questioning on student questioning, and how the modeling of asking questions is essential in encouraging students to ask questions. Therefore, the lesson described in this article focuses on questioning from the point of view of the teacher, while pointing out opportunities for students to raise their own questions in order to engage them further in the learning.

To effectively use questions, teachers first have to decide which type of question to ask. Asking the right question at the right time can help a student clarify his or her thoughts, recognize a pattern, or overcome a conceptual hurdle (WBGH, 1999). Asking the right question at the right time leads to where the answer can be found and asks students to show rather than to just say the answer (Elstgeest, 1995). Similarly, good, or productive, questions engage students in thinking, invite a closer look, a new experiment, or a fresh exercise (Elstgeest, 1985). Productive questions stimulate productive activity (Harlen, 1995). Productive questions can further be classified into several sub-categories: attention focusing, measuring and comparing, comparison, action, and problem-posing. Answering each type of question depends on evidence gathered from a learning experience. On the other hand, unproductive questions usually ask for some type of explanation (Harlen, 1996). One example of an unproductive question is the "why" question. If a teacher asks a student "why" something happens, and the student does not know, the student will likely have no response. If instead, the teacher asks, "Why do you think [this] happens?" the modified question gives every child the opportunity to share their ideas. All children can tell the teacher what they think, even if they do not "know" the answer.

In any lesson utilizing a learning cycle, certain types of questions match the purpose of a particular phase of the learning cycle. For example, during the Engagement phase, questions that encourage students to share their pre-existing ideas about the concept are particularly effective so that the teacher is aware of and can make use of these ideas in planning. Questions that promote conceptual conflict can also be effective during this phase of the lesson. Beginning the lesson with these types of questions, students self-realize that they need more information to respond to the question. Needing to find more information in order to answer the question provides the motivation to learn and to move on to the Exploration phase of the lesson. During the Exploration phase, the teacher wants the students to gather evidence related to the concept. To do so, the students make observations, and collect and record data. To facilitate this, the teacher might ask attention-focusing questions, such as "Have you noticed exactly where the wire is

connected to the bulb when the bulb is lit?” or “In what ways are these leaves different?” During the Elaboration phase, the teacher might consider what reflective questions illustrate the connection between science and the students’ lives. For example, What is an example of a time when evaporation occurs in your house?

When planning a lesson, teachers might ask themselves questions in order to consider the types of questions that might be most effective. For example, during the Explanation phase, the teacher might ask herself, How can I use teacher questioning to help students connect their findings to the concept and refrain from telling the students what they should have found? (Martin, et al, 1998). In order to help plan specifically for opportunities for students to raise their own questions, the teacher might consider, Now that the students have been introduced to the concept, what unanswered questions do the students have about the concept? During the Elaboration phase, the teacher might ask herself, What new experiences do the students need in order to expand on the concept? Simultaneously, in order to encourage the students to raise questions, the teacher might ask, How can the students use their findings to generate additional questions for further investigation? In the Evaluation phase, the teacher might ask herself, What specific questions will let me know whether or not students are developing understanding of the concept? The reflexive use of questions can help teachers plan for the use of questions throughout the lesson. Since the learning cycle provides continuous opportunities for formatively assessing student understanding, if the teacher finds that her questions are not leading students toward understanding, the road map can be revisited.

The Lesson

“The Nose Knows...Or Does It?” is an example of an inquiry-based lesson planned according to the “5 E” model of the learning cycle: Engagement, Exploration, Explanation, Elaboration, and Evaluation. The lesson plan pays careful attention to the purpose and function of each phase of the learning cycle in helping students to construct understanding of the concepts. The lesson plan also models the types of questions that are most productive for each phase and its intended purposes. Because the lesson plan was written to demonstrate the use of questions, each phase of the plan is primarily organized around the suggested questions, with enough directions for a teacher to adapt the lesson to his or her own needs. “Using questions in inquiry-based science is an ongoing decision making process” (WBGH, 1999). Therefore, when teaching the lesson to students, many questions will be asked that are not written in the plan and many questions that are in the plan, may not be asked depending on the students’ observations.

Student background

The lesson, as planned, is intended for third or fourth grade students. The main concept addressed in the lesson at this grade level is the sense of smell, specifically how our bodies detect and identify scents. Using a familiar toy, students build on a basic understanding of the particulate nature of matter (i.e. molecules exist and have different behaviors in different states of matter) to develop a beginning understanding of diffusion and micro-encapsulation. Students may begin this lesson thinking that the scent of an object goes directly to their nose; and/or that each of our senses works independently of each of the other senses. Students have had experiences smelling a variety of scents, including a family member’s perfume or cologne, food

cooking on the stove, or danger signals such as smoke. Please note that these are general trends in student thinking about these concepts. More specific questions that can be used to assess students' experiences with and understanding of the concepts in the lesson are described in the body of the lesson plan. Students may have played with scratch-and-sniff stickers or scented markers prior to the lesson. The skills of observing, predicting, and communicating are integral to students' participation in this lesson.

Teacher background

The teacher needs to be familiar with the following explanation of the concept, adapted from Sarquis, Sarquis, and Williams (1995), to help facilitate student understanding. All matter is made up of tiny particles. They are so small that under normal circumstances they cannot be seen. However, in some cases you can detect the presence of the particles by smelling them. Each of the smelly substances in this activity contains particles that have characteristic odors. When these smelly particles reach special receptors on the inside of our noses, a series of complex chemical reactions begins that ultimately results in the perception that you smell a particular substance.

When the scented substances are encapsulated in the scratch-and-sniff stickers, the smelly particles are for the most part sealed in. However, once the sticker is scratched or the scented crayon is used, the encapsulated bubbles pop, and scent particles evaporate (change from the liquid to the gaseous state). The gas particles quickly diffuse (spread out) through the air until some reach our noses.

Since this activity was originally developed (Sarquis, et al, 1995), there is some evidence to suggest that newer scratch-and-sniff stickers may not be made by micro-encapsulating the scent. Instead the newer stickers seem to be made by layering: first the color, then the scent, then a protective coating to seal in the scent. This would explain why the scent is not as strong as when it is micro-encapsulated (like when the stickers were first produced), or why the stickers may lose their distinct scents when they are stored together in one bag. The scent molecules may "escape" out of the sides of the sticker where they are not completely sealed, thus mingling with other scent molecules, to cause the odors to mix.

Materials

The teacher will need to gather an assortment of scratch-and-sniff stickers of different designs and colors. Each group will need an assortment of stickers. Students will also need magnifying lenses for making close and careful observations. The teacher will also need Crayola "Magic Scent"™ Crayons and a set of scented markers.

Safety considerations

Some children may be more sensitive to certain odors than others, therefore, have a variety of scented stickers for the activity.

Objectives and proficiencies

The design and content of this lesson most closely align with the K-4 content standards for Science as Inquiry and Physical Science. While additional connections can be made, the closest alignment between the Standards and the lesson are presented in Table One.

Table 1

Alignment of National Science Education Standards with the lesson, “The Nose Knows”.

| Content Standards K-4 | Lesson - The Nose Knows |
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| <p>Science as Inquiry, Content Standard A: As a result of activities in grades K-4, all students should develop abilities necessary to do scientific inquiry. The fundamental abilities that underlie this standard include: ASK A QUESTION ABOUT OBJECTS, ORGANISMS, AND EVENTS IN THE ENVIRONMENT. Students ask questions that they can answer with scientific knowledge combined with their own observations. Students should answer their questions by seeking information from reliable sources of scientific information and from their own observations and investigations.</p> | <p>Students make observations of the scratch-and-sniff stickers that lead to questions. Students attempt to answer their question using observations, simple investigations, and information provided by the teacher. These sources of information help students build on their existing knowledge of the particulate nature of matter to understand how scent molecules diffuse and reach their noses in order to identify a scent.</p> |
| <p>PLAN AND CONDUCT A SIMPLE INVESTIGATION. In the earliest years, investigations are based on systematic observations. As students develop, they may design and conduct simple experiments to answer questions.</p> | <p>Students design a simple investigation based on repeated observations of the sticker to gather evidence for their theories about how the scratch-and-sniff sticker works.</p> |
| <p>USE DATA TO CONSTRUCT A REASONABLE EXPLANATION. This aspect emphasizes the students’ thinking as they use data to formulate explanations. Even at the earliest grade levels, students should learn what constitutes evidence and judge the merits or strength of the data and information that will be used to make explanations. After students propose an explanation, they will appeal to the knowledge and evidence they obtained to support their explanations. Students should check their explanations against scientific knowledge, experiences, and observations of others.</p> | <p>Students are continually asked to refer back to the information they have gathered through their observations to explain how the scratch-and sniff stickers work and how the scent gets from the sticker to their noses. Furthermore, they are asked to provide evidence to support their theories and to make use of evidence from their observations and investigations when sharing their ideas with others.</p> |
| <p>COMMUNICATE INVESTIGATIONS AND EXPLANATIONS. Students should begin developing the abilities to communicate, critique, and analyze their work and the work of other students. This communication might be spoken or drawn, as well as written.</p> | <p>Students use multiple forms of communication including drawing, writing, and speaking to communicate their ideas about the concept. Students are asked to revise their drawings and explanations as they gather evidence and deepen their understanding.</p> |
| <p>Physical Science, Content Standard B: As a result of the activities in grades K-4, all students should develop and understanding of properties of objects and materials.</p> | <p>Using a common childhood toy, students observe the properties of the scratch-and-sniff stickers and investigate how the materials of the sticker are</p> |

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| Objects have many observable properties, including size, weight, shape, color, temperature, and the ability to react with other substances. Objects are made of one or more materials, such as paper, wood, and metal. Materials can exist in different states, solid, liquid, and gas. Some common materials, such as water, can be changed from one state to another by heating or cooling. | responsible for the sticker's ability to hold a scent until it is scratched. To understand the release of the scent and the diffusion of the scent molecules, students deepen their understanding of the states of matter and the ability of some substances to change from one state to another. |
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In support of these Standards, specific objectives for the lesson include the following:

- I. Students will be able to explain that when an odor is detected by a person, the scent molecules have spread out from the scented object and traveled through the air (diffused), to our noses. Our brain then either identifies the scent as something familiar or something new.
- II. Students will be able to explain that our senses work together and often our sense of sight provides valuable information to help us identify different scents.
- III. Students will be able to describe micro-encapsulation as the enclosure of something in very small spaces.

ENGAGEMENT

The Engagement phase is meant to interest the student, arouse curiosity, assess students' background and readiness, and set the direction for the lesson. During this phase of the lesson, the student is introduced to the topic of the lesson and is helped to make connections with what they already know and can do (Bybee, 1993).

1. Each group of students should have an assortment of scratch-and-sniff stickers (vary the scent, as well as the type of scratch-and-sniff sticker). The students should NOT scratch the sticker yet! (Assure the students that they will have the opportunity to scratch and sniff!)
2. The students should choose two or three stickers from the collection given to the group. Ask the students to spend a few minutes making and recording observations about the sticker.

Ask: What are some characteristics of the stickers? What colors do you see on the sticker? What are some of the pictures on the stickers? Do different types of stickers have different characteristics? How does the sticker feel? Is it rough or smooth? Is it dull or shiny?

Ask: Do you think you could identify the scent of the sticker based on your observations, without scratching the sticker? Do you think either the picture on the sticker or the color is a clue to the scent? Can you give an example? What other clues do you think you could use to identify the scent of the sticker without scratching it? Can you give an example?

3. The teacher wants the students to begin to think about the connection of visual clues in helping us to identify scents. Specifically, using the observable characteristics of the stickers as clues to identify the scent of the sticker.

Ask: Can you smell the scent of the sticker without scratching it? Why do you think they are called “scratch and sniff” stickers? What do you think scratching has to do with being able to smell the scent of the sticker?

4. Challenge the class to suggest how the scratch-and-sniff sticker is made, as well as generate questions they might have about the sticker.

5.

Ask: How do you think the sticker is made? How do you think the smell gets from the sticker to a person’s nose?

6. Students should draw a picture in their journals to show how they think the sticker “works.” The students should include in their picture in their journals to show they think the scent gets from the sticker to a person’s nose.

7. Ask several students to share their ideas about how the sticker is made and how the smell gets from the sticker to their nose. Ask questions that will encourage students to think about their theories. For example, if a student says that the heat from the scratching is responsible for the scent being released, ask what did they do to the sticker that made them think heat released the smell? Ask the student how he or she could find out if it is the heat? If a student says there is some kind of coating covering a layer of scent, and the coating is removed to release the scent, ask why they think there is a coating. Ask what evidence could he or she look for to demonstrate whether some type of covering exists? Ask students the basis for their theory, What did you see that made you think (insert the student’s theory)? Ask students whether they think it is possible that different stickers are made differently?

Transition

An important transition between the Engagement and the Exploration phases of the lesson provides the cognitive dissonance necessary for motivating the learner. The transition should be thought provoking and should be phrased in a way so that the learner needs more information to respond to the question. Thus, the learner has a reason to continue to be engaged with the rest of the lesson.

Ask: Why do you think the smelly sticker must be scratched in order to smell the scent? How do you think we could find out why the smelly sticker must be scratched in order to smell the scent?

EXPLORATION

Engages students in meaningful experiences relevant to the content of the lesson. Students acquire a common base of experience through direct exploration of the content of the lesson. Assures children’s thinking is engaged before ideas are sought (Harlen, 1996).

Ask: What do you think you might see if you used a magnifying lens to observe the sticker?

1. Each student should observe the sticker using a magnifying lens.

Ask: What does the sticker look like through the lens? What are some characteristics of the stickers that you noticed when looking through the magnifying lens? What do you notice if you look at the sticker from the side? (Students might say that they see dots or lines on the surface of the sticker. They may also say that they see bumps, or that the texture is different on different areas of the sticker.)

Ask: What do you think those dots/lines are? What do you think the shiny (or dull) part of the sticker might be? If the dull part is the scented part of the sticker, how could we find this out?

2. At this point, students might want to compare the scented stickers with non-scented stickers. Have several unscented stickers available for students to observe.

Ask: Does looking through the magnifying lens help you to identify the scent of the sticker? Now that you have observed the sticker through the magnifying lens, what additional detail did you notice? Did you find any evidence for your theory about how the sticker works? What evidence did you find? Has anyone changed their theory about how the sticker works? How has your theory changed? What did you observe that made you rethink your theory?

3. The students should modify their previous drawing about how they think the scented stickers work, based on any additional information they gathered by looking at the sticker through a magnifying lens.
4. Since students know that they can scratch the sticker to release the scent, allow students time to develop a plan and test their own theories about how the sticker works. If, for example, a student thinks that the heat is responsible for releasing the scent, the student could be encouraged to take an unscratched sticker and simply hold it in their hand, put it on a radiator, or place it under their leg while sitting, to see if the scent is released. If, as another example, the student thinks that only the lines (or the rough or smooth part of the sticker) are scented, they can be encouraged to scratch only that part of the sticker to see if the scent is released. Students should be guided through their explorations with the use of questions as much as possible.
5. At this point, students will need to scratch and sniff the stickers to continue to gather evidence for learning how scratch and sniff stickers work and how the scent travels from the sticker to their nose. Each member of the group should predict the scent of their stickers and record their predictions using the clues previously discussed. They can write a brief explanation of their prediction for each sticker. Once each member of the group has made his or her own prediction about each of the stickers, have the group discuss their predictions and the reasons for them. Now, students should scratch their sticker, and sniff! Students should record their findings. Allow time for students to identify, discuss, and compare the scents of the stickers, as some of the scents will not be readily apparent. Students will really want to identify the scent of their sticker before moving on with the lesson.
6. Each group should identify the scents of their stickers and describe the clues that they used in addition to the sense of smell.

Ask: Did the clues (ex. color of the sticker, picture or saying on the sticker) help to identify the scent? Which clues were more helpful in identifying the scent? Which clues were less helpful?

7. Help students establish the connection between the use of visual clues and identifying scents. Many students who will not be able to identify the scent of their sticker, will have a look of “Oh yeah, that’s it” once the scent has been stated by another student. The “big idea” that the teacher wants to establish is that while our sense of smell can and does work without our sense of sight, visual clues often help us to identify a scent. It is likely that the scent of a sticker with a picture of a slice of cherry pie was much more identifiable than the pineapple scent of a sticker with a picture of a frog.

EXPLANATION

Students share ideas based on their observations. Students explain their understanding of the concept(s) they are learning. Through carefully sequenced questions, the teacher helps to clarify students’ understanding by connecting the learning experiences to the concept (moving from concrete to abstract) and introducing any new concepts or terms.

1. Students should reexamine the scratched sticker using the magnifying lens and describe what they observe.

Ask: What happened after you scratched the sticker? Has the sticker changed since before it was scratched? What are some changes you observed?

Ask: Now that you have investigated your theory about scratch and sniff stickers, scratched the sticker and identified the scent, observed the sticker closely before and after you scratched it, what evidence have you found to support your theory about how the sticker works?

2. Students should refer back to their earlier description of what the sticker looked like through the magnifying lens and compare the “before and after,” including the fact that they could smell the scent after the sticker was scratched. Students might say that they see some of the dots/lines scratched off, or they have something under their fingernail. The teacher should ask questions based on the students’ theories and supporting evidence.
3. Ask the students to label their picture and summarize in writing their explanation of why they think the stickers need to be scratched in order to smell the scent.

Ask: What do you now think is the relationship of what you observed to how smelly stickers work? Why do you now think the sticker has to be scratched? How do you think the scent gets from the sticker to your nose?

4. Have students explain their ideas to the class so that other students who have had similar experiences can provide additional evidence and those students who have different experiences and ideas can provide other viewpoints. Once more, after listening to other students, each student should redraw their picture to explain how they now think smelly

stickers work and how the scent travels from the sticker to their nose. Students should compare these ideas with the ideas proposed at the beginning of the lesson.

5. The teacher should put the word “micro-encapsulation” on the board. Challenge the students to find familiar words within “micro-encapsulation” and to explain what they mean *in order to develop their own explanation for the word*.

Ask: Can you find a familiar word within the word “micro-encapsulation”? What does the root “micro” mean? Students will respond that “micro” means “very small.”

Ask: How small? Can you see something that is this size with just your eyes? Probe students with questions so that they think about the size of something that is described as “micro.”

Ask: What is a “capsule”?

Ask: Therefore, if we say that something is “micro-encapsulated,” what do you think that means? How do you think this word is related to the scratch and sniff stickers? Have the students explain the relationship of micro-encapsulation to the stickers.

6. The teacher can fill in the students’ explanation where needed by explaining that when the smelly substances are encapsulated on the surface of the scratch-and-sniff stickers, the smelly particles are for the most part sealed in and we cannot always smell them or we can only smell them a little (almost like when something is in a sealed container). However, once the sticker is scratched, the capsules holding the scent “pop” open and the scent is released (like opening the lid on the container).

Ask: Can anyone explain evaporation? (This assumes that students have some previously learned the concept). The teacher is looking for a simple explanation that evaporate means to change from a liquid to a gas.

Ask: What happens when you put perfume or cologne on your wrist? Does the perfume or cologne stay wet very long? What do you think is happening? (The perfume is evaporating, or changing very quickly to a gas. With scent molecules, evaporation, or the change to a gas, happens very quickly.)

Ask: Where do you think the gas molecules go? Once students establish that the gas molecules go “into the air,” the teacher can label this concept as diffusion, or the spreading out of molecules, in this case, the scent molecules through the air.

Ask: If someone you know is wearing perfume, do you have to get very close to the person to smell their perfume?

Ask: What do you think happens so that you can smell the perfume without having to get close to the other person? Or, what do you think is happening to the molecules so that you can tell what is cooking in the kitchen without having to see what is in the pot? If someone in your house is cooking, do you have to be in the kitchen or peek in the pot to know what is cooking?

7. At this point, the students should be able to explain that the gas particles of the scent quickly diffuse (spread out) through the air until they reach our noses. This is why we can smell the perfume or cologne or tell what is cooking without being right next to the source of the scent. The scent molecules diffused through the air.

8. Students should think about the temperature in each of these cases.

Ask: What happens when the molecules are heated, as they are when cooking or when they are applied to warm skin? (The molecules move faster so we are able to smell the scent more quickly and often more intensely.)

Ask: How do you think this is related to the role that heat plays in the scratch and sniff stickers? (The friction from rubbing causes the molecules to move quickly and therefore the scent is released quickly and smelled most strongly closest to the sticker.)

9. The teacher can use a sheet of bubble wrap filled with a scent extract to demonstrate micro-encapsulation (this is like looking at the surface of the smelly sticker through a very powerful magnifying lens).

Ask: What do you think the bubbles represent? What do you see on the inside of the bubbles? What state of matter is the scent on the inside of the bubbles? What happens when the bubbles are popped? What happens to the scent molecules? Why do you not have to hold the sticker to your nose in order to smell the scent? Again, the students should be able to explain that the scent is encapsulated in the bubbles, when the bubbles are popped the scent is released, the particles are diffused through the air, and we are able to smell the scent that is encapsulated inside the bubble.

ELABORATION

Students apply what they have learned to a new situation. They continue to build on their understanding of the concepts and use new experiences to extend their knowledge and skills (Bybee, 1993).

1. Students are shown a scented marker and a Magic Scent™ crayon.

Ask: Has anyone ever seen these two coloring tools? Can you explain what you have to do in order to smell the scent of each? What happens when you remove the cap from the marker? (The scent is embedded in the ink in the marker, so you can smell the scent as soon as you remove the cap.)

Ask: Is this what happened to the smelly stickers?

Ask: What about the crayon – can you identify the scent, simply by smelling the crayon? What do you have to do in order to smell the scent? What happens when you color? (You actually have

to color with the crayon in order to release the scent). How do you think this is like the smelly sticker?

Ask: Therefore, which coloring tool do you think shows micro-encapsulation? Why do you think it is either the marker or the crayon?

2. Students should write an explanation in their journal describing the reason(s) why they chose a particular coloring tool. They should also include how the scent gets from the coloring tool to their noses, to reinforce the concept of diffusion.
3. The students should be able to summarize the following. The scent in the crayon is encapsulated. When you color, you break open the scent pockets and the scent is released, allowing us to smell the scent of the crayon as it diffuses through the air. This journal entry can be used as an assessment of student understanding of the concepts.

EVALUATION

Students assess their own knowledge, skills, and abilities. Teachers can use the outcomes to evaluate students' progress.

1. Students create and act out the process of the scent getting from a smelly sticker to the nose. The enactment should include the scent being encapsulated, the capsule being broken open to release the scent, and the scent diffusing through the air and ultimately traveling to a "nose."

The cycle continues

The cyclical nature of the learning cycle indicates that each lesson should build in a spiral continuum to the next lesson. Therefore, the next lesson deepens student understanding of how the brain actually identifies the scent. Now that students can explain how the scent gets from an object to our noses, next, the students learn what happens when the scent molecules actually enter our noses and trigger the smell receptors to identify the scent.

Conclusion

The lesson, "The Nose Knows," was designed to model the use of a learning cycle and questioning to facilitate student construction of knowledge. The teacher's use of questions guide the students toward understanding the concept. Key points that summarize the use of questions within a learning cycle model include:

1. Plan specific questions.
2. Talk less, ask more – make the questions count.
3. Try to use questions that yield more complete and more complex responses.
4. Ask different types of questions to encourage all children.

Teachers' questions provide a model for students as they engage in inquiry. The more comfortable and more proficient a teacher becomes at asking questions, the more students will be

encouraged to follow their lead and ask their own questions, leading to student inquiry. What could smell any sweeter?

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