Prior Knowledge Investigation

Teachers often focus on the concepts they want their students to learn. However, research has shown that a student's prior knowledge often inhibits a teacher's best efforts to deliver the concepts correctly (Jones, Tordova, & Vargo 2000). A student’s prior knowledge is one of the strongest factors influencing educational achievement (Jones, Tordova, & Vargo 2000). The research piqued my interest in seeing how students’ prior knowledge affected their learning in my own classroom.

For my prior knowledge investigation, my cooperating teacher suggested that I create a lesson on genetic engineering. Genetic engineering is a very new field in genetics, and my teacher stated that this was the first time that a whole chapter had been devoted to it in the students’ biology textbook. Additionally, my teacher thought that the students in his 10th grade general biology classes would not have any prior knowledge on the subject area. Contrary to his belief, my interview with three students in one of his biology classes produced interesting information on what the students knew about genetic engineering. My questions and the students’ answers were as follows:

<table>
<thead>
<tr>
<th>Questions</th>
<th>Students’ Answers</th>
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<tbody>
<tr>
<td>What is genetic engineering?</td>
<td>Student 1: “Putting traits together”</td>
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<td>Student 2: “Engineers building stuff...so it’s like the building of genes and matching and putting genes together”.</td>
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<td>Student 3: “DNA splicing. Putting together specific traits and it makes a gene”.</td>
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<tr>
<td>What is selective breeding?</td>
<td>Student 1: “Picking out certain things”.</td>
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<td>Student 2: “Picking certain genes to make a person the way you want them to be”.</td>
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<td></td>
<td>Student 3: “Taking specific animals with specific traits and breeding them to force out the bad”</td>
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How does selective breeding occur?

Student 1: “Invitro fertilization”.
Student 2: “Scientists examine the animal and use tools to pull out the DNA of the specific traits they want”.
Student 3: “Scientists examine the sperm and the egg and pull out the traits that they want and stick them in a new egg”.

The students’ answers revealed several misconceptions about genetic engineering and selective breeding. One of the first misconceptions is that a student believed genetic engineering is completed by engineers, since the words “genetic engineering” include the word “engineer” right in the title. Another misconception was that a student thought that animals have bad genes and selective breeding forces those bad genes out of the animal. Finally, the largest misconception that all the students had was that genetic engineering and selective breeding only occur in animals and not plants.

Keeping the students’ thoughts in mind, I developed a 5-E model lesson plan to tackle the students’ misconceptions on genetic engineering and selective breeding. My lesson began with a natural discrepant event that included containers of seeded and seedless grapes. The students were allowed to smell, touch, and examine the two types of grapes. During the examination of the grapes, I probed the students for explanations with questions such as “What do you notice about these grapes?” and “Why do you think there are no seeds in the one container of grapes?”. The event engaged students and the questions triggered the students to think about selective breeding and genetic engineering. I then gave a brief lecture on how seedless plants were produced and discussed the concept of hybridization with the students. The discrepant event and lecture addressed the students’ misconceptions that selective breeding only occurs in animals.

After the discrepant event, the students took part in an exploration activity that included them exploring why selective breeding occurs. The activity included students picturing themselves as a tribe of
prehistoric hunter/gatherer nomads living in a savanna. In order to survive, the students must choose an animal to domesticate to relieve pressures of the hunt. Students were divided into four groups and were assigned one of the four different animal species listed on the student organizer (wild dogs, wild pigs, deer, and cattle) to consider as candidates for domestication. Once the information on their species was filled out, the groups shared their information with the rest of the class. Based on their student organizer answers, the class was asked to vote on which animal they think offers the most to their hypothetical grassland tribe. Most of the students chose cows as their answer. The activity demonstrated to the students that animals are selectively bred to help humans, not just to “get the bad genes out”.

During the explain section of the lesson, the students watched several video clips on how and what cows are selectively bred for. The students answered questions on their activity sheets about the qualities that make good beef and dairy cattle. The students learned that most selective breeding actually occurs on farms and not in laboratories. Additionally, the video addressed the students’ misconceptions about how selective breeding occurs. The students learned that traits aren’t actually “pulled out” of the DNA of an animal. Instead, animals with more desirable traits are selectively bred by humans to produce the next generation of offspring. After the video, the students were briefly lectured on how animals are selectively bred. The lecture focused on the differences between artificial and natural selection and the advantages and disadvantages of selectively breeding organisms.

Following the video clips and brief lecture, the students completed a selective breeding activity. Within groups of 2 or 3, the students were allowed to choose any organism and one trait they would like to selectively breed their organism for. The activity allowed the students to elaborate on the advantages and disadvantages of selectively breeding organisms. Additionally, the selective breeding exercise addressed the students’ misconceptions that selective breeding has no consequences. The students learned that traits that are good for humans may be harmful to the animals. For example, one of the
groups of students chose to selectively breed a cheetah with no spots. The group realized that no spots would help the cheetah blend in grassy areas but would not camouflage the cheetah in areas of patchy grass or in trees.

Two days after my lesson, I re-interviewed three of the students and asked them the same questions as before. Their responses were as follows:

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| What is genetic engineering?  | Student 1: “Scientists putting genes together to create a better plant or animal”.  
Student 2: “Scientists changing genes in an animal to produce an animal with better traits”.  
Student 3: “The splicing of DNA to produce better plants and animals”. |
| What is selective breeding?   | Student 1: “Selective breeding is when humans breed animals and plants for specific traits”.  
Student 2: “Selective breeding is when farmers mate certain animals to get the animals with qualities they want…like cows with lots of meat”.  
Student 3: “The mating of two organisms to get an organism with traits you want”. |
| How does selective breeding occur? | Student 1: “Selective breeding happens in lots of different ways. People can mate specific animals for specific traits, and with plants you can cross species and get the traits you want… like seedless grapes”  
Student 2: “It depends. Farm animals are selected and mated to get the traits the farmer wants. With plants, the farmer clones the plant”.  
Student 3: “Selective breeding occurs when a person mates two animals for their specific traits so those traits can be passed on to the next generation.” |
The students’ responses changed dramatically for all three questions. I was most impressed with how much students’ answers changed for how selective breeding occurred. None of the students suggested in the post lesson interview that DNA or traits are pulled out of the animal.

My prior knowledge investigation results were very similar to findings in published research. Baker and Piburn (1997) found that when it comes to selection and adaptations, students tend to have a Lamarckian point of view. Students tend to believe that the animal’s adaptation suddenly makes it immune to potentially harmful changes in the environment (Baker & Piburn 1997). All of my students thought selective breeding was for the betterment of the animal. Additionally, Hills, Stanisstreet, Boyes, and O’Sullivan (1998) conducted a survey on 16-19 year olds about genetically modified foods and discovered that very few students thought that genetically modified foods could be unsafe for the environment and the consumer. During the last activity when students selectively bred their own organism, I found that most students were able to quickly come up with the advantages of their new organism but had difficulties seeing how the new trait organism had could have negative affects on the environment, the consumer or the organism itself. For example, one of the groups decided to selectively breed a cow for 2 udders. The students thought two udders would be a fantastic idea since it would allow the cow to produce more milk. However the students failed to realize how 2 udders would affect the cow’s ability to stand or walk.

A student’s prior knowledge is critical to understanding where the student is coming from and how that student is going to interpret the material in the classroom. Studies have indicated that lessons based upon a student’s prior knowledge address any misconceptions the student might have and allows the student to gain a more correct understanding of the scientific concepts they encounter (Wright & Bilica 2007). With all of its success, I look forward to incorporating prior knowledge lessons into my future classroom.
References


