**Energy in Biology and How Students Understand**

April 17, 2020

**Energy in Biology**

*You need an introduction to your paper that describes the focus of the paper. Start with an introduction about the topic in 1-2 sentences. What are the key ideas about this topic that you plan to discuss in your paper? Why is it important to investigate?*

Teaching and learning the concepts of field, potential and energy pose special difficulties for students and teachers. We report on a study in the area of ​​electricity and magnetism. The understanding of basic aspects of those concepts reached by second-year students of Engineering careers who had completed the course and passed the corresponding evaluations is analyzed.

Higher education institutions require offering quality education. Quality teaching is defined as that which achieves teaching goals, which are distinguished by their ambition and complexity, such as seeking that students achieve critical thinking, be creative and develop complex cognitive skills. However, according to the available information, the majority of students at this level do not meet these goals. One of the distinctive features of this educational level is to seek deep and ambitious learning outcomes as it is already a high level of education.

The term energy is one of the scientific terms with the greatest presence in our daily life: energy problems, renewable energies, energy drinks are part of the universe of students long before the idea of ​​energy is worked on in classrooms. This fact implies that any compulsory secondary school student has surely already built their concept of energy linked to various aspects such as, for example, food, fitness, consumption, among others.

The results show the need to further complement instruction with qualitative, conceptual, and comprehensive approaches, which in normal instruction are usually postponed by treatments almost exclusively focused on mathematical formalisms whose physical meaning is not clear to students. Energy as a concept that is still being studied to date, achieving a deeper understanding of this concept opens the doors for a better understanding of the sciences, however, if we study what are the factors by which a student increases or does not develop the Energy understanding can be connected across disciplinary boundaries.

Energy is a fundamental concept in all-natural sciences, in engineering, and geosciences. The understanding of energy is given by four central energy aspects which are: forms of energy, energy transfer/transformation, energy degradation, and energy conservation. Energy is also considered as a central idea in subjects such as biology, chemistry, and physics. In addition to being a concept that runs through them.

Currently defining the concept of energy remains a complex task. The Nobel Prize in Physics Richard Feynman states that energy is only a mathematical principle, it is a numerical quantity that does not change when a change occurs (Opitz, 2017). According to the same author, it is an abstract concept, it is a property, a characteristic of a system or an object to which we can give a numerical value; therefore, we cannot talk about the energy contained in an object, nor is energy the mechanism that explains how things happen.

This definitional difficulty has led to didactic discussions on how to approach the concept. Numerous works highlight students' problems in understanding the nature of energy (Duit, 1998; Domenech, 2001) and this has given rise to didactic debates on how to start conceptualizing the term. Here are some of them.

One of the initial proposals was to treat the term from a perspective of material substance, invisible and intangible, a kind of magical substance that flows from one place to another changing shape. As this conception is very close and coincident with the everyday meaning of the term, it seemed that it could facilitate its learning (Duit, 1987), although at the same time it could hinder the understanding and learning of the scientific concept, since this character of substance that was applied the concept of energy has nothing to do with the current scientific conception.

Another approach was to look for a more elemental meaning of the term, "energy as efficacy or origin of the activity." This meaning seemed to be closer to the scientific concept (Watts, 1983) since it approached the term from a more abstract and less tangible perspective. But it was still far from the current definition by bringing the concept of energy closer to the concept of gasoline, in which energy is used and consumed. Thus, we find associated with this concept phrases such as "food is the gasoline of living beings", where clear energy is not conserved, used and consumed.

Why is the concept of energy important? As we said before, energy is a fundamental idea in science, which makes it known as a central concept for science education. Energy is everywhere understanding it can facilitate analysis in scientific contexts it has been shown that energy experts can quickly recognize and address key ideas of a problem and solve it.

Findings by Park and Liu (2016) show that context prominently influences the understanding of energy, thus suggesting that energy understanding is highly correlated between biology, college level, chemistry, physics, and the contexts of environmental sciences. Students add knowledge almost spontaneously so they may have trouble differentiating it, students may have difficulty with a large amount of information they receive and thus fail to notice relevant connections and underlying concepts that are intertwined between topics of Science.

Within the biological discipline, and especially in ecology, there is an increasing awareness of the importance of thermodynamics in the area. Thus, thermodynamics can provide biology with explanations for the structuring phenomena of living beings that at first seemed to contradict physical laws.

Therefore, it seeks to promote levels of integration of knowledge as such, an integrated scientific understanding is considered beneficial for critical analysis. When we talk about an individual disciplinary context, the central ideas will aim to organize and review the content. On the other hand, cross-cutting concepts aim to allow students to organize content more coherently across disciplinary boundaries.

The effectiveness of the integration of knowledge depends on many factors, the most important is the structure of the student's knowledge, a structure classified as efficient revolves around central ideas. A central idea such as energy works as an axis to mark the link between the contents and to emphasize the similarities in the complexity of the scientific contents. In this way, it is considered that the central ideas facilitate the integration of the knowledge of the scientific understanding of the students.

The most important aspects that play a fundamental role in understanding the concept of energy are Energy forms and sources, energy transfer and transformation, energy degradation and dissipation, and energy conservation. When we speak energy in a biological approach, we mainly analyze the transfer and transformation of energy in open systems, for example, animals.

The extent to which an organism transforms limited available energy into desirable forms of energy (eg, kinetic energy) rather than degrading it to thermal energy is an important factor in natural selection. Therefore, the efficiency of energy transformations and heat emission is often focused on biological approaches (for example, on energy flow diagrams).

The difficulty of understanding the concept of energy in biology is practically nothing due to the abstract nature of the concept, its wide and varied applications, its connotations in everyday language, as well as the confusion with related concepts such as force, work, power, and matter. So, if a student enters formal education with varied conceptions of everyday experiences, students advance by relating energy in the first instance to living entities and then to non-living ones before learning the stored energy and finally the degradation and conservation of the energy. Energy.

Research suggests early energy learning is possible and should be sustained effectively through high school. This can happen if we explicitly address alternative conceptions, alternative ideas, such as the application of forms of energy or energy as an almost material substance, can be useful tools for a later understanding. Chemical engineering students' energy understanding of bond breakage/formation is highly dependent on textbook definitions.

Another very important key to developing a better understanding is in contact with the student about whether he is reasoning what he is learning. Students were found to achieve an understanding of forms of energy at the primary level, while an understanding of energy transfer was achieved marginally in lower secondary school. Degradation and energy conservation were not even fully understood in high school

If curricula are organized along with learning progressions, students have to connect knowledge more meaningfully around the respective central idea and thus achieve a more integrated understanding of science. Learning progressions are derived and validated through empirical research results.

The understanding of energy in all disciplines is based on an energy conceptualization that is applied consistently to different contexts or that students' understanding of energy is generally vague, possibly based. on alternative conceptions of everyday language and, therefore, highly related between disciplines. Students exhibit difficulties in transferring energy content from physics to biological contexts, raising the question of how energy understanding is related to disciplinary contexts.

In concept, the character of energy in biology is mainly limited to transfer and transformation. Consistent curricula that are structured around core ideas and crosscutting concepts such as energy can promote integrated scientific understanding (Fortus et al., 2015). Students depend on an integrated energy understanding if they will use energy as a concept in all subjects and disciplinary contexts.

With this in mind, the importance of a stronger focus on energy conservation and degradation can be derived as a goal for teaching in all science subjects. Conversely, students' widespread understanding of forms of energy (Jin & Anderson, 2012), as well as their relatively high performance in physics contexts, could further develop as steppingstones to more complex energy contexts in biology and chemistry.

Regardless of the type of discipline or specialty, universities must train their students in high-level thinking and make them autonomous learners. Although these goals are shared, there are differences between the disciplines on what is important for each of them. For example, science and math teachers attach great importance to learning factual mastery of the facts and principles of subdisciplines; on the other hand, those of humanities and social sciences give greater weight to the student's personal development, discussion and communication, and social skills.

For this reason, methods are very important in the process of planning, design, evaluation, and systematization of ordered and coherent processes that have a logical sequence and that result in a qualitative transformation of the situation from which it started; for this reason, they are very important in the educational process, since they guide us in search of an objective, a goal, a purpose or an end.

*I can see that you did a lot of work on this paper. But it still has many issues with organization of ideas and flow. You have different ideas presented that do not seem connected, and you do not attempt to connect them. For example, you talk about higher education learning in general, and it is not clear how those ideas connect to students’ understanding of energy. In other places, you seem to go back and forth between student understanding of energy, and then defining energy. Here’s what you need to do to revise this paper:*

1. *You need to go back and write a very detailed outline so you have logical flow in your paper. Think about how ideas are related to each other.*
2. *Write an introduction that focuses on the topic. From reading your paper, the topic seems to be: students’ understanding of energy concepts in Biology. This should be the title of the paper.*
3. *Delete content that is not related to your outline.*
4. *Review what you have written and re-organize your paper following the outline.*
5. *Write transition statement between ideas.*
6. *Write a conclusion that summarizes key ideas from the paper.*
7. ***MAKE SURE you include in-text citation anytime you are paraphrasing from a paper you read. Your paper does not cite work that you read, which is considered plagiarism. A paper with plagiarism will result in a failing grade.***

**References**

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