EDUCATION-TEACHING TEACHERS TO TEACH-THERMODYNAMICS

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ABSTRACT

Education is the job of Educators. In our case we must make sure that the laws of Nature are well discussed in a correct and precise fashion. The First Law of Thermodynamics deals with Energy. This is rather simple to understand and apply in solving engineering problems. However, The Second Law of Thermodynamics deals with the realities of nature; that is what is possible and what is not possible to occur in nature. Exergy is the term used to explain the taxation of Nature since available energy cannot be utilized below the temperature of the environment. This taxation leads to environmental impact and unsustainability of current lifestyle. Every moment we turn on the light switch or crank our cars, we accept the fact that we impact the environment. There is absolutely no way out of it.

Teaching is the profession of most of us. Unfortunately nobody taught us how to teach. We were hired as a Professor because we had a doctoral degree and NOT because we knew how to teach. Thus we must start programs that will teach new Professors how to teach and become effective in their work.

Thermodynamics education has been deteriorating over the last three to four decades. We must make sure that this stops so that the new generation sees and understands the intricacies of Thermodynamics, its importance in all other thermal science courses and learn how to effectively use it. It is not too difficult to see how mistakes in literature, presentations and publications are made. It is our job to stop this and reinvigorate correct and precise teaching, use and application of Thermodynamics.

EDUCATION

There are three issues that are important. Education is the first one since we have accepted the job as an educator. What does education in Thermodynamics include? There are many textbooks on the subject matter written during many decades; some are very good and precise and some are quite bad and wrong, [1-4]. Thus depending on what is used and who the teacher is, the students get different exposure to this very important subject matter. Starting from the fundamental definitions and going through the fundamental laws, applications must be handled accurately and consistently. Otherwise, the students will learn the facts wrong and make mistakes in the fundamental understanding and subsequent applications. Our job as an educator is to make sure that everything that is presented is precise, accurate and always correct. We must also make sure that topical coverage is up-to-date with modern developments, meaningful and again precise. This cannot be over emphasized.

We have become educators just because we have a doctoral degree and not because we know how to educate. Also the emphasis on research and funding that is expected to be brought in by faculty, places educational issues as a second or third priority. The faculty is interested in promotions, both rank and salary, and not necessarily education. But the reason we are where we are in academia is because of EDUCATION!

TEACHING

Teaching is not well understood. What we, by default, have become is a teacher because we have a doctoral degree. We are brought into a University to do research, which we should know something about coming out of a university graduate school, teach for which we have had no education in although we may have taught as a graduate assistant, and some of us are asked to teach Thermodynamics whether we have had prior education at the graduate level on the subject matter or not. Personal experiences are reflected here; some other person's experiences may be different, though it is doubtful!

Teaching is considered to be a word which has no place in scholarship. If your paper has the word teaching on its subject, it is rejected not by one but a multiple technical journals although it may be on some highly important technical subject matter. Acceptance occurs after the word teaching is taken out, [5-8]; personal experiences prove this fact to this author. Now if teaching is not a good word, the quality of teaching is also not well controlled. How many of us, teachers of thermal sciences-Thermodynamics, Fluid Mechanics, Heat transfer, Energy Conversion Systems- have had experience in teaching of these? Normally we are told to teach these courses upon arrival to a university not because we have had experiences in a classroom, or maybe even have taken the appropriate graduate level courses to understand in depth the technical material. As a young person we are put in a situation that should be better controlled if we are serious about teaching, but then are we? This is a topic that can/should be debated!

In my personal case, I started as a Graduate Teaching Assistant at Duke University, Durham, NC followed by part-time Instructor at North Carolina State University, Raleigh, NC in graduate school. Then I went through the ranks at Louisiana State University, Baton Rouge where I am now a Professor Emeritus since December 1985. All those years nobody

approached me and asked me if I knew what to do in class or how to teach. I was just placed there and, I assume, expected to do the job in an acceptable fashion though no one checked on me. I hope I have not embarrassed anyone in my teaching!

There may be institutions where incoming faculty do go through some sort of pedagogical seminars. To my knowledge there are very few. In the United States, I know that at West Point there is a Instructor Summer Training program that last for six weeks before the Fall semester starts in early August. Incoming military and civilian instructors have to go through this well instructed and organized program during June-July of every year. This has proven to be a very successful program and the young instructors become very polished when they face a class for the first time. Thus TEACHING-TEACHERS-TO-TEACH turns out to be a good program that serves us very well each year. One would hope that this type of a program can be instituted in each and every institution if we are serious about teaching.

THERMODYNAMICS

The topic of Thermodynamics is very important to many of the energy situations that we face today. Unfortunately, I believe that it is not taught well, at least in the United States. One of the reasons is the fact that for many decades, no graduate student did research in thermodynamics. The research dealt with it but not directly. As such only one course is taught at the graduate level, if at all, and hopefully by those who have actually studied it. I have witness the attitude that "anyone can teach it" too often at different institutions. Thus those who are not knowledgeable in thermodynamics, select a very "easy reading" book and thus eliminating themselves from challenging questions from the smart students. Unfortunately, this is going on as we speak.

Many decades ago, three courses in thermodynamics were taught at the graduate level: classical, statistical and non-equilibrium. Nowadays, one is sometimes difficult to find. This is an unacceptable situation and it should be remedied. Unfortunately, it will not happen in my lifetime.

The topics in Thermodynamics are not that difficult [9]; even students who receive good teaching say this. The first law of thermodynamics, dealing with energy, is like a bank account. Students will definitely understand money, and hopefully how to use it, better than thermodynamics. The second law is a lot more difficult to understand because of the concept of entropy and exergy. It is very important that this is done correctly so that the student can see its value with respect to what happens in nature and why; global warming, sustainability and the like. As we speak more and more about these issues, we listen and read tirades of people who know nothing about thermodynamics. Unfortunately, it gets to be politicized and then it gets even worse. Our remarks about issues that relate to energy and its effects should be clear and must be made in such a way that the common people can understand. To me the second law of thermodynamics is the taxation put on energy use by nature! Unlike normal taxation, we can do absolutely nothing about it. Anytime we use energy, nature takes away a portion of it right away and dumps it into itself, for example pollution. Anytime we start a car, nature gets a big percentage of the energy released as a result of combustion. Anytime we produce a product that we need, the nature taxes us on the energy we used to perform this act. Use of solar energy is, of course, very good. However, the panels must be produced and this production needs energy, thus pollution, as well as the chemical pollution that takes place in this production. The total "foot print" must be considered. The same situation exists for fuel cells; let us not forget that we need many billions of kW of energy in the world at any given time! Thus the associated pollution.

Understanding of precise thermodynamics and applying it correctly also does not solve the problems that we face. What we need to be able to do, since we cannot reduce the taxation of nature, is to better utilize the available energy that is left after nature's taxation. To do this, we must have better materials that can withstand higher temperatures, such as the blades of gas turbines. This way, while the taxation stays the same the energy that can be used increases. This was the case many years ago and still is the case, [10].

CONCLUSIONS

We see that education in energy, exergy and environment must go hand in hand with teaching teachers to teach-thermodynamics. Mediocre teaching of any subject is not acceptable. To be an effective teacher, one must be prepared in pedagogy. That is why E4-T4+1 is a topic of interest to all who are involved in academia. We must make sure that university professors are appropriately involved on these issues of education, energy, exergy and environment and are taught how to teach in the context of correct use of thermodynamics so that we can intelligently pursue correct, precise and meaningful education in Thermodynamics.

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