



# Lecturer's Capability to Improve Quality of Teaching and Learning Process: a Case Study on Statistical Physics Course

I Made Joni

Physics Department, Faculty of Mathematics and Natural Science  
Padjadjaran University, Bandung  
Phone:022-7796014, e-mail:madejoni93@yahoo.com

## ABSTRACT

*In this article, I shall describe my experience of developing instructional tools of course on Statistical Physics as well as the implementation of Instructional Technology. I shall discuss the approach I took, the difficulties I faced, and the experiences I drawn from this education experiment during teaching and learning process.*

## 1. INTRODUCTION

In recent years there has been a tendency for *Learner (or Student) Centered Education* and this being paradigm shift from teaching to learning. Besides, the development of instructional technology allow instructors at all levels to put their teaching materials on the Internet, either for distance-learning or ease-of-access purposes. Designing instructional materials for online teaching and learning is quite a challenge to instructors in any field. Teaching materials of this kind can be quite different to those used in traditional classrooms or lecture theatres, in the sense that *they must somehow replace or compensate the role or presence of the instructor.*

I intent to discuss about student learning related to the capability of lecturer as a designers of learning environments; they study and apply best methods for producing learning and student success. A lecturer expecting to be able to identify students' problem with learning: *how they learn, how they feel about their learning, what problems they encounter when learning, what helps /hinders their learning, what they have actually learned, and how they have changed as learners.* Therefore, one of our goals as instructors is to provide students with opportunities to become active, critical thinkers who move beyond a view of learning as information-gathering to a view of learning as knowledge-building. Real learning is transformative. It changes the nature of what is learned because it involves the learner's ability to synthesize, evaluate, and accommodate new information into old systems of knowledge. *Traditionally, the "best" teachers are assigned to teach the highest achievers.* On the other hand, *low-achieving students require the most effective teachers.* The question arise is how to make a good teacher and what are the observable qualities of teachers who positively impact the academic performance of low-achieving and at-risk students? The aim of this article is to take a case study on statistical physics discussing the methodologies used and report the difficulties encountered during the course design.

## 2. FUNDAMENTAL LEARNING THEORY

Learning is multi dimensional includes the following aspect:

1. Understanding and comprehending knowledge; learning terms, concepts, and vocabulary.
2. Developing advanced cognitive abilities including critical thinking, problem solving, analysis, and evaluation.
3. Improving communication skills including writing, reading, speaking, listening, and working in teams.

## Instructional Knowledge

Effective teachers exhibit a breadth of knowledge, bring information together from a variety of sources, analyze concepts effectively, and stay up to date in their specialty. Just how we present our knowledge will depend on our approach to teaching in general, but we can take advantage of the expertise we have over mere textbook presentations by:

1. Revealing our thought processes and demonstrating and sharing our thinking so that students get a sense of what it means to think like a psychologist or a chemist or an art historian and tackle problems in the discipline.
2. Discussing current developments and their effect on present theory
3. Being careful not to oversimplify; there is sometimes a tendency for Teacher to summarize what students *need to know* from a course rather than invite them into the discipline and into academic inquiry as a process
4. Staying at least a week ahead of the students if we are teaching outside our specialty, but remembering that we are not responsible for knowing all the answers or that we need not apologize for our lack of knowledge -Helping our students find out answers to questions they have by agreeing to look it up later—and following through with this offer—or by helping them find out the answers for themselves
5. Determining through evaluation procedures that are consistent with course goals and teaching strategies whether students have learned what we intended. Remember that we are not responsible for knowing all the answers; so we do not feel compelled to apologize for our "lack of knowledge." If we cannot answer a question or we have made an error, admit it, but tell our students where they may find the answer or offer to look it up—and then do it.

## 3. CASE STUDY ON STATISTICAL PHYSICS

### 3.1. Brief description of Statistical Physics Course

This is an introductory course on statistical mechanics, which aims to calculate the thermodynamic properties of a system from a suitable microscopic description. To describe processes involving a very large number of particles, special statistical method must be used for computing average values of dynamical quantities instead of accurate individual values of each member of the system. The technique for dealing with these systems is called statistical mechanics. Statistical mechanics is the incredibly successful theory which allows us to describe macroscopic or thermodynamic properties of materials in terms of the known dynamics (either classical or quantum) of the constituent microscopic particles (such as atoms and molecules). Statistical mechanics gives a microscopic understanding of phenomena as diverse as entropy and the second law of thermodynamics, the ideal gas law, the cosmic microwave background radiation, neutron stars, superfluidity, the denaturation of proteins, magnetic phase transitions, and the electronic properties of metals. These diverse applications will be illustrated in the tutorial problems or paper assignment in the end of this course.



The subject provides part of a comprehensive, complete and coherent program of education in Physics intended for students aiming to become professional physicists. It is a compulsory subject for entry into Master degree in Physics or Postgraduate. The course would also be beneficial to students in biochemistry, chemistry, computer science, materials science, and mechanical and chemical engineering. At the end of this course we should be able:

1. To determine the equilibrium state of one or many harmonic oscillators, spins, classical gas molecules, and of electromagnetic radiation (in all cases assuming negligible interactions between the particles or weakly interacting particles )

2. To calculate the thermal values of the entropy, Helmholtz free energy, and internal energy and also the heat capacity.
3. To understand the use of maximum entropy to define the equilibrium distribution of a system particles.
4. To understand the feature of Maxwell- Boltzmann, Bose-Einstein and Fermi-Dirac distribution.

I assume that the essential background of the student to entry this course are : Thermodynamics and Condensed Matter Physics, and the Mathematics are : – Calculus and Linear Algebra II (or Mathematical Physics) as well as desirable – Quantum Physics. Intending students need to be competent in calculus, particularly including the theory of first order partial derivatives. The course is presented on the assumption that the student is familiar with Gibbsian Classical Thermodynamics. The development proceeds from an assumed background that includes all the basic results of a course in elementary quantum mechanics.

### **3.2. Instructional Analysis**

The first step to the preparation of instructional plan is doing instructional analysis. The result of instructional analysis is shows in figure 1. Then the next step is designing a General Course Outlines (GBPP) and Instructional unit which considering the generally *define and delimit* Course Content:

1. Content that the student will be required to know
2. Content provided for individual student inquiry or projects
3. Content of interest only to students interested in specializing in the course subject matter

Base on the instructional analysis, I systematically able to develop all others instructional tools (see attachment) such as, Problem Design (Kisi-kisi Soal), Learning Guidance (Panduan Perkuliahan/Kontrak perrkuliahan), Evaluation Plan , Course Materials lecture note and slides (Bahan Ajar).



### 3.3. Teaching Strategy

The teaching strategy taken during the implementation of this course in year of 2005 is conventional lecturing, tutorials, paper assignment and group presentation.

*Lectures* will mostly be held in Monday 10am and Saturday in 12am contact hours, although this will be varied in order to keep the tutorials in step with the lectures. They will cover the foundations of statistical mechanics. Lecture notes will be made available in advance where possible, and students are strongly encouraged to read them before attending the lecture.

*Tutorials* will cover the application of statistical mechanics to a diverse range of physical systems. The tutorial problems will be handed out in lectures in advance, and solutions will be made available after each tutorial. Students are **required** to attempt these problems before attending the tutorials.

#### *Paper Assignment*

To gain a better understanding of the course material students may use the relevant application as topic of this paper assignment. Student has to perform oral presentation before final exam conducted. Time schedule for this activity will be announced later.

#### *Other information*

Students often find statistical physics one of the hardest courses they study in a physics degree. The concepts are abstract, and one of the best ways to gain an understanding of the underlying theory is in attempting to apply it to problems. The tutorials form an integral part of this course. Students are expected to attend all of the lectures and tutorials, and to attempt the tutorial problems before they are covered in class.

**Past experience suggests that students who do not do so are unlikely to pass the course.**

Students may be required to take turns at presenting their solutions to particular tutorial problems in front of the class, individually and in groups. Tutorial and lecture times may be interchanged. Reading textbooks is also an essential learning method, and all students are expected to have a copy of the set text. It is a good idea to get to know it well. If you miss a lecture or tutorial it is students responsibility to either get a copy from her friend, or directly contact lecturer.

### 3.4. Assessment

Required assessment tasks:

1. Problems for each tutorial will handed out in lectures, and attempted solutions are to be handed in at the beginning of each tutorial. These are a form of formative assessment – their intention is to help you to understand and apply the course material. There will also be two short test or quiz during semester. The requirement for grade for a given tutorial or short test is a serious attempt at every question. Both will be worth 10% of the total assessment for the course.
2. There will be paper assignments and presentation in the end of course, worth a total of 10%. The due dates and presentation time will be announced later.
3. There will be a midterm test and final test centrally-timetabled two hour exam. The exam is worth each 40%.

### ***Assessment criteria***

Answers to written examination questions, will be assessed in terms of the extent to which they demonstrate the ability of the student to:

1. Define, explain and interrelate the key concepts involved in the course.
2. Recognize the regime of applicability of the theory presented.
3. Use the basic theory to describe quantitatively the behavior of important physical systems treated.
4. Apply the theory to new physical problems and obtain correct analytical and numerical results in the appropriate units of measurement.
5. Utilize the appropriate mathematical and other *techniques to derive relationships for physical quantities*.
6. *Have an appreciation of the orders of magnitude of important quantities.*

### ***Criteria for the award of grades***

To earn a Grade of “A”, a student must demonstrate an excellent understanding of the course material. This includes clear expression of nearly all their deductions and explanations, the use of appropriate and efficient mathematical techniques and accurate answers to nearly all questions and tasks with appropriate justification. They will be able to apply mathematical techniques to completely solve both theoretical and practical problems. A student satisfying this criterion will normally achieve a final mark between 80 - 100 %.

To earn a Grade of B, a student must demonstrate a comprehensive understanding of the course material. This includes clear expression of most of their deductions and explanations, the general use of appropriate and efficient mathematical techniques and accurate answers to most questions and tasks with appropriate justification. They will be able to apply mathematical techniques to partially solve both theoretical and practical problems. A student satisfying this criterion will normally achieve a final mark between 70 - 79 %.

To earn a Grade of C, a student must demonstrate an adequate understanding of the course material. This includes clear expression of some of their deductions and explanations, the use of appropriate and efficient mathematical techniques in some situations and accurate answers to some questions and tasks with appropriate justification. They will be able to apply mathematical techniques to solve fundamental problems. A student satisfying this criterion will normally achieve a final mark between 60 - 69 %.

To earn a Grade of D, a student must demonstrate an understanding of the basic concepts in the course material. This includes occasionally expressing their deductions and explanations clearly, the occasional use of appropriate and efficient mathematical techniques and accurate answers to a few questions and tasks with appropriate justification. They will have demonstrated knowledge of techniques used to solve problems and applied this knowledge in some cases. A student satisfying this criterion will normally achieve a final mark between 50 - 59 %.

To earn a Grade of E, a student could not demonstrate some knowledge of the basic concepts in the course material. This includes occasional expression of their deductions and explanations, the use of a few appropriate and efficient mathematical techniques and

attempts to answer a few questions and tasks accurately and with appropriate justification. A student satisfying this criterion will normally achieve a final mark below 50.

### ***Assessment policy***

The deadlines for assignments given in this course profile will not be extended. Students are expected to hand in their work on time; **otherwise it will not be marked and no grade will be awarded.** This is to ensure fairness to those students who do hand their work in on time. In exceptional circumstances individual students may receive extensions; however you should contact your lecturer as soon as possible if such circumstances arise. After the due date no extensions will be given. Tutorial work must be handed in before or at the beginning of each tutorial. This assessment ensures that an attempt at the problems has been made in advance. A comprehensive compilation of relevant formulae will be provided for the examination. Calculators/pocket computers may be used in the examination, so long as they are small, and portable.

### **Plagiarism:**

Definition of plagiarism is the action or practice of taking and using as one's own the thoughts or writings of another (without acknowledgement). The following practices constitute acts of plagiarism and are a major infringement of the University's academic values:

1. where paragraphs, sentences, a single sentence or significant part of a sentence which are copied directly, are not enclosed in quotation marks and appropriately footnoted;
2. where direct quotations are not used, but are paraphrased or summarized, and the source of the material is not acknowledged either by footnoting or other simple reference within the text of the paper;
3. where an idea which appears elsewhere in print, film or electronic medium is used or developed without reference being made to the author or the source of that idea.

When a student knowingly plagiarises someone's work, there is intent to gain an advantage and this may constitute misconduct. Students are encouraged to study together and to discuss ideas, but this should not result in students handing in the same or similar assessment work. Students do not allow copying another students' work. While students may discuss approaches to tackling a tutorial problem, care must be taken to submit individual and different answers to the problem. Submitting the same or largely similar answers to an assignment or tutorial problem may constitute misconduct. If a deliberate act of plagiarism is proven, the results of the assessment may be annulled and other action may be taken as is considered appropriate in the circumstances of the case.

### **Special examinations**

If a student is unable to sit a scheduled examination for medical or other adverse reasons, she/he can and should apply for a special examination. Applications made on medical grounds should be accompanied by a medical certificate; those on other grounds must be supported by a personal declaration stating the facts on which the application relies.

### 3.5. Evaluation Design

The evaluation is designed for the purposes of the evaluation on teaching learning process, those are:

1. To get a feedback of quality of teaching and learning process from students and other teacher.
2. To know the students' opinion about the teaching strategy used during teaching learning process
3. To know the students' perception about the teacher capability to deliver teaching and learning strategy used during teaching learning process.
4. To know the students' and other teacher opinion about the effectivity of using the facilities during teaching learning process.

The resulting design has been tabulated as shown in attachmnet.

## 4. EVALUATION RESULT AND DISCUSSION

### 4.1. Evaluation

#### Students Performance

No	Tahun	Jml MHs	DISTRIBUSI NILAI				
			A	B	C	D	E
1	2003-2004	42	6	10	10	5	11
			14.29%	23.81%	23.81%	11.90%	26.19%
2.	2004-2005	64	6	41	9	1	7
			9%	64%	14%	2%	11%
3	2005-2006	54	10	34	5	1	3
			18.52%	62.96%	9.26%	1.85%	5.56%

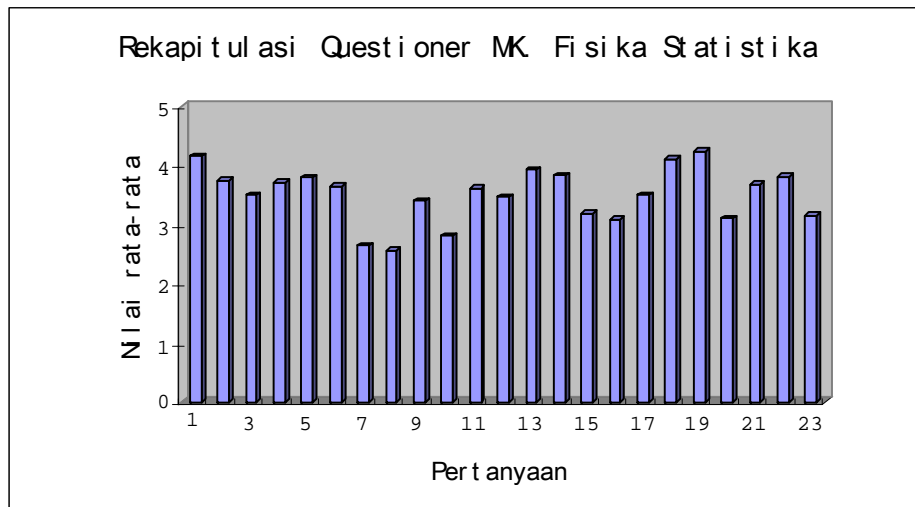
## Teacher Performance

Dari hasil evaluasi mata kuliah yang telah dilaksanakan diperoleh informasi seperti di bawah ini:  
 Table 1. HASIL REKAPITULASI QUESTIONER MAHASISWA PESERTA MATA KULIAH FISIKA STATISTIKA SEMESTER GANJIL TAHUN 2005-2006, PENGAJAR: I MADE JONI, M.Sc., JUMLAH RESPONDEN: 53 ORANG

No	Uraian	Penilaian Responden					Jumlah Responden	Nilai rata-rata
		1	2	3	4	5		
1	Memberikan silabus sebelum perkuliahan dimulai	0	1	3	35	1	53	4.15
2	Memberikan standar penilaian yang jelas	0	4	9	32	8	53	3.75
3	Memberikan informasi buku referensi utama dengan jelas	0	6	15	24	7	52	3.50
4	Menjelaskan pokok bahasan yang akan diajarkan pada awal perkuliahan	0	2	15	30	6	53	3.72
5	Menjelaskan relevansi mata kuliah yang diajarkan dengan mata kuliah lain yang terkait	0	2	9	38	4	53	3.79
6	Menyajikan materi kuliah sesuai dengan silabus yang diberikan	0	3	13	34	3	53	3.64
7	Menerangkan materi kuliah dengan jelas	3	1	28	9	1	53	2.64
8	Mengajar dengan tahapan-tahapan yang mudah diikuti	0	1	28	9	0	53	2.57
9	Menggunakan contoh yang menarik dalam menjelaskan sesuatu	0	3	26	21	3	53	3.40
10	Mempertajam kemampuan mahasiswa dalam menjawab dan menyelesaikan soal	1	9	33	10	0	53	2.81
11	Mendorong mahasiswa terlibat (bertanya, menjawab pertanyaan dsb) dalam perkuliahan	0	3	16	28	5	52	3.62
12	Menjawab pertanyaan mahasiswa dengan baik	0	4	20	25	4	53	3.47
13	Memberikan tugas yang relevan dengan mata kuliah yang diajarkan	0	2	5	39	7	53	3.92
14	Membina kemampuan mahasiswa untuk bekerja dalam <i>team work</i>	1	1	11	32	8	53	3.83
15	Memberikan kesimpulan tentang pokok-pokok perkuliahan yang telah diajarkan	0	6	26	20	1	53	3.19
16	Memeriksa serapan mahasiswa terhadap materi yang diajarkan melalui quiz	1	9	18	25	0	53	3.09
17	Memberikan soal-soal UTS dan UAS sesuai dengan materi yang diajarkan	0	4	16	31	2	53	3.51
18	Menggunakan fasilitas proses belajar mengajar di kelas secara optimal	0	2	3	33	1	53	4.11
19	Hadir dalam waktu perkuliahan rata-rata di atas 80%	0	1	3	30	1	53	4.25
20	Mengganti waktu kuliah apabila berhalangan hadir	1	8	23	16	4	52	3.12
21	Hadir tepat waktu (tidak terlambat)	0	2	17	28	6	53	3.68
22	Membuat catatan kuliah/handout	0	4	6	35	8	53	3.81
23	Secara keseluruhan saya puas dengan perkuliahan ini	0	7	24	22	0	53	3.15
<b>Nilai rata-rata total</b>								<b>3.51</b>

Keterangan skala penilaian:

- 1 = sangat tidak setuju
- 2 = tidak setuju
- 3 = netral
- 4 = setuju
- 5 = sangat setuju



Three criteria of evaluation having most highest grade above 4 those are

1. The availability of Course Outlines or Learning Guidance
2. Use the learning facility effectively
3. Teacher Attendant above 80%

The most promising writer is the success of promoting discussion and improving communication and team work of the students. And the lowest grade occur in the criteria of evaluation ability to explain lecture clearly and systematic way of teaching. I think this may be due to the strategy of promoting independent study by shifting from conventional teaching to combination with learner center learning by providing the problem set and also paper assignment. Other fact also may cause this problem, the number of student is large due to the attendance of this lecture both A class and B class student. Therefore, careful consideration has to be taken, since the low-achieving students may face problem on following the lecture and they require more clear explanation. *However*, over all teacher performance shows that satisfy the student and also has a good correlation with the performance of student.

#### 4.2. Discussion

1. In order to get better quality of teaching and learning process, lecturer need to perform continuous research student's learning
2. The resulting assessment shows that lecturer on this course should implement the new Instructional Technology
3. The evaluation should be conducted using a last design of evaluation and conduct periodic evaluation and reconstruction of Instruction Unit and implementation of Instructional Technology
4. Open mind and welcome to the implementation of new Instructional Technology and Teaching Skill
5. Because this course have a wide entry behavior and also supporting to other courses, it is propose to handle this course by a Team of Lecturer.
6. In other to response the few student having difficulties on following my lecture, I propose to make a separate class A and B teaches by a Team of Lecturer. This also can be done by developing web base instructional technology to allow alternative interaction of teacher and students.

## 5. CONCLUSION

Experience tells us that it is hard to stimulate students to find material independently and improve their ability to search, gathering and elaborating of information. For a course requiring Active Learning like statistical physics, the problem cannot be simply solved by setting examinations or otherwise forcing students once more into drill and practice patterns. Therefore, a better instructional design should be considered. We find that giving an opportunity to deliver presentation improve their ability to communicate ideas, work within a team and ability to write articles. At this stage I have solve the problem by arranging classroom tutorials and additional discussion under an appointment with student during the teaching and learning. I also find that the proper arrangement of instructional tools give less tension during preparation of teaching and learning process. As a result of my teaching experiences on Statistical Physics course for five years implementation, I have been completely fulfilled the Instructional Tools of Course. However the implementation of teaching technology and teaching skilled is necessary to improves in order to promote better quality of teaching and learning process and in turn will result a success learner (student). I also hope my experience will assist the audience to decide what instructional strategy or which design components would serve them best in designing and distributing their teaching and learning strategy.

## Acknowledgments

I thank for Drs. Cukup Mulyana, M.S. of Directur of TPSDP UNPAD and Dr. Bernard Y. Tumbelaka, M.Eng.Sc. a PIC of the Activity of Improvement of Curriculum Relevance for their effort to organize the workshop and advice on scope of the articles.

## References

- Allen, R. R., and Rueter, Theodore. *Teaching Assistant Strategies: An Introduction to College Teaching*. Dubuque, IA: Kendall/Hunt Publishing Company, 1990.
- Bates, A. W., and Poole, Gary. *Effective Teaching with Technology in Higher Education: Foundations for success*. San Francisco: Jossey-Bass, 2003.
- Blythe, Hall and Sweet, Charles. *It Works for Me: Shared Tips for Teaching*. Stillwater, OK: New Forums Press, 1998.
- Boice, Robert. *First-Order Principles for College Teachers: Ten Basic Ways to Improve the Teaching Process*. Bolton, MA: Anker Publishing Company, 1996.
- Brookfield, Stephen D. and Stephen Preskill. *Discussion As A Way of Teaching: Tools and Techniques for Creating Democratic Classrooms*. San Francisco, CA: Jossey-Bass, 1999.
- Clark, Christopher M. *Thoughtful Teaching*. Teacher Development Series. London: Cassell, 1995.
- Grasha, Anthony F. *Teaching With Style: A Practical Guide to Enhancing Learning by Understanding Teaching and Learning Styles*. Pittsburgh: Alliance, 1996.
- Halpern, Diane F., and Associates. *Changing College Classrooms*. San Francisco: Jossey-Bass, 1994.
- Johnston, Kevin M. *MSU Teaching Thoughts # 12: " Teaching Principles as Teaching Practice: Worthwhile, Or Not?"* 2002. <http://tap.msu.edu/PDF/thoughts/tt12.pdf>.

- Lowman, Joseph. *Mastering the Techniques of Teaching*. San Francisco: Jossey-Bass, 1995.
- Marincovich, Michele, Jack Prostko and Fredrick Stout, Eds. *The Professional Development of Graduate Teaching Assistants*. Bolton, MA: Anker Publishing Company, 1998.
- McKeachie, Wilbert J., Nancy Chism, Robert Menges, Marilla Svinicki, Claire Ellen Weinstein. *Teaching Tips: A Guidebook for the Beginning College Teacher*, 8th ed. Lexington, MA: D. C. Heath and Company, 1994.
- Miller, W. R., and Marie F. Miller. *Handbook for College Teaching*. Sautee-Nacoochee, GA: PineCrest Publications, 1997.
- Newby, Timothy J. *Instructional Technology for Teaching and Learning: Designing Instruction, Integrating Computers, and Using Media*. Englewood Cliffs, NJ: Merrill, 1996.
- Nilson, Linda B. *Teaching At Its Best: A Research-Based Resource for College Instructors, 2nd Edition*. Bolton, MA: Anker Publishing Company, 2003.
- Roblyer, M. D. *Integrating Educational Technology into Teaching*. Upper Saddle River, NJ: Merrill, 1997. *The Teaching Professor Newsletter*. ISSN 0892-2209. Madison, WI: Magna.
- Weimer, Mary Ellen. *Learner-Centered Teaching: Five Key Changes To Practice*. San Francisco, CA: Jossey-Bass, 2002.
- Yelon, Stephen L. *Powerful Principles of Instruction*. White Plains, NY: Longman Publishing, 1996.