Some Physics teaching whispered fallacies

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Abstract

Some erroneous common facts that appear in a current informal learning context are discussed. In this note, it is shown several examples that illustrate this practice.

Keywords: Current errors, informal learning.

Resumen

Se discuten algunos hechos comunes erróneos que aparecen en un contexto actual de aprendizaje informal. En esta nota, se muestran algunos ejemplos que ilustran esta práctica.

Palabras clave: Errores actuales, aprendizaje informal.

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I. INTRODUCTION

Informal learning (sometimes called experiential learning) has been recently recognized as a useful method widely used for learning purposes. Some people asset that the use of botanical gardens, science fairs or exhibitions, museums, etc. may be used -and in fact they had been used- for the enhancement of science knowledge. Other learning situations described by this term refer to the side-by-side knowledge obtained for fellows in the same environmental situation, i.e. by high school or undergraduate students. A third situation came today in mind: it is not really necessary to have a physical neighborhood to access the information. The World Wide Web network is a source of an almost infinite quantity of informal data and facts. Furthermore, they are advocates for the thesis that, because all the information is located in the web, the main purpose of instruction is to learn to use it and not to discuss the content of this information. Last but not least, I guess that almost all you (and me) know about PCs arises from informal learning.

Appealing as it is, it is not the purpose of this note to discuss the utility and pertinence of these learning resources. I simply stress the fact that we, Physics teachers, are submitted to this type of influence since the pre-net times. Also, caution must be exerted as that this type of learning must be severely tested before acceptation. In order to discuss this fact, I will present some examples of commonly believed facts, that, although have been shown false in the literature, continue to be taught by a kind of fellow-to-fellow heritage. I will call these cases myths, in a different sense that other well know (proper) myths such as the Newton's apple fall or the Galileo's free fall experiment in the tower of Pisa. These later legends are taught as really unfounded or as unreal facts (although they can be profitably used for pedagogical purposes), instead the facts we will deal with, are false, but with a mode that is well reflected by the Italian proverb, "si non è vero, è bene trovato" [1].

A recent nice account by Sawiki [2] on myths about gravity and tides triggered the present note.

II. EXAMPLES

A. The coincidence of Newton's birth with Galileo's death

To be in tune with the last paragraph let us consider the common statement that the year Galileo dies, Newton was born. The myth even consigns the date: 1642. It is easy to confirm this fact: Galileo dies on January 8, 1642 and Newton was born on December 25, 1642.

The fallacy stems from the fact that both dates belong to different calendars. The Newton birth's date was given in the old Julian system; instead, the Galileo' death date is expressed in the (then) new Gregorian calendar [3]. This is a net example of the fact that equal numbers do not always represent the same physical fact.

B. The flow of cathedral window glasses

It is a well-known fact that atoms in glasses and liquids present a disordered state or short-range order as opposite to crystalline materials that present long-range order. Therefore, solid glasses (as the ones belonging to cathedral windows) must possess liquid properties, that is, they must flow. Surely, solid glass viscosity must be greater than ordinary liquids, but for long exposure times, the consequent deformation can be noted. Medieval glass windows seems to be the perfect target for testing purposes and it is asserted that they are wider in its lower than in its upper edges.

In fact, it has been shown [4] that this effect is not

measurable −at room temperature− during historical times (say, 5000 years), and therefore the thickness difference −if it exist− can be attributed to manufacturing defects. Furthermore, it is curious that older glass objects (ancient glass vases) do not seem to show this effect and do not appear in this myth.

C. The different rotation sense of water into a washbasin exhaust in the North and South hemispheres

Vortex movements are well known phenomena in domestic bathroom environments. Claims had been whispered that due Coriolis non-inertial forces liquid spins in opposite senses in different hemispheres, in due account for the earth rotation around its North-South axis.

This argument has been labeled an "old wives' tale" by Crane [5], showing that this effect would be unnoticeable if the liquid is initially quiet. What the observer visually perceives is the increase in rotation (due to angular momentum conservation) of the liquid due to the fact that its initial angular momentum is different from zero. If fact, it is possible to whirl the liquid in either sense, by simply selecting the initial angular moment of the system in a "clockwise" or "anti-clockwise" state.

D. Römer "measurement" of the velocity of light

Galileo -in his book "Two New Sciences"- proposes an experiment to measure the velocity of light. In the words of Salviati (Galileo himself) the unsuccessful experiment was not due to the instantaneous propagation of light, instead "(light propagation) if not instantaneous, ...is very swift" [6]. In 1676, Olef Römer [7] communicates his explanation on the apparent anomaly in the measurement of the period of the Jupiter´s moons. This fact is usually mentioned as the first measurement of the velocity of light. In fact, Römer does not communicate this measurement, noting only that "le retardement de la lumiere" (that is, the finite velocity of light) is a necessary condition to explain the astronomical phenomenon. Based in Römer data, Huygens indeed published the first known figure for the velocity of light (for further comments, see the papers of Wrobleski [8] and Saito [9]).

E. The colored rainbow

"The traditional description of the rainbow is that it is made up of seven colors - red, orange, yellow, green, blue, indigo, and violet. Actually, the rainbow is a whole continuum of colors from red to violet and even beyond the colors that the eye can see" [10]. Written in this quote is the correct description of the colors observed in a rainbow as appears in the cited web page. The common belief in the quantization of colors is obviously untrue. Perhaps the equivoque follows from a misquote of Newton himself [11]: "The original and primary colours are Red, Yellow, Green, Blew and a Violet-purple, together with Orange, Indico, and an indefinite variety of Intermediate gradations". Former versions forgot the last part of the sentence.

F. The Franck and Hertz experiment

It is usually assumed that the well known Franck and Hertz experiment is a consequent confirmation of the quantum hypothesis first proposed by Bohr. As remarked by Franck himself, "It might interest you to know that when we made the experiments we did not know Bohr's theory. We had neither read nor heard about it" (quoted by Holton [12]). In fact, they pretend to measure the ionization energy of mercury and misinterpreted its own results [13].

G. Kinetics at T=0K

Dialog from the web [14] between teacher (T) and pupil (P).

- Question (T): "Well, look what happens if you set the temperature of the atoms in the box as low as it can go."
- Answer (P): "The atoms are stopped."
- Conclusion (T): "So that is as cold as the atoms can be. We call that Absolute Zero."

This dialog between teacher and student shows one expression for the fallacy that at 0K, there is no movement at all. The origin of this error perhaps stems from the (spurious) extrapolation of the ideal gas laws to low temperatures. On the contrary, it is a standard topic in Physics texts to study the Fermi-Dirac distribution showing that even at T=0K, a free electron gas has a lot of (kinetic) energy.

III. FINAL REMARKS

A good pedagogical advice is "not always believe written arguments" (by the only merit of being written). A better would be "not always believe whispered arguments" (although written on the net). Informal learning is an inevitable and useful way of learning, but extreme care must be exerted on the examination of the offering evidence. Recourse to authoritative sources (although old fashioned) or better, original papers, must be considered.

Finally, the author does not assume to know all these myths and therefore the reader would add his/her experiences on true/untrue explanations for known/unknown phenomena.

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REFERENCES

[1] Quotations are untranslatable, but in a free version: "*if it is not true, it seems to be*"; or in a more literal mode, "*if it is not true, it is worth to be discovered*".

[2] Sawiki, M., *Myths about Gravity and Tides*, Phys. Teach. **37**, 438-441 (1999).
[3] Babb, S. E., *When was Newton born?*, Am. J. Phys. **48**, 421-421 (1980).
[4] Dutra Zanotto, E., *Do cathedral glasses flow?*, Am. J. Phys. **66**, 392-395 (1998).
[5] Crane, H. R., *A Tornado in a Soda Bottle and Angular Momentum in the Washbasin*, Phys. Teach. **25**, 516-517 (1987).
[6] Galilei, G., *Two New Sciences*, translated by S. Drake (Wall & Emerson, Toronto, 1989) pp. 50-51.
[7] Although not directly written by Römer, this communication appeared in Journal des Scavants, 233-236 (1676) and an English version in Philos. Trans. R. Society, **62**, 893-894 (1677).
[8] Wroblewski, A., *de Mora Luminis, A Spectacle in Two Acts with a Prologue and an Epilogue*, Am. J. Phys. **53**, 620-630 (1985).
[9] Saito, Y., *A Discussion of Roemer Discovery concerning the Speed of Light*, AAPPS Bull. **15**, 9-17 (2005).
[10] http://www.eo.ucar.edu/rainbows/, Oct. 15, 2007.
[11] Newton, I., *A new theory about light and colours*, Philos. Trans. R. Society **80**, 108-112 (1672), reprinted in Am. J. Phys. **61**,108-112 (1993).
[12] Holton, G., *On the Recent Past of Physics*, Am. J. Phys. **29**, 805-810 (1961).
[13] Frank, J. and Hertz, G., *Collisions between Electron and Mercury Vapors Molecules and the Ionization Potential of such Molecules* (English translation of Verhand. Deut. Physik **16**, 457-467 (1914)) in The World of the Atom, Vol. 1. (Henry A. Boorse and Lloyd Motz, Eds., Basic Books, New York, 1966).
[14]http://www.colorado.edu/physics/2000/bec/temperature.html, Oct. 15, 2007.