Action Research Project

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Abstract

This action research project was aimed at understanding what first graders’ know about the tooth structure of herbivores and carnivores, and scientific models, and how our inquiry-based instruction impacts their knowledge. It is our goal to add to the limited research base of the teaching community on the chosen topics. Our research began with an observation of a science lesson taught to this first grade class. Next, we studied research on our chosen topic. We then conducted a pre-assessment of 20 first grade students in an effort to understand students’ prior knowledge. After analyzing data from the pre-assessment we confirmed students’ lack of knowledge about the “big idea” of models and their misconceptions about tooth structure. Next, we taught two inquiry-based lessons, one about models and the second about tooth structure. In order to understand how our teaching impacted student knowledge, we conducted a post-assessment a few days following the second lesson. Post-assessment data revealed that our instruction greatly improved student understanding of models. In the pre-assessment, not even one student answered the two questions about models correctly. On the post-assessment, 61% could identify models and 61% gave partially correct answers describing why models are used. This was a great improvement considering these were first graders with no understanding of models. Unfortunately, not as much progress was made in improving misconceptions about tooth structure. When comparing pre and post assessment results, there was only a 5%-10% improvement in student understanding of tooth structure. We concluded that even very young students have the ability to learn about models and benefit from inquiry-based lessons.
As part of our student teacher education at University of Michigan-Dearborn, our team participated in action research using the “big idea” of scientific models as a tool for effective teaching. A model is a representation of a concept, object, or function that is intended to assist in the understanding of its target. Models are used in every science discipline; however, classroom use and instruction of models is lacking. According to the National Science Education Standards, learning about models is one of the “unifying concepts and processes” that all students must encounter in the classroom (National Science Education Standards, 1996). Furthermore, in the article, “Models and Modeling: Routes to More Authentic Science Education”, Gilbert proposes that “models are essential to the production, dissemination, and acceptance of scientific knowledge” and connects this idea to the classroom where he explains that using models promotes “authentic” science education (Gilbert, 2004, p.116). Authentic learning allows students to be the scientists, not just learn about science. In order for models to be effective in learning science concepts, it is necessary for all students to understand the importance of using models, as well as learn about the limitations of models.

Our team proposes that even young children will have a more meaningful science learning experience from analyzing and using models. As part of our action research, we worked as a team to complete a five-step process of observing, pre-assessing, teaching two lessons, and post-assessing. This was an on-going process throughout the entire semester. Refer to Appendix A to view time schedule.

In order to stay focused on our research goal, we formulated our action research question: What do first graders know about the tooth structure of herbivores and carnivores and scientific models, and how does our inquiry-based instruction impact their knowledge? Next, we conducted research to decide on a topic and create an effective pre-assessment. According to the
Michigan Grade Level Content Expectations (GLCEs) (Michigan Department of Education, 2010), first grade students are required to develop an understanding that animals can be classified by observable physical characteristics, as well as identify the needs of animals. We felt that studying animal teeth was an effective way to guide students to these understandings, as well as provide a simplistic understanding of scientific models. In order to study teeth, it is not practical to bring in a cow or a tiger, and have students examine the animals’ teeth. Therefore, we will need to use models to gain an understanding of the different shapes of teeth and how the shapes allow animals to eat the food they need for survival.

Unable to find evidence of research about our exact topic, we decided to focus our research on the types of questions we will ask during the pre-assessment. We discovered that open-ended questions, specifically “probing” questions, would fulfill two of our pre-assessment goals: understanding student thinking and engaging the students in the topic itself. Keeley (2010) finds, “Probing informs the teacher about appropriate next steps for instruction and engages students in thinking about their own ideas (p. 27).” Since we were working with a group of first graders who knew nothing about models (as related by their classroom teacher) we decided to expand on Keeley’s findings by noting the impact these probing questions had on student learning with regard to animal teeth and models. We noted student responses to questioning during the lesson, as well as used the post-assessment data, to make inferences about the impact of our instruction.

Martin (2005) provides further insight about successful questioning; he describes the importance of choosing questions that will promote divergent thinkers rather than fact givers. Martin (2005) makes the point that scientists of the past, like Copernicus and Galileo never would have discovered so much were it not for their own divergent thinking. Martin (2005)
explains that, “divergent questions encourage a wide range of answers without concern for a single correct answer (p. 21).” We had decided to use these questions in our pre-assessment, lessons, and post-assessment. Since we were working with a very young group, with most students being age 6-7, we wanted to expand on Martin’s research to see if that young group would also benefit from divergent thinking.

Since our goal was to teach about models and our first grade group of students had limited knowledge about models, we used previous research to help us integrate models in an effective way. One type of model that had been found to be useful with younger children is the analogous model. Glynn (2007) describes a systematic technique to use analogous models. Glynn’s (2007) technique includes introducing the target concept, reminding students about what they know of the analog concept, identifying relevant features of the target and analog model, connecting the similar features in a map, and indicating where the analogy between the target and model breaks down, and drawing conclusions. Since analogous models have been found to work well with younger students, we used this type of model in our lessons. Glynn’s (2007) guide provided a context in which students could learn about animal teeth and about scientific models. We decided to expand on this research by also using analogous models to teach about models themselves. Furthermore, we were able to identify how well this age group, in particular, was able to understand and use analogous models.

Our first step of the action research process was to observe our intended research group in their classroom setting. We wanted to understand how they typically learn about science and we wanted to become familiar with the students and classroom setting. We conducted our action research at Miller School located in East Dearborn, Michigan. The classroom we were using for our action research project was a first grade classroom. Due to the design of the classroom, we
inferred that this class was familiar with working in groups. There were three groups of six students and one group of two students. While the science instruction was being conducted, three students from special needs were integrated into the classroom. A paraprofessional instructed these students separately during written work. A carpet lay in front of a chair which the students and teacher used for class discussion. The teacher used this area for reading, showing things at a closer view, and for student/teacher communication. Below is a map showing a physical image of the classroom.

The classroom consisted of 23 students; 14 boys and 9 girls. Most students were of Middle-Eastern decent, with about 2/3 being bilingual (according to the teacher). According to greatschools.net, 84% of the school is eligible for free lunch. This data shows that low income families attend the school. With this information we inferred that some of the materials needed for the students in their curriculum may not be available. The teacher had informed us that science kits were rotated between classrooms; in addition, teachers usually collected or bought some of their own supplies. Science inquiry depends on supplies and without the correct materials, student discovery is challenging. Furthermore, due to their low income level, it is
likely that these students do not participate in extracurricular science discovery, such as visiting the science museum, discovery camps, and cable television programs related to science.

We were disappointed with the passive role of students during our classroom observation. The teacher started out the lesson by asking students close-ended questions to learn about students’ previous knowledge related to the topic-The Sun. The teacher then read a big book about the topic out loud to the class. The teacher asked the students questions about the facts in the book and wrote the correct answers on the board. Many students were not involved in the discussion and appeared unengaged. If a student gave a wrong answer the teacher would move on to another student until the correct answer was given. After a 15 minute discussion, students returned to their desks to work on a recall based writing activity for the remainder of the period.

The science curriculum in this classroom was based on the McGraw/Hill Science trade books. We concluded from our observation and through a discussion with the classroom teacher that inquiry-based learning is not the teaching method used in this classroom. Life, Earth, and Physical Science are covered in this first grade classroom. Life Science pertains to how plants are living and growing and all about animals and their homes. Earth Science covers taking a closer look at the Earth; how to take better care of it, the weather, and the sky. Matter, motion, and energy are discussed during Physical Science. Due to the scheduling of Life Science during the time period of our lessons, we decided to focus our research project on this topic.

Our pre-assessment was focused on the topic we wanted students to understand: how an animal’s tooth structure is related to the food eaten, as well as an understanding of the concept of a scientific model. We were not confident that simply allowing students to fill out a worksheet would give us all the students’ understanding we needed to know. So, we decided that our pre-assessment would be in two parts. Part one was the students filling out a handout and the second
part was us interviewing six students from different achievement levels (the teacher chose the students).

For the first part of the pre-assessment procedure, the students completed the handout. This gave us a visual of student knowledge of animal teeth and the food eaten, their ability to identify a scientific model, and an idea of their drawing and writing skills. The handout was shown on an overhead for the whole class to view. Each student received their own handout to fill out. We read the directions aloud and pointed out questions on the overhead. We developed our questions to cover three concepts. The first question asked students to draw the teeth and food corresponding to the represented animal (cow and tiger). The answers of these questions told us whether they knew the different types of animal teeth (sharp and flat), and if they associated it with the related food the animal eats. This answer was rated as correct or incorrect for each of the four drawings. The students were to draw flat teeth and plant type food for the cow, and draw sharp teeth and meat type food for the tiger in order to be correct. The second question asked students to identify a scientific model. Three object names were given in a list format. Students were to draw an X next to the object given (book, doll, or toy truck) if it represented a scientific model. This question showed us if the students knew what objects were considered to be scientific models. This answer was rated as correct or incorrect. To be correct there needed to be an X next to the doll (target baby) and toy truck (target truck) representing them to be scientific models. The third question asked for a written description of a scientific model.

The data from this showed us if they could define, explain, and truly understand what a scientific model is. It also gave us an idea about their ability to communicate through writing. Many times students have the knowledge but can’t put it into their own words. In first grade we
did not expect them to know every aspect of scientific models. In first grade they should know that models are similar and different from the target object. They did not need to use this vocabulary; they simply needed to explain something similar in their own words. Their answers were analyzed on a five level scale (1-don’t know, incorrect response, or no response, 2-gave an example, 3-only mentioned one of three ideas about models identified in scale 5, 4-partial response, and 5-full Response-identified models are similar and different from target and used by scientists to understand things about the object it represents). We wanted at least three fourths of the class to understand each concept. From the analysis we would be able to better understand what concepts to introduce first in our lessons.

For the second part of the pre-assessment we interviewed students. Students were interviewed alone so that students would not influence each others’ responses. Four questions were asked. The first question asked if the student’s teeth were different than a tiger’s teeth and the second question probed them to explain their reasoning. They needed to come up with the idea in both their responses for questions 1 and 2, that a tiger’s teeth are sharp and we have teeth that aren’t sharp. Another possible answer may be that we have some sharp teeth so ours are similar to a tiger’s teeth. As long as the child identified sharpness in a tiger’s teeth and that it is because he eats meat, then this was considered to be a correct response. A scale of 1 to 3 was used for questions 1 and 2 (1-don’t know, 2- identified that tiger’s teeth are sharp, 3- identified that tiger’s teeth are sharp because a tiger eats meat). For question number 3, students were asked how scissors are like teeth. Students were expected to identify that scissors cut things into smaller pieces or something to that effect. This understanding is important because students should be aware that teeth perform this function. Furthermore, we wanted to see if these students could identify with analogous models. Students could also say that scissors are like our teeth
because they are sharp. This was also accepted as correct. As long as they stated a common characteristic or function, their answer was considered correct. The fourth question was telling us more about student understanding of models and their role in science. The question asked, “How can a scientific model help us learn about teeth?” A correct response to this would be that the student understands that a model tells us something about the characteristics of teeth. For example, a correct answer would state: A model can show us the shape of the teeth” or “a model can show us how teeth work”. We identified similar responses and grouped them according to their similarity to the correct answer. The interview data gave us an understanding of the whole class knowledge. We used this data alongside the individual worksheet to identify the content and direction of our first lesson. Refer to Appendix B for the pre-assessment documents.

In creating the pre-assessment questions, we used pre-existing research as a guide. This research helped us create the handout as well as the interview questions. For the handout our research was based upon two articles, “Does it have a life cycle?” by Paige Keeley (2010) and “Visual formative assessments: The use of images to quickly assess and record student learning” by Gary Aylward (2010). We used the justified list along with a rule or reasoning as Keeley (2010) recommends. Keeley (2010) presents her questions in the form of a justified list about objects that have a life cycle and then asks a question to describe the rule of reason to decide if an organism had a life cycle. In our pre-assessment we used a justified list to pose a question about which objects were considered to be scientific models. According to Keeley (2010), “The justified list is used to check off all the objects that fit a particular statement and the rule or reasoning is the part of the probe that allows you to get into your students’ heads and examine their thinking” (p. 27).
Our decision to use visual response was based on Aylward’s (2010) studies using a visual formative assessment to determine student knowledge about the planets in our solar system. He created a visual response grid and had the students draw pictures of their responses in the circles. Similarly, the students in our research project were asked to draw the animals’ type of teeth in the circle and the animals’ type of food it eats in the square. Aylward (2010) says, “Diagrams and sketches help identify students’ misconceptions in a quick and effective format” (p. 42). We also talked to a few students individually about the pre-assessment. Aylward (2010) writes, “It is necessary to engage in a conversation with a student (or class) and tailor instruction to the answers that the students give” (p. 42). The visuals and written answers were then matched up to what the students said orally.

For the student interview, we used, “The Teaching-With-Analogies Model” (2007) and “Teaching Science for all Children: An Inquiry Approach” (2005) to guide our pre-assessment. Martin (2005) describes the benefits of questioning tools used by John Langrehr, a cognitive psychologist and conductor of educational research. Langrehr recommends choosing question starters carefully. He has come up with 16 question starters that have been found to better stimulate student thinking and questioning (Martin, 2005, p.253). Each question starter is designed to stimulate a different kind of thinking from the following categories: Object/event, Situation, Reason, and Means (Martin, 2005, p. 254). For the interview, we chose question starters from Langrehr’s list. As part of the interview, there were five questions altogether, four of which gave us clues about student’s prior knowledge of tooth structure, and two of which told us about how students think about models.

Since we intended to use analogous models in our lesson, we included a question on the interview that used an analogy model. Our goal was to find out first grade students’ abilities to
use “mental models”. According to Glynn (2007), analogies models greatly assist students in forming, “limited but meaningful understanding of complex concepts” (p.52). Glynn (2007) also makes the point that some students may not be familiar with the analog concept and this will pose a problem during teaching (p. 53). For this reason we had chosen to include a question on the pre-assessment to assess these first graders’ understanding of analogy concepts. The question asked students how teeth are like scissors. As long as they made a reasonable connection, we were satisfied that they were familiar with analogous models.

Based on our data analysis of the handout and interview pre-assessment, we have concluded that students do not have a firm understanding of models, nor of the relationship between animals’ teeth and the food they eat. Figure 1 shows the raw data from the student answers to the handout and how they were analyzed. Table 1 shows an overall graph of student achievement.

Figure 1

1. Draw the kind of teeth for a cow.

<table>
<thead>
<tr>
<th>Correct – 18 responses</th>
<th>△ △ △</th>
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</thead>
<tbody>
<tr>
<td>Incorrect – 2 responses</td>
<td>○ ○ ○</td>
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<td></td>
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</table>

2. Draw the kind of food for a cow.

<table>
<thead>
<tr>
<th>Correct – 20 responses</th>
<th>Drew or wrote grass</th>
</tr>
</thead>
</table>

3. Draw the kind of teeth for a tiger.

<table>
<thead>
<tr>
<th>Correct – 17 responses</th>
<th>△ △ △</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incorrect – 2 responses</td>
<td>△ △ △</td>
</tr>
<tr>
<td></td>
<td>○ ○ ○</td>
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</tbody>
</table>

4. Draw the kind of food for a tiger.

| Don’t know – 2 responses | |
|--------------------------| |
| Incorrect – 8 responses | Drew grass  
|                        | Drew people |
| Correct – 10 responses | Wrote meat  
|                        | Drew animals |

5. Put an X next to each object that is a scientific model.

| Incorrect – 20 responses | Chose every object.  
|                         | Chose just book.  
|                         | Chose book and truck.  
|                         | Chose truck.  
|                         | Used checks and xs. |

6. What is a scientific model?

<table>
<thead>
<tr>
<th>Don’t know – 2 responses</th>
<th></th>
</tr>
</thead>
</table>
| Incorrect – 17 responses | Work to do.  
|                         | Something that moves.  
|                         | Gave examples (animals, books, toys). |

Table 1

![Pre-assessment Handout](image)

For questions 1-3 an average of 90% (n=18) of students knew what kind of teeth a cow had and what it ate and also what kind of teeth a tiger had. For question 4 only 50% (n=10) knew what a tiger ate. Models presented the greatest challenge for students, with 0% (n=0) of the students being able to identify or know what a scientific model is (question 5 and 6).

The second part of the pre-assessment was the interview with individual students. Figure 2 shows the raw data from the students and how their answers were analyzed. Table 2 shows an overall graph of student achievement.
Figure 2

1. Are your teeth different than a tiger’s teeth?

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<table>
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<tbody>
<tr>
<td>(1) – 0 responses</td>
<td>No response</td>
</tr>
<tr>
<td>(2) – 6 responses</td>
<td>“Yes”</td>
</tr>
<tr>
<td>(3) – 0 responses</td>
<td>“No”</td>
</tr>
</tbody>
</table>

2. Why are your teeth different than tigers’ teeth?

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<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>(1) – 1 response</td>
<td>“They are like that.”</td>
</tr>
</tbody>
</table>
| (2) – 5 responses | “Tiger gots sharp teeth and we don’t gots sharp teeth.”  
| | “Because a tiger’s teeth are sharp, but mine is not.”  
| | “Because mine are the shape of a square.”  
| | “Ours are a little bit small.”  
| | “A tiger…he like eats animals. We don’t eat animals, he does.” |

3. How are scissors like teeth?

One child asked to skip the question.

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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) – 1 response</td>
<td>“The scissors are like teeth.”</td>
</tr>
</tbody>
</table>
| (3) – 4 responses | “Because they cut stuff”  
| | “Cause they’re sharp”  
| | “They are sharp”  
| | “Strong” |

4. How can a scientific model help us learn about teeth?

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
</table>
| (1) – 2 responses | I don’t know  
| | “When you try to read and then if you get one mistake you go back and read it.”  
| | “Maybe because you can make a school and then go to the school and learn.”  
| (2) – 4 responses | “They can tell us about teeth. What teeth they have.”  
| | “Tell us about it.”  
| | “They look at teeth and see stuff inside of them and know about teeth.”  
| | “Shows us the teeth” |
For question 1, 100% (n=6) of the students answered that a tiger’s teeth are different from humans. However, responses for question 2, 83% (n=5) of the students could identify a difference in tooth structure but could not make the connection that a tiger’s teeth are all sharp because tigers eat almost all meat for their diet. For question 3, our main goal was to understand if students had the ability to think about analogous models and 66% (n=4) did understand that teeth are sharp like scissors. We found on question 4 that about 67% (n=4) gave a partially correct description of how a model can help us learn about teeth.

Since both pre-assessment analyses produced evidence that students know the least about models, we decided to use the first lesson to teach about models. According to the American Association for the Advancement of Science Benchmarks, by the end of second grade students should know that a model of something is different than the real thing and can be used to learn something about the target. They should also be able to describe how it is and isn’t like the target. We also used an inquiry-based method to teach both lessons. We believed using the 5E’s (engage, explore, explain, extend, and evaluate) would allow students to learn these scientific concepts in a meaningful way so that we would have a positive impact on their knowledge.

For the first lesson students worked in groups observing three objects; one object being the actual real thing and the other two objects being models of the real object. Students studied
their objects and decided how they were similar and different and described how the models could help them learn something about the real thing. Refer to Appendix C for lesson one.

The pre-assessment also advised us that students did not understand the relationship between animal teeth and their diet. We wanted to develop this understanding by using models to help students understand their use. For lesson two students used models to identify the needs of animals. According to the Michigan Curriculum Frameworks for science first graders need to be able to identify the needs of animals. Animals need flat teeth to eat plants and sharp teeth to eat meat. Students explored with models to identify that flat teeth grind and sharp teeth cut. Students used a block of wood to represent flat teeth grinding broccoli, apples, and parsley, and a staple remover representing sharp teeth to cut bologna and ham. By the students using both concrete and functional models we expected students to understand the shape of animals’ teeth and how the shape determines what an animal eats. Refer to Appendix D for lesson two.

After the lessons were completed we wanted to determine how our instruction impacted their knowledge. We had the students complete a post-assessment. The post assessment was similar to the pre-assessment, with the exception of a few details. We decided to reword some of the questions but use the same format and test the same concepts for our post-assessment handout. The animals that we used in the post-assessment for the students to draw the teeth and food were a horse and lion. The same concept was being tested to determine if the students related the type of animal teeth to the type of food an animal eats. We changed the animals so the two tests wouldn’t be as repetitious since the students did so well with the cow and tiger in the pre-assessment. The second main topic question was to check off the objects that are considered models. We changed the objects to “a picture of a car”, “a real car”, and “a toy car”. When we taught this lesson we encouraged students to think about how models are similar and
different from the real thing. So, rather than changing object categories (as in the pre-assessment), we questioned about only one category being a car. For the last question of the post-assessment we asked, “Why are scientific models used?” With the pre-assessment we had asked, “What is a scientific model?” and the students were identifying objects. We wanted to focus more on whether or not they understood that models are used to learn about the real thing. During the post-assessment we placed dividers between students so that they could not view each others answers. For the post-assessment we did not use the individual interviews because we felt the questions on the handout would be efficient in determining student thinking. We decided instead to ask students to clarify their answers on the worksheet when answers were incomplete or unclear. Refer to Appendix E for the post-assessment.

In our comparisons of the pre and post assessments, we found that students improved greatly in identifying models and had some improvement in the understanding of why models are used. With regard to the lesson about animal teeth, although we observed much student engagement and learning during our lesson discussions, we did not find much improvement in students’ understanding of the relationship between animal teeth and their diets. Figure 3 shows the raw data from the students and how their answers were analyzed. Table 3 shows an overall graph of student achievement.

Figure 3

1. Draw the kind of teeth for a horse.
   
   **Correct – 18 responses**

   |   |   |   |

2. Draw the kind of food for a horse.

   **Correct – 17 responses**
   Drew or wrote grass

   **Incorrect – 1 response**
   Wrote meat

3. Draw the kind of teeth for a lion.

   **Correct – 17 responses**

   |   |   |   |
4. Draw the kind of food for a lion.

<table>
<thead>
<tr>
<th>Correct – 10 responses</th>
<th>Incorrect – 8 responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wrote meat</td>
<td>Drew grass</td>
</tr>
<tr>
<td>Drew animals</td>
<td>Drew people</td>
</tr>
</tbody>
</table>

5. Put an X next to each object that is a scientific model.

<table>
<thead>
<tr>
<th>Correct – 11 responses</th>
<th>Incorrect – 7 responses</th>
</tr>
</thead>
</table>
| Chose “a picture of a car” and “a toy car” | Chose two options one being “a real car” 
| Chose all three options | Chose just “a real car” |

6. Why are scientific models used?

<table>
<thead>
<tr>
<th>Correct – 1 response</th>
<th>Partial correct - 11</th>
<th>Incorrect – 5 responses</th>
<th>Don’t understand – 1 response</th>
</tr>
</thead>
</table>
| Learn about real stuff | So we do not need the real thing. 
| See what it is and looks like. | Learn about them and become smart. |
| Know how to do it. | So we can know about them. 
| Can be used again. | Learn make teeth. 
| Use and ask questions. |

Don’t understand – 1 response

Table 3

The average of correct answers in questions 1-3 for the post-assessment was 95% (n=18).

Question 4 had an average of 55% (n=10) for the post-assessment. Students seem to have
knowledge about what kind of teeth an animal has and if the animal has flat teeth it eats plants but if an animal has sharp teeth some continuously struggle to know they eat meat. Students improved in identifying whether an object is a model or not (question five: 61% (n=11)). Students improved on question six but not by giving an exact correct answer but by giving a partial correct answer. For the post-assessment 6% (n=1) gave a complete correct answer and 61% (n=18) gave a partial correct answer.

Based on our comparison of pre and post assessment data, first graders’ knowledge of tooth structure and models can be improved using inquiry based lessons that utilize models as a learning tool. Student knowledge of models improved 61%. This is a great improvement considering this was achieved in only one lesson and with such young learners, ¼ of which are differently-abled learners. In fact, many of these special needs students were among those showing great improvement. Our research builds upon studies (Glynn, 2007; Gilbert, 2004) about the benefits of students’ using models to learn about science concepts. Our research shows that even with very young students, learning about and using models is effective in improving student learning. In both the lessons about models and the lesson on tooth structure, student learning improved.

The post-assessment data showed only slight improvement in student understanding of tooth structure and animals’ diets. Before our lesson, 90% of students knew the diet of a cow (herbivore) and a tiger (carnivore), after the lesson, 100% of students had this knowledge. However, before the lessons only 50% could identify meat as a tiger’s main diet. After the lessons, 55% could identify this fact. We believe that the lack of efficient time for student exploration and explanations, along with the young age of the group under study, were contributing factors in only minimal improvement in addressing student misconceptions.
Previous research (Martin, 2005; Keeley, 2010) shows the benefit of divergent thinking in science lessons with older students; our research builds upon this by including divergent thinking as beneficial for students as young as 6-7 year olds. During both lessons, we used open-ended questions and had students explore using models to answer these questions. Reflecting on our research project, we realize our error of missing the opportunity to assess one important aspect of student learning, the relationship between animal diet and tooth structure. We later realized that students could have identified the type of teeth and diet of the animals based on prior knowledge, not because of the connection between diet and teeth. We made the connection during our lessons; however, our assessments did not include a question aimed at accessing student knowledge about this relationship. For future studies we intend to include this in our assessments. Perhaps this can be achieved by using a made up animal and telling the students that it eats meat and then have students draw the tooth structure. Based on our experience with student answers to discussion questions during the lessons, I believe students did benefit from both the open-ended questions and the inquiry-based lessons. Even with our mistake, our research is of value in that it proves the worthiness of using models and teaching about models with young students. Through this action research we learned that students know very little about models and that our inquiry-based lesson have a significant impact on their knowledge. We believe students would benefit from further exploration. Furthermore, more effective assessment questions would give us a better idea of whether students truly understand the connection. We hope to conduct further action research with improvements in the future.
References


## Time Schedule

<table>
<thead>
<tr>
<th>Date</th>
<th>Reason For Visit</th>
<th>Responsible Party</th>
</tr>
</thead>
</table>
| Feb. 17, 2011  | Observation       | Amy Smart
                | Terri Alt            |
| March 18, 2011 | Pre-assessment    | Terri Alt
                | Amy Smart            |
| April 5, 2011  | Lesson One        | Amy Smart
                | Terri Alt            |
| April 8, 2011  | Lesson Two        | Terri Alt
                | Amy Smart            |
| April 12, 2011 | Post-assessment   | Amy Smart
                | Terri Alt            |
Appendix B

Name____________________________________Date____________________

Draw the kind of teeth each animal has in the circle. Draw the kind of food each animal eats in the square.

Put an X next to each object that is a scientific model.

_____ Book

_____ Doll

_____ Toy Truck

What is a scientific model?

_____________________________________________________________
Questions for Interview
(Teacher writes student answers in space provided)

Student Name____________________________________     Date_____________________

1. Are your teeth different than a tiger’s teeth?

2. Why are your teeth different than a tiger’s teeth?

3. How are scissors like teeth?

4. How can a scientific model help us learn about teeth?
Appendix C

GRADE LEVEL: 1st grade

SCIENCE CONCEPT: Models

NSSES CONTENT STANDARD,K-4:

- A model of something is different from the real thing but can be used to learn something about the real thing. 11B/P2 (2061, 1994)
- One way to describe something is to say how it is and isn't like something else. 11B/P3 (2061, 1994)

DESCRIPTIVE OBJECTIVE

Students will investigate to determine how models are similar and different from the real thing. Students will investigate to describe how a scientific model can be used to learn something about the real thing.

MATERIALS

Non-transparent bags—one per group

White paper—one per group

Power point presentation (includes alien pictures and pictures of scientists using models in their areas of study).

Plastic egg
Hard boiled white egg
Picture of an egg

Real Phone
Toy phone
Picture of a phone

M&M candy
Drawing of M&M candy
Construction paper M&M

A plant or flower
A fake plant
Picture of a plant

rock
plastic toy rock
rock candy

water bottle filled halfway with water
picture of a wave
paper weight with liquid inside that can be moved to create a wave

(Evaluate: A real fish
A toy fish with a moving tail
A rubber fish
An X-ray picture of a fish
A storybook with a fish)
CLASSROOM SAFETY

Remind students not to eat any of the objects.
Remind students not to touch the fish.

ENGAGE

Teacher should pass out a bag to each group and instruct students not to touch the bag. A picture of an alien can be shown on an overhead while the teacher explains to the students that an alien has landed in our classroom and needs our help. As he was walking around town he collected some items he has never seen before and put them in these bags. He placed the objects that he thought were the same in each bag. He now wants to take them back to his home. Before he takes them back, he wants to know if they are all the same thing or if they are different.

Teacher should ask students how they can help this alien. Teacher should lead students to the proposal that they (the students) can see what is in the bags and decide if these objects are similar or different. If students are not forthcoming with this solution to the problem, teacher should lead students by asking questions. For example, the teacher may ask, “Do we need to know what is inside the bags to know if the objects are the same or different?” This questioning technique should be used until students come up with the idea that they will view objects and decide for the alien.

Teacher should instruct students that the alien will not believe them unless they provide evidence. Teacher should explain to students that they must explain to the alien why these are or are not the same by giving examples. Teacher should remind students that this alien wants to return home to his planet of Wahoo with these items and needs to know what to tell his leader about these things. Teacher asks the question, “What makes these items the same and what makes them different?”

EXPLORE

1. Students should look at each object and discuss the similarities and differences.
2. Students should conclude whether or not the objects are the same or different than the real thing and discuss how and why they are the same or different.
3. Students should record their evidence by classifying their objects into groups. They should be given one empty paper per group to record their evidence and classify objects.

EXPLAIN

1. Students will come together as a whole class and present their findings.
2. The teacher will guide the student discussion so that students understand that the models are like the real thing in some ways, but not in every way.
3. Teacher should write the word model on the board and explain that scientists call objects that are like the real thing in some way, “scientific models” or we can refer to them as just “models”.
4. The teacher should restate the main idea that models are like the real thing, but not exactly, by using the students’ evidence as an example.

EXTEND

1. Teacher should ask students if they have ever seen an x-ray. Teacher should show students an x-ray and ask students how this model is like the real thing.
2. When students discover that it is the same in some ways, but different in others, teacher should ask how this x-ray helps doctors learn about the real thing.
3. Students should discuss this as a whole class. Teacher can write key ideas on the board.
4. Teacher can show a few power point slides of scientists using models in their area of study.

PERFORMANCE ASSESSMENT

1. Hold up a real fish tank with a fish swimming. Show students different models of fish—a toy fish with a moving tail, a picture of a fish in a storybook, an x ray picture of a fish, or a rubber fish.
2. Students should be told that the alien cannot take a real fish home with him, but he wants to take something that will teach his alien friends about how some fish move. Have students vote on which model the alien should take home. Select a few students to provide their reasoning for their choice. Wrap up by thanking the students for their help.

References

2061, P. (1994). *Benchmarks for science literacy*. Oxford University Press, USA
Appendix D

GRADE LEVEL: 1st grade

SCIENCE CONCEPT: Animal Tooth Structure

GLCES
S.IP.01.13 Plan and conduct simple investigations.
S.IA.01.13 Communicate and present findings of observations.
L.OL.01.13 Identify the needs of animals.

DESCRIPTIVE OBJECTIVE

Students will describe the shape of animal teeth.
Students will investigate how the shape of teeth determines what an animal eats.

MATERIALS

Pieces of wood
Staple remover
Pepperoni Slices
Halal meat
Broccoli
Apple slices
Parsley
(Extend: Picture of a human’s teeth)
(Performance Assessment: Picture of animals, pictures of food, clay)

CLASSROOM SAFETY

Remind students not to eat any of the objects.
Remind students to be careful with the staple remover and only use it on the objects provided.

ENGAGE

Ask the students why humans and animals have teeth to begin the students’ brainstorming about teeth. Tell the students that you want them to take their tongue and rub it against all their teeth. What are some of the different things that you noticed about your teeth? The teacher will write on the board the description that the students say. Then ask why they think the teeth are different. The teacher asks all open ended questions in order to see the students’ previous knowledge. To begin the investigation the teacher asks, “How does the shape of animals’ teeth help to make food into smaller pieces?”
EXPLORE

1. Students should look at the wood and staple remover to investigate how these objects could make food into smaller pieces.
2. The teacher should walk around the room posing questions for the students to think critically about how the wood and staple remover models the shape of animal teeth.
3. Teacher should have the students’ think of the process they are performing to make the food into smaller pieces.
4. Students should record their evidence by grouping the food together with the process tool they used to make the food into smaller pieces. They will record this information on a chart.

EXPLAIN

1. Students will come together as a whole class and present their findings.
2. The teacher will discuss that we cannot see inside an animal’s mouth to see how the teeth work so we used models to represent the teeth shape. Teacher can ask questions to guide students to the understanding that the wood models flat teeth and the staple remover models sharp teeth. Remind students that models help us learn something about the real thing.
3. The teacher will relate the students’ findings to having flat teeth like the wood they could grind the broccoli and apple slices like an animal with flat teeth would grind plants. Show pictures of animals that have flat teeth.
4. The teacher will relate the students’ findings to having sharp teeth like the staple remover they cut the halal meat and pepperoni slices like an animal with sharp teeth cuts through meat. Show pictures of animals that have sharp teeth.
5. Summarize that you can tell what an animal eats by knowing what type of teeth it has.

EXTEND

1. Show the students a picture of the structure of a human’s teeth. Don’t tell the students that it is a human’s mouth.
2. Ask them what type of teeth they see and what food it suggests they eat.
3. Students should conclude that with these types of teeth it can eat both plants and animals.
4. Ask students if they know of anything that eats both plants and animals.

PERFORMANCE ASSESSMENT

5. Give each student a picture of an animal.
6. Give each student a picture of a meat and a plant.
7. Have the student match the correct food picture to the animal.
8. Have each student make a model of the teeth with clay to represent the type of teeth the animal would have.
References


Appendix E

Name ___________________________ Date __________________

Draw a scientific model of the kind of teeth each animal has in the circle. Draw the kind of food each animal eats in the square.

Put an X next to each object that is a scientific model.

_____ A picture of a car

_____ A real car

_____ A toy car

Why are scientific models used?

________________________________________________________________________

________________________________________________________________________