

**CoRe: Content Representation Tool**  
**(Loughran, Mulhall, & Berry, 2004)**  
**Emily M. Walter – University of Missouri, Columbia**

<b>Big Ideas/Concept:</b>	A theory never becomes a law!
1. What you intend students to learn about this idea	<p>The colloquial use of the term “theory” is different than how it is used in science. In everyday use, theory means a guess or hunch, as something that needs evidence (Theory, 2000). However in science, a theory is a well-substantiated, well-supported, and well-documented explanation for a phenomenon (Law, 2008). Likewise, this is not the word “theory” is also used differently in mathematics and music.</p> <p>Theories do not evolve into laws with the accumulation of evidence. Theories cannot become laws because laws are different things. Laws are generalizations that <i>describe</i> phenomena and theories <i>explain</i> the causes behind why that phenomenon occurs (CSMEE, 1996; McComas, 1996; National Center for Science Education, 2008). Students should be able to support this idea with an example. For example, the Law of Gravitation basically describes that if you let go of something, it will fall. It does not explain why. There is more than one explanation (theory) that can explain why.</p> <p>Theories are the goal of science, not laws (NSS, 2007). Theories are considered the best answer for a particular phenomenon or fact. This means that a given theory has been supported by all relevant observations and experiments.</p>
2. Why is it important for students to know this	<p>Society often dismisses a scientific theory because it is “just a theory” and this misconception is widely held. Sustaining an argument on this measure relies on a fallible vernacular. It is important that the public not dismiss theories in general, however, as not acting upon or pursuing deeper understanding of certain ideas could be detrimental to the human race.</p> <p>For example, dismissal of the Theory of Anthropogenic Global Warming could lead to complete disruption of the ecosphere if the theory holds true. Ignoring the Theory of Natural Selection could be detrimental to continual adaptation of the flu vaccine to evolving influenza viral strains. These reasons relate back to Driver et al. (1998) as sociological or humanistic benefits of learning science.</p> <p>As a scientist, I find it personally gratifying to know that my opinions are verified by observations and experiments. I would not be able to sustain my career path if I did not believe that if it was not based on the best explanation for phenomena. Students may also find gratification in this idea. So many popular ideas are empirically unsound. Ignorance is nothing to be proud of.</p>

<p>3. What else you know about this idea (that you do not intend students to know yet).</p>	<p>The heated debate between scientists and creationists on the topic of evolution is a topic of high public sensitivity. Weak arguments are placed behind <i>whether</i> evolution happened, and a better argument, although still fallible, attacks the explanation (theory) as to <i>how</i> evolution happened. Most of the counterargument for creationism is based on the ‘irreducible complexity’ of cellular interactions and biological molecules.</p> <p>I am aware have several examples of laws and theories beyond those of the students, although it seems redundant to list those here.</p> <p>I know how to designate a paradigm (and its theories) as ‘in crisis’ (Kuhn) or as ‘generally accepted’. This can only happen if the science (requires evidence) from a rival paradigm can solve the previous puzzle’s anomalies.</p> <p>I believe, especially in the adult learning classroom where personal histories weigh so heavily on perceptions, that personal beliefs should be respected. Conversely, I feel should still be ready to constructively counter the arguments that are commonly encountered. Especially for the one of the most commonly attacked theories in science, natural selection – the best explanation for the fact of evolution. These I will fully discuss in my synthesis paper and won’t be detailed here.</p>
<p>4. Difficulties/limitations connected with teaching this idea</p>	<p>Personal religious and cultural beliefs can be barriers to learning this material. This barrier is less associated with the law/theory concept and more with the acceptance of science as best explanations, but could still undermine classroom discussion.</p> <p>It is also possible that other instructors and past experiences can and will influence my efforts. Students will likely have a difficult time if they believe what I have taught them as dogma and not that of a future instructor.</p>
<p>5. Knowledge about students’ thinking which influences your teaching of this idea</p>	<p>Most students coming in will likely have the presumption of a chronology between hypothesis, theory and law. I plan to be explicit about the relationship between the three, although the goal of this CoRe is to differentiate between theory and law. This misconception is also portrayed by the media and by public figures (McComas, 1996).</p>
<p>6. Other factors that influence your teaching of this idea</p>	<p>The definition of hypothesis can become part of this discussion as well. I want to remove the veil that is held over science as an elitist, nerdy, and atheist pursuit. Although, I don’t really see how to remove the atheist veil because I personally am agnostic, so that makes it difficult avoid the pinpointed religious discussion other than to perhaps avoid it forthright.</p>
<p>7. Teaching procedures</p>	<p>Conceptual cartoons can help students communicate their thoughts on the topic and warm up to further discussion.</p>

<p>(and particular reasons for using these to engage with this idea)</p>	<p>If the classroom was equipped with multiple choice responders, a quick and anonymous survey could be quickly conducted.</p> <p>I should explicitly lecture on the difference between the colloquial use and scientific use of the term theory. I will provide examples for the difference and ask students to find examples of when a theory became a law. (good luck!)</p> <p>I like the idea of bringing in different definitions of theory and law to allow them to develop their own best working definition. I also like the idea of allowing students to bring in one scientific theory and one law to allow the class to compare. This could even work in the large classroom if done in small groups.</p> <p>I think integrating this concept throughout content I think works well, although a single lecture providing scaffolding to the remainder of the content would be the most explicit. There are several theories in biology and each could be referenced back to the initial lecture.</p>
<p>8. Specific ways of ascertaining students' understanding or confusion around this idea (including likely range of responses).</p>	<p>Using a survey tool such as the VNOS-C could give me a more articulate idea of where problems are with the concept. A verbal discussion in class can also help to uncover some problems.</p> <p>Questions: What is a theory? What is a law? What do you think about natural selection as an explanation for evolution? Is there a difference between the scientific use of the term theory and the everyday use of it? How?</p> <p>A: "How can competing theories exist if a theory is <i>the best</i> explanation of a phenomenon? Why not put trust in the Prevailing alternative theory, such as creationism/intelligent design?"</p> <p>R: A theory cannot be an alternative scientific theory if it does not have valid evidence-based explanations. The evidence cited for intelligent design is not scientific evidence, so therefore cannot provide a scientific explanation.</p> <p>A: "But I learned in another class to prove and disprove theories."</p> <p>R: "You were likely demonstrating or disproving given hypotheses."</p> <p>A: "Theories are appropriate only when you can observe the phenomenon. I can observe gravity. I cannot observe evolution."</p> <p>R: Evolution can be observed – fossil record, homologous anatomy, and the universal DNA code.</p> <p>A: "Natural selection is a theory in crisis, whereas intelligent design is a valid theory."</p> <p>R: To be in crisis, you must have a valid counter-theory that is based in evidence. There is no evidence that is against the theory of natural selection. Likewise, intelligent design is not a valid theory because it is not based in observable</p>

evidence.

A: I thought a law held more weight than a theory. I was taught this in another class? How can my other teacher be wrong?

R: It is a very common misconception, especially with the common use of the terms theory/law, to think that laws should be obeyed always, just as they expected to be in our society. However, in science, theories are explanations and laws are descriptions. If I drop the ball, it will fall. That's the law of gravity. *Why* it falls is the explanation, and believe it or not, there is more than one accepted theory of gravity. There can be more than one explanation because both are supported by the evidence available. Some theories are the only scientific explanation for a fact because they are the only theory supported by the evidence available.

### References

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