



# **TEACHING PORTFOLIO**

***FOR***

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**Course: Thermodynamics**

**Code: CMT 251/CMT 408**

**Program: Diploma in Industrial Chemistry**

**Bachelor of Science (Hons.) in Applied Chemistry**

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## TEACHING PORTFOLIO

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### Course taught:

Thermodynamics  
Codes: CMT 251 & CMT 408  
Program: Diploma in Industrial Chemistry & Bachelor (Hons.) in Applied Chemistry

### A. Introduction

#### 1. *Teaching Philosophy*

Physics is the science involved in studying the physical world. Laws and theories have been discovered based on numerous experiments performed over the last four centuries. Ideas proposed by Aristotle on the events of the physical world had to be disposed when Galileo and most importantly, Newton, proposed new ideas based on further experimentation. It took hundreds of years before theories are accepted by the masses.

In our classroom setting, students with different learning styles and social background are being **taught** the laws and theories of physics over a period of between two to three semesters. This duration would be incomprehensible to the scientists of the past since the laws and theories required extensive experimentation to repeat and confirm. **Yet, our students are taught and expected to acquire the knowledge within a fraction of the time spent by scientists who invented and confirmed the theories.**

Science is based on experiments and knowledge is accumulated and propagated through this method along with sessions of brainstorming among the experts. Based on physical observations, hypotheses are proposed, predictions are made, experiments are performed and repeated to confirm the predictions before modifying and accepting the hypotheses as laws. But science taught in the classroom is usually done by the transmittalist instructional technique. In a normal setting, students will sit in a way where all will face the lecturer (the knowledge transmitter) in an almost passive way. They are supposed to listen, to write and at the same time trying to comprehend what is being lectured; three skills in any given lecture session. At times, the transmitter will be asking questions or will ask if students have any questions but given that the Malaysian culture does not usually perpetuate answering or asking questions among the receiver, seldom do students engage in an intellectual exchange of ideas in or outside of a classroom setting.

Assessment of students' understanding during the ongoing lecture session for the purpose of problem identification and remedying problems, is a very rare activity. Hence, a lecture session usually ends with the transmitter having completed his/her role of imparting knowledge but without any means of assessing as to how much learning actually took place. The cycle is repeated in the next *transmitting* session. An analogy that is relevant in this context is to think of students as mobile phones and the telecommunication provider as the transmitter. As long as signal is being transmitted, regardless of where the mobile phones are or the types of mobile phones used, the signal is supposed to be received in its entirety, crystal clear sound in real time. I call upon educators to ponder over this analogy with respect to the transmittalist instructional teaching method that is very dominant in almost every classroom at UiTM.

Ideas in physics and sciences are in most cases very abstract even though it is only at an introductory level. Dealing with abstract ideas demand that a student must be able to perform mental operations involving many abstract ideas. In Piaget's terms, comprehension of abstract concepts require that an individual be a formal thinker, a stage where an individual no longer need concrete objects to form mental models of new knowledge. Furthermore, the mental operation performed must not conflict with the individual's current beliefs (mental models). Conflicts of mental models must be confronted in order to assure new knowledge is received and true learning takes place.

In addition to the levels of intellectual development that students are at, students have different learning styles in ways that they handle information to form new knowledge. I had done some research and found that most of my students are active (not reflective), visual (not verbal), sensing (not intuitive) and sequential (not global). As a result of this, students learn better if information is presented (input domain) with a lot of pictures and graphs rather than just listening, they process information more efficiently when they are actively involved, they perceive (receive) information more efficiently when their senses are utilized and they will understand ideas much easier when all the information is presented in a very organized and orderly fashion. Hence, lecture (transmittalist method of teaching) will not match the learning styles of most of my students. In fact, lecturing is also not the preferred mode of learning by many scientists and educators at universities and tertiary institutions in Malaysia (outcome of the same research).

Realizing all this shortcomings, I believe that the transmittalist instructional method should be minimized in a classroom setting. Students should be treated as a human being rather than just a receiver of knowledge. I believe that we should adopt the constructivist view in our teaching. Students must be given opportunities to develop their own mental model about a specific physics concept and build on a network of those concepts. More importantly, they must be provided the environment to confront and elicit their wrong existing beliefs about concepts of physics and sciences. I believe that when students are guided in developing their own mental models through techniques that have been proven to be successful in physics such as, interactive engagement, all students, regardless of their learning styles can learn concepts of physics and sciences.

In order to guide the students and motivate them in an interactive engagement learning technique, I believe that we must first get to know the students on a personal basis. Hence, I always request that students introduce themselves during the first week of class. Besides knowing their names, I asked the students to provide their commercial name such as JJ. In addition, they also inform me of their

family background, hometown, mission and vision. When classroom time does not permit, students use email to send the requested particulars. Surprisingly enough, more than 30 percent of the students do not have a vision in life after UiTM. Nonetheless, I believe that by knowing the students by their commercial name, I can link up with them with ease. This will break the barrier between student and lecturer and improve on classroom communication. For the past 3 semesters, I have been taking pictures of the students using a digital camera and create a photo album of the students. A commercial name is attached to every picture. This allows me to know each student easily especially when we are having a discussion session. In fact, feedback from the students reveal that they appreciate that I know their names, at least when they are still in my class. When the semester is over, I find it difficult to recall their names but I always have my photo album to fall back to.

I believe that the best way to minimize on passive learning is to provide a different learning scenario than the lecture-tutorial-recipe lab format. Students must be actively and continuously engaged in the learning process rather than passively listening while trying to focus on scribbles and figures on the board and transfer them onto their own writing pads. Often times, the information written on the board is hardly legible from the back of the class. Hence, I assert that *collaborative learning through peer-facilitating learning-cycle* is a better option in increasing student's engagement in the learning process and hence increase understanding and learning of the subject matter.

I believe that learning is a life-long process but acquiring of new knowledge should happen at the time that the knowledge is shared rather than years after that. Hence, students should be made to be aggressive in the knowledge-seeking strategy. I reckoned that preparation towards a peer-facilitating discussion through construction of concept maps and graded reading assignments is a significant effort in acquiring knowledge. Both the concept maps and the reading assignments form part of a formative assessment to identify and remedy conceptual problems that students are facing which will then lead to better qualitative and quantitative comprehension of the subject matter. I believe that formative evaluation must be done continuously and in a variety of ways in helping the student shape and retain appropriate mental models regarding the study of thermodynamics. In addition, summative evaluation must also be done on a continuous basis to inform the students of their present standing with respect to the content of the subject matter. Having said that, the final examination must not exceed 40% of the total marks for this course.

I believe that lecturers must read the journal of science (physics, chemistry, chemical, biology and mathematics) education and do research in the same area in order to keep abreast with what others around the globe are doing in increasing teaching effectiveness. *Research has proven that the transmittalist instructional technique is the least effective technique in learning qualitative and quantitative aspect of a subject matter.* Unfortunately, due to the lack of reading (a factor of access to available journals) and due to our past experience as a student (the transmittalist is the most adopted method used when we were students), **this transmittalist instructional technique is the preferred teaching method at UiTM and in the country.** I believe that attending seminars and conferences to share problems encountered in learning and teaching and effective methods to overcome them, is an essential component to help with the interactive engagement instructional method.

Science researchers who are so proud of their laboratory research with highly sophisticated and expensive equipment must realize that in order to share their

expert findings, they must first know how students are learning and hence must find ways and means to improve on their teaching styles.

I assert that students must be guided and encouraged to practice verbal reasoning as a precursor to pictorial or graphical representation and mathematical formulas for ideas not just in physics, but in all realms of science. Ideas communicated verbally, pictorially and mathematically in its respective order and its reverse order must be stressed in the learning process in order to develop students in becoming critical and analytical thinkers and hence, a critical and analytical member of the society. This, I believe, can only be achieved through interactive engagement and not through passive, teacher-centered learning.

## **2. *Scope of Teaching***

Thermodynamics is the study of energy conversion from available energy resources, into work. The subject matter covers the property of pure substances that are usually used as a system to convert energy resources into different forms. The skill that students gain encompass reading the property table and the knowledge of determining phases of pure substances for any given state of the substance. In addition, students acquire the skill of representing information read from the table into graphical form and vice-versa. The substance involved include water used in power production, refrigerant in refrigeration and gases such as air or carbon dioxide. Few fundamental mathematical representation and formulation is also involved in determining some of the properties but this forms a very small portion of the knowledge acquired.

The laws and rules governing the energy transformation and mass conservation are probed and discussed in terms of its applicability to the different types of power production cycles. The first and second law analysis for engineering devices is approached conceptually first before casting the concepts into mathematical forms. Using the verbal expression, mathematical expressions and pictorial/graphical representation, engineering devices such as nozzles, turbines, compressors and pumps are quantitatively analyzed. Problem-solving is usually guided by breaking up a problem into its respective levels (Bloom's categories of cognitive domains) before eventually integrating it at the end.

Energy that is lost in work-production devices is analyzed quantitatively by analyzing entropy. As entropy is the hardest concept to comprehend, students use analogy of chaotic arrangement of books on a table to indicate high entropy and hence high energy losses. After this idea has been accepted, students approach entropy quantitatively through mathematical formulation in all the engineering devices that are relevant to power cycles. Finally, the skill and the rules are integrated to study real power devices such as the Rankine cycle for determination and enhancement of engines' efficiency.

## **B. *Teaching Experience and Repertoire***

### **1. *Challenges***

One of the biggest challenges is the fact that a large percentage of the students do not take any physics classes before taking my class. Some took general

science at the high school level while some may have taken physics at the preparatory level before being accepted programs at the faculty but the understanding is rather discouraging. Hence, dealing with average and below average students with limited physics understanding had force me to resort to non-traditional methods of teaching and learning.

Using an interactive engagement method to improve learning is a very challenging task. The amount of time involved in preparing the documents for peer-facilitating learning cycle and implementing both the training of facilitators and the formative and summative evaluation on a weekly basis is tantamount. Ideally, a grader is made available to assist on the grading of reading assignments and quizzes. This would reduce the burden on me and allow me to focus on material development for the facilitators and their peers. Unfortunately, there is no solution in sight and I still have to slave developing the concepts, typing it out, editing it, and printing them on top of the weekly grading of 60 reading assignments and 60 quizzes on alternate weeks. In addition, I also have to download and analyze self-assessments that students sent to me via email (120 email a week for the pre and post assessment). The fact that the top administration at the faculty level are not sensitive to the commitment and hence recognizing the long hours involved so that it is reflected as part of the weekly workload, makes the effort even more challenging.

I believe that effort to incorporate interactive engagement in increasing learning effectiveness in any science or engineering classes must be recognized and strongly supported by the management at the faculty and at the university. The reluctance of the management to support this paradigm shift will result in faculties producing students who are only doers rather than thinkers.

In trying to overcome the challenges above, I have made a few changes to my teaching methodologies. I initiated the use of a course outline where the details on course topics and the timeframe when they will be discussed (weekly schedule) are clearly spelled out. In addition, the course outline also informs the students on the course learning method and the aspects on how the students will be graded. Timeframe for both the formative and summative assessments are also included. The use of a textbook, "Thermodynamics for Engineers" by Cengel & Yunus, 4<sup>th</sup> Ed., to be used for the course, is also incorporated in the course outline. All my notes during discussion and reinforcement sessions are made available to the students on my website. All other notes in the form of operational objectives and notes for peer-facilitators are for the students to copy and retain for their own benefit. At the moment, all the documents are available in [Portable Document Format \(PDF\)](#) and can be printed by accessing the documents from my website. Passwords are needed to open the files and students will need to send email to me to obtain passwords.

In view of the weakness of the students in both English and physics, I trained peer-facilitators every *Fridays and Sundays (only 20% of the students are involved and each student only have to do this twice a semester)*. Friday sessions are for concept revision regarding the previous week topics. Facilitators form small groups consisting of 5 members and discuss the materials before they are engaged in a Socratic Dialogue session. Those having problems are immediately assisted with rectifying their problems. Concept introduction is also done on the same day through small group discussion, presentation and rectification towards the last 30 minutes of the session.

*Sundays (only twice a semester)* are picnic days and are spent on concept introduction and reinforcement along with problem solving for the week's topic. Again,

small groups are formed, content being discussed and presented. I correct misconceptions and unclear ideas during each group's presentation. I usually provide lunch for the students. At the end of the day, students submit concept maps, a tool that will identify students' understanding of concepts and how those concepts are connected or linked to each other. In addition, the purpose and outcome to be accomplished during the peer-facilitating session on Tuesdays are clearly spelled out to guide the facilitators.

On Tuesdays, each of the facilitators who were with me on Sundays, will be in charge to facilitate a small group of 4 students each. I do the selection of peers belonging to a group for the peer-discussion. Each group will consist of students ranging from good to below average CGPA. The purpose is for everyone to help each other in comprehending the subject matter. During the peer discussion, a review of the past week topics are done beginning with the review of their quizzes that are returned to them at the beginning of the session. From there, they then use the self-assessments along with the textbook to fulfill the objectives of the week's session (I had downloaded the pre assessments they emailed me and each facilitator are given a copy of the pre-assessments to help them identify weakness among the group members). In addition, each facilitator has the facilitator's notes to assist them in achieving the objectives of the week's session. [A point to note is that these sessions are meant for the facilitator to start and guide the discussion. Unfortunately, many students look at the facilitator to do the teaching (transmitting) and some students are not even prepared for the discussion session.]

Thursdays are used for concept reinforcement with all the students and formative/summative assessment for the week's topic. The formative assessment comes in the form of reinforcement (Power Point lectures) that took into consideration the post assessments that students sent to me via email. The day before the lecture, I would download and analyze all the post-assessments that were sent to me (both the pre and post assessments form parts of the summative assessments). I try to minimize the *transmittalist* technique even though I have my delivery materials all ready to be shared. Instead, I let the students ask me questions about the topic of the week since they had discussed it on Tuesday. Usually, I don't get many questions (this is culturally influenced). So, I end up lecturing for 70 minutes (with a lot of pauses and question and answers in between) but focusing on the weaker concepts as indicated in the post assessment emailed to me. At times, the students just want to do more discussions with their peers while I answer some of their questions instead of them falling asleep while watching my slides and listening to my "lullaby". They want the discussion in order to prepare for the ten-minute quiz (*mostly up until comprehension level*) at the end of the two-hour class. The session is meant to focus on ideas that were very challenging and need further clarification from me. The cycle ends on Wednesdays or Thursdays and begins again on Fridays, where a different group of facilitators are involved (only these pupil have to be present, not the whole of the class).

### **C. Evaluation and Amelioration of Teaching**

The fact that the peer-facilitating learning cycle that I employ in my thermodynamics is showing positive outcome is shown by the results of both the comprehensive final exams and the grades attained at the end of semester (attached sheet). For the past two semesters and given that the standard of the students and standards of the exam questions remains unchanged, the average for the final exam



(subjective questions) had increased to more than the 20 percent mark of the possible 40 percent. If one were to judge student's learning by the final exam (since it is comprehensive and testing up to the problem-solving level of Bloom's taxonomy), the percentage of students acquiring a minimum of 20 out of 40 is really high particularly for the Dec 02 – Apr 02 semester. The semester grades have seen a fast decline in the number of failures (see the attached result sheets). Potential failures usually come from those who do not submit their reading assignments and those whose attendance in class is not encouraging.

As part of determining the amount of learning taking place, students are asked to evaluate themselves by using sets of operational objectives designed for each topic. Every week students compare their comprehension before and after peer-facilitating by using a Likert-type scale of 1 (strongly disagree), 2 (Agree), 3 (Undecided/Unsure), 4 (Agree) and 5 (strongly agree) to the statements claimed in the operational objectives. A summary of the [evaluation is attached](#). This semester (Dec 2002 – April 2003), the responses to the operational objectives are sent via email to me. Students would download the file from my website, key in the responses to match their names and send it back to me as file attachment in their email. I then download and analyze their responses (*it takes about 4 hours to do all of this since there are more than 60 students in the class*) and use it to better teach the students by sharing the pre-assessment analysis with peer facilitators while they lead discussions and the post-assessment for me to focus on difficult aspects as admitted by the students in their responses. In addition to the self-assessment, students evaluate the teaching method and evaluate me as their lecturer/chief facilitator at the end of the semester. A summary of the [course evaluation is attached](#). The summary clearly reflects the students' love for the instructional method and their support for my commitment in doing the things that I did for them. I strongly urge the management to read the summary. The course evaluation allows students to comment on the positive and negative part of components including their efforts, the method of learning, the course expectations and me as their lecturer/mentor/facilitator.

#### **D. Conclusion**

I believe that the implementation of the peer-facilitating learning cycle has made a difference in the way that students learn thermodynamics. The fact that students have not taken any physics course at the department level proved an uphill challenge to engage them in intellectual reasoning and quantitative analysis of the subject matter. But I took that challenge to the limit. I have been living on a day to day basis trying to utilize all the available hours I have in order to design and type the materials, grade the reading assignment and quizzes and all other summative evaluation in between classes, meetings and family obligations. Sacrificing 4 to 6 hours every Sunday to coordinate and train the peer-facilitators to prepare them for their small group discussion is indeed difficult but satisfactory. My hope to produce students who has longer retention on the understanding is beginning to show its fruits of success from the course grades, and from verbal and print feedback evaluation that I received. Some day in the very near future, the labor of my work will be presented and published in physics conferences or educational journal and I hope will trigger an interest to other faculty members to try it out in their classes.

## E. Evidence Available

(Check my website at <http://www.uitm.edu.my/faculties/fsg/drjj1.html>).

### Peer-Facilitating Learning Cycle & Course outline

<http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/peerfcins02.pdf>.

### Summary and samples of course evaluation

<http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/sumsemeval501.pdf>

<http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/sumeval1101.pdf>

<http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/sumeval502.pdf>

[http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/semval1202\\_dic.pdf](http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/semval1202_dic.pdf)

[http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/semval1202\\_bsac.pdf](http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/semval1202_bsac.pdf)

### Samples of (formative) self-evaluation

#### Summary of course grades

<http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/thermogr.pdf>

<http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/thermogr00.pdf>

#### Self assessments - Operational objectives

<http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/self-s/2self1.pdf>

<http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/self-s/2self2.pdf>

<http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/self-s/3selfhw.pdf>

<http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/self-s/3selfcm.pdf>

<http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/self-s/4selfcv.pdf>

<http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/self-s/5self-1.pdf>

<http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/self-s/5self-2.pdf>

<http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/self-s/6selfent.pdf>

<http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/self-s/9selffrank.pdf>

#### Samples of pre and post self-assessments

[http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/2self2\\_1202.xls](http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/2self2_1202.xls)

[http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/6self1\\_1202.xls](http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/6self1_1202.xls)

#### Peer-facilitating notes for the peer-facilitators

<http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/fcnotes/2peer.pdf>

<http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/fcnotes/3peerhw.pdf>

<http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/fcnotes/3peercm.pdf>

<http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/fcnotes/4peercv.pdf>

<http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/fcnotes/5peer-1.pdf>

<http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/fcnotes/5peer-2.pdf>

<http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/fcnotes/6peer.pdf>

<http://www.uitm.edu.my/faculties/fsg/DRJJ/Evaluate/fcnotes/9peer.pdf>

## Samples of Summative Evaluation

### Papers presented at conferences.

- Invited Talk at SMK Seksyen 11, Shah Alam, Selangor  
<http://www.uitm.edu.my/faculties/fsg/DRJJ/Talks/SMK11.pdf>
- Invited Talk at Seri Negeri Auditorium, Air Keroh, Melaka  
<http://www.uitm.edu.my/faculties/fsg/DRJJ/Talks/PnPMelaka.pdf>
- Invited Talk at MARA Headquarters, KL  
<http://www.uitm.edu.my/faculties/fsg/DRJJ/Talks/maralec03.pdf>
- Plenary Speaker, Karachi, Pakistan  
<http://www.uitm.edu.my/faculties/fsg/DRJJ/Talks/DRJJlecture.pdf>
- Workshop Facilitator, Karachi, Pakistan  
<http://www.uitm.edu.my/faculties/fsg/DRJJ/Talks/DRJJwshop.pdf>
- Invited Talk at Matriculation Center, Perlis  
<http://www.uitm.edu.my/faculties/fsg/DRJJ/Talks/matarau.pdf>
- Invited Talk at Matriculation Center, Sabah  
<http://www.uitm.edu.my/faculties/fsg/DRJJ/Talks/labuan02.pdf>
- Invited Talk at AsPEN Seminar & Workshop, Kuantan, Pahang  
<http://www.uitm.edu.my/faculties/fsg/DRJJ/Talks/aspen02.pdf>
- Keynote Address at Universiti Tenaga Nasional, SMILE 2001, June 2001.  
<http://www.uitm.edu.my/faculties/fsg/DRJJ/Talks/keynotejj3.pdf>  
<http://www.uitm.edu.my/faculties/fsg/DRJJ/Talks/keynotejj4.pdf>
- Contributed Paper at Universiti Malaysia Sabah, Nov. 2000  
<http://www.uitm.edu.my/faculties/fsg/DRJJ/Talks/peerfctalk.pdf>