# POTENTIAL PROBLEMS OF USING SCIENTIFIC TERMS AND ITS AFFECTION TO COMMUNICATION

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In modern science and its applied fields such as technology and medicine, a knowledge of classical languages is not as rigid a prerequisite as it used to be. Scientific terminology is the part of the language that is used by scientists in the context of their professional activities and suggest consequences of technological and scientific advancements and innovations. While studying nature, scientists often encounter or create new material or immaterial objects and concepts and are compelled to name them. Scientific terminology, or science terms, is a language specifically designed for use in scientific fields. Moreover, established practice in this field gives a very disturbing picture. The number of erroneous, misleading, and conflicting conceptualizations, either in different textbooks or within a single text, can hardly contribute to better teaching and learning, especially for young students. Teaching can be thought of as an effort to help students examine their "initial knowledge," colored with many alternative conceptions, as well as to build "new knowledge" consistent with their new experiences with natural phenomena. Much research has paid attention to the study of student initial knowledge , but we are still a long way from being as effective as we wish at enabling students to actually reconstruct their initial knowledge. Discussions of both initial knowledge and new knowledge which in any way resemble aspects of the canon of physics are confounded by the problem that there is not universal agreement as to the meaning of terms. We can only arrive at meaning which we come to take-as-shared with each other for these terms through interaction with each other. Arguing against the term heat energy, Pushkin (1996) says that the right term is heat, or in more elaborated form "thermal energy flow" or "transfer of thermal energy due to a temperature differential between substances."[1] Accordingly, "heat energy" should be changed to "heat" because heat is a process (flow, transfer). Contrary to this view, Lewis and Linn (1996) argue that they use the term "heat energy" in order to reinforce the idea that heat is a "form of energy" and that such a use supports a process rather than a substance model of thermal

[1] Pushkin. (1996) Journal of Research in Science Teaching, 33, 223–224, 1996 VOL. 34, NO. 6, PP. 655–660 (1997)

phenomena.[2] So, here two different interpretations of the same term "heat" are in obvious conceptual collision. In one view, heat is a "process of energy transfer" and in the other, heat is a "form of energy." This difference is not the invention of Pushkin (1996) and Lewis and Linn (1996), but reflects a much richer phenomenology (Slisko, 1993) and has a much longer history.[3] This kind of diversity calls for more serious attention. Nevertheless, the problem is not merely in conflicting conceptualizations, "process versus energy," which are used in the definition of one term, but further in confusing linguistic and logical structures arising in the network of related terms. To illustrate, we call attention to a few terms used by Pushkin. We use these examples not because Pushkin's use of the terms is unique, but because the use is in many ways typical of the position with respect to the definitions he is using and, for the convenience of the reader, the examples come from the specific context which motivates our comments here. We believe that thoughtful students trying to make sense of what they read or hear might wonder the following: 1. If "thermal energy flow . . . is known as 'heat' " and "thermal energy flow is . . . transfer of thermal energy", then what is the meaning of "heat transfer"? . . . transfer of transfer? 2. If heat is "transfer of thermal energy," then what is "amount of heat"? . . . amount of transfer? Because science intends to be a coherent view of the world, its terminology is expected to show a logical structure with some internal consistency. If our terminology leads to confusing conceptual constructions when such simple logic is used, then it is unfair to ask students to think logically and make sense of what is written or spoken in that terminology. The above problems seem to be compounded when the terminology is used in describing yet other terms involving important concepts encountered in the Lewis and Linn work with students. Trying to give a "proper" definition of some terms, Pushkin (1996, p. 223) says: It should be noted that thermal conductivity is defined by its dimension as the rate of heat transfer through a material of given thickness, while specific heat is defined by its dimension as the amount of heat required to raise the temperature of a given quantity of a material by one degree". Generally in physics we intend to define a physical quantity by its operational definition, which leads to a specific dimension (and unit) and not vice versa. In addition, common definitions of thermal conductivity and specific heat are slightly

[2] Lewis and Linn. (1996) Journal of Research in Science Teaching, 33, 335–337, 1996) Inc. J Res Sci Teach 34: 655–660, 1997.

[3]Slisko.(1993) European Journal of Physics Education Published on 10 Jul 2009 https://dx.doi.org/10.20308/EJPE.V9I1.168

different. Thermal conductivity is the rate of heat flow per unit area and unit temperature gradient. If through a rod of length, L, and cross-sectional area, A, due to a temperature difference between its ends (T2-T1), a quantity of heat is transferred per second, H, then the thermal conductivity is given by K 5 H/A(T2-T1)/L. The specific heat of a material is the quantity of heat needed to increase by 18 the temperature when the mass of material is 1 kg. If Q is the quantity of heat used to raise the temperature by the amount (T2-T1), and if the mass of material is m, then the specific heat is c 5 Q/m(T2-T1). Some would say, quantity of heat per unit mass and unit temperature change energy equal to the amount of heat required to raise the temperature of a given amount of a material by 18, if the mass of material is not 1 kg, is called "heat capacity." Therefore, specific heat is sometimes called "specific heat capacity." It is important to note that the quantity, H, rate of heat flow, in the first equation is expressed in units of joules/second (j/s); the quantity, Q, heat, in the second equation is expressed in units of joules (j). In both cases the heat seems to be measured in joules, which is the standard unit of energy. The discussion between Lewis and Linn and Pushkin, which is representative of discussions about the term, heat, historically, and the above formal definitions show that the appropriate use of scientific terminology is not clear even for those who have had training both in what the scientific conceptions are and in how they might be verbalized in research and teaching settings. Although this section of the discussion is not the right place to offer a robust phenomenology for such behavior, we cannot resist giving a few additional examples of erroneous or confusing conceptualizations because they come from a book (Farrow, 1996) written to "support and extend teachers' own science knowledge" (p. 3) and they illustrate the point we are trying to make.[4] Here are some pieces of "science knowledge" on heat: 1. "Heat energy is a function of the vibration of the atoms and molecules of which a substance is made" (p. 142). 2. "Heat is the total amount of thermal energy contained in a given amount of material . . ." (p. 142). Note the almost circular use of three different terms (heat energy, heat, and thermal energy) to denote the same concept and the former bodies-contain-heat conceptualization.3 In addition, what does the phrase "a function of the vibration of the atoms and molecules" mean to students whose notions of atoms and molecules are decidedly not what scientists think of atoms and molecules? What do students think of the phrase "a function of"? For that matter, what do scientists think of this phrase used in this context? Confusing terminology is even worse in the case of electricity._*From*

[4] Matthew Farrow (1996) art. pub. November 26, 2010 www.letsrecycle.com/news/cbi-energy-matthew-farrow-join-esa

*vaccinations to climate change, getting science wrong has very real consequences. But journal articles, a primary way science is communicated in academia, are a different format to newspaper articles or blogs and require a level of skill and undoubtedly a greater amount of patience.* So reading a scientific terms is a completely different process than reading an article about science in a blog or newspaper. Not only do you read the sections in a different order than they're presented, but you also have to take notes, read it multiple times, and probably go look up other papers for some of the details. Reading a single paper may take you a very long time at first. The process will go much faster as students gain experience.