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Teaching Portfolio

Starting in 2009 as a full-time teaching assistant appointed as a researcher at the Technische Universität Berlin in Germany, I had the privilege to teach undergraduates and graduates in many different scales from ten graduate students up to one thousand freshmen. Besides the preparation of exams and classes for tutors (graduate students working as part-time teaching assistants), I have visited a broad range of teachers' trainings to develop and improve my method of teaching. In 2014 I started working as a lecturer and sponsored my own course for graduates. In this portfolio I am reporting about my success and outcomes of using the methods as well as about the preparation and evaluation of my teaching to and for learners in higher education.

Philosophy of Teaching

In engineering lectures the outcome shall be justified by giving concrete examples. An engineering application is the best method to introduce, motivate, explain, exercise, and even conclude a lecture. In my opinion, an efficient lecture has to use different methods for engaging all learners in such a pattern:

- Classes, where the instructor delivers the theory
- Solving of engineering applications by the instructor
- Assignments and a term-project prepared by learners in small groups

The lecturing style for each of bullet-point differs slightly and are discussed in what follows. In the beginning of the semester, I provide a detailed weekly time schedule of the lecture in order to help the learners prepare their own schedule for preparation of assignments and their other duties.

Classes

A conventional teaching is a one way delivery of information from the instructor to the learner. This method is indeed necessary, but I believe that the instructor has to realize this action as a performance on stage in front of a specific group of learners. Each unit of lecture needs to be prepared precisely for the audience and it needs to engage and include the learners in a conversational style. I try to adapt a style as if having a conversation with the audience and complement the delivery by using many repetitions and rhetorical questions. I tend to use a less formal and simple language by clearly explaining the technical terms. Generally speaking every unit starts with a short recap in order to let the learner remember what we have reached and where we are heading.

A good instructor achieves to interest the learner in the topic. In order to obtain the maximum interest, I use several methods as follows: a varying pace in the language, using attenuation before the key words such as technical terms, and using a joke before delivering a take home message. Moreover, I utilize gestures for giving vivid descriptions of mostly abstract ideas. Teaching is not a copying ideas from instructor's to learner's brain. It needs to pulsate the

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audience with the goal of presenting the theory in a fascinating way such that the learner is willing to remember the details.

Instead of a board I use e-chalk where the monitor is projected on the wall behind me. Thus the learners are occupied by following the instructor and the screen at the same time. They can choose to write with or not, all the material is provided online after each lecture. A short recording of a lecture[1] held on February 10, 2012 and a part of its notes can be seen in Fig. 1 as an example.

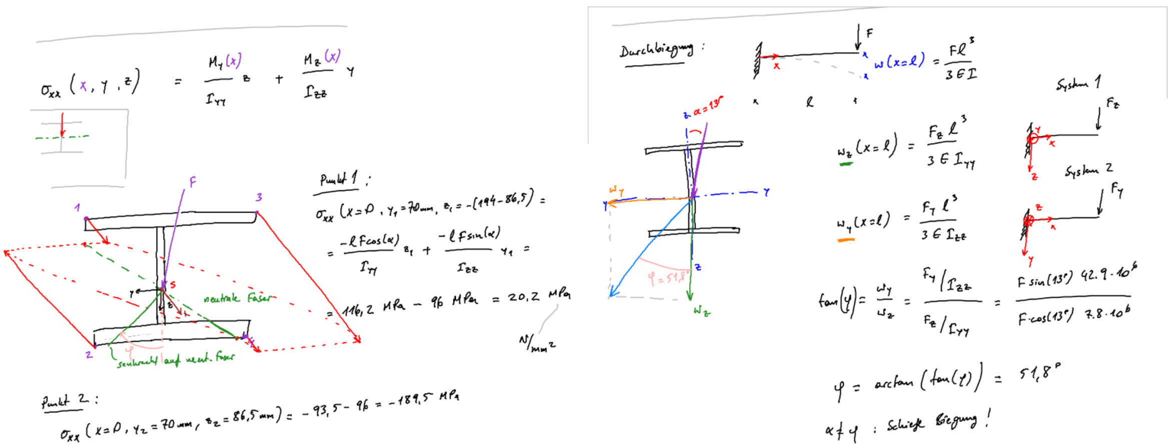

Figure 1: Part of notes showing an exercise of superposed stresses in a cantilever beam (unsymmetrical) bending.

Solving

The method of solving an engineering example needs to be presented as an additional subject. For beginners it is challenging to learn a new topic and apply an engineering approach to solve a problem. Therefore, many examples need to be given and discussed with learners to help them construct a strategy how to define solutions to different problems. Personally, I find it useful to make the strategy as clear as possible such that every learner starts to be engaged. Many recaps and repetitions are necessary of why and how a certain step is decided to conduct. Trying to receive suggestions from the learners help in twofold. Firstly, the interaction and engaging helps to remember the connections. Secondly, it serves as a feedback of the level of understanding such that the instructor has a chance to repeat some unclear steps. An important fact is to bridge every step with the overall goal in order to break down the cognitive dissonance and keep the beginner on track.

Assignments and Term-project

Assignments and a term-project are prepared in small groups, which help learners to interact with their colleagues. I give a detailed correction of every assignment in order to show transpar-

[1]Last 15 minutes: youtu.be/1lDVTF2RNjc

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ently what can be done in future works. In mentoring the projects I try to obtain a flash feedback from every member of the group in order to develop a solution to an existing problem based on the ideas of the learners. This method improves the involvement and generates an enthusiasm of "we develop an approach together with the advisor." I believe that emotions play a significant role in learning.

Professional Development

As an instructor I exactly know the importance of getting trained. From the day I started being involved in teaching, I began visiting teachers' trainings. Over the years I have accomplished in several institutions many trainings and certificates. I received a professional certificate in teaching in higher education from the TU Berlin after successfully completing the continuing education programme for promoting of quality in teaching. I have been awarded a Berlin higher education teaching certificate from the Berlin Center of Higher Education, which is financed by all 13 public universities and colleges in the Federal State of Berlin in Germany. Recently, I have participated academic teaching seminars given by the British Council in Berlin.

Several of learned educational methods are already exploited in my given lectures. In this configuration I realize the role of an instructor as a "pathfinder." The learners are finding their own ways by using my directions. I have a responsibility to lead them to an objective by giving a possibility of creating their own paths. Of course I need to be prepared not only for the subject in the way that I understand it, but stimulate different paths. This method needs an immense preparation time for any subject that I am teaching. Such a preparation helps also me to grasp the theory even in a better way leading to a fascination of the subject activating again the emotions of learners.

Teaching Experience

A course consist of several units in a week. Often, one lecture lasts 90 minutes (two units) without a pause for the whole semester of approximately 15 weeks.

Undergraduate Courses

Statics and Mechanics of Materials

As a teaching associate I have prepared and held classes (2 units a week) where engineering examples are solved in front of all students (approximately 850 freshmen attending). I have organized all tutors and problems solved by graduate students in smaller classrooms (20 in each classroom, more than 40 sessions a week). In cooperation with the instructor, I have prepared three exams. I worked for the course in total for 2 terms at the TU Berlin in Germany. The course includes force, moment, statics in a rigid body, bars and trusses, elastostatics in 1D, beam bending, rod torsion, stability of elastic systems, friction, strain and stress as well as Hooke's law in 3D.

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Kinematics and Dynamics

As a teaching associate same duties—preparation and holding classes (2 units a week), organizing tutors and their sessions, preparing three exams—for a smaller amount of students having completed Statics and Mechanics of Materials one semester before (approximately 630), for 2 terms at the TU Berlin. The course explains fundamentals of kinematics, work, power, balance of linear and angular momenta of rigid bodies, elastic and plastic collisions, system dynamics and introduction to control theory.

Mechanics of Materials

As an instructor I have held classes (8 units a week) for solving engineering problems in plenary sessions in front of approximately 350 freshmen for 1 term at the TU Berlin. I have supported the organization of smaller sessions held by tutors and helped for creating 3 exams. The course includes preliminary mathematics and vector calculus, introduction to elastostatics in 1D, beam bending, balance of momenta in rigid bodies.

Continuum Mechanics

As a teaching associate I have prepared, held, organized classes (1 unit a week) as well as two exams for approximately 150 students for 2 terms at the TU Berlin. The course introduces to the balance laws in 3D continuum for deformable non-isothermal bodies, presents and solves wave equation in 1D and 2D analytically as well as linear fluids in hydrodynamics.

Energy Methods

As a teaching associate I have prepared, held, organized classes (1 unit a week) as well as two exams for approximately 200 students for 2 terms at the TU Berlin. The course introduces concepts like Euler–Lagrange equations and analytical solution methods such as method of virtual work and virtual displacement, Rayleigh–Ritz and Castigliano methods, method of variational calculus.

Finite Element Method

As a teaching assistant I have held some classes (50 students), evaluated the assignments and supplied supervision to the term-projects in smaller groups (4-6 students) for 12 terms at the TU Berlin. The course introduces to mechanics for elastic and plastic deformations in 3D, presents the commercial software Abaqus, and solves fatigue problems in electronic packages, numerically.

Simulationtools and its Applications

As a lecturer I have defined several projects about inverse problem of determining material parameters out of rheometer measurements for 7 terms at the TU Berlin. Students in small groups of 4-6 have conducted experiments and written their own code (by using open-source packages) in Python.

Statics MEC 101

As a lecturer I have acted on determining the content for the newly started course and prepared all classes for solving engineering applications for 1 term (50 students) at the Turkish-German University in Istanbul, Turkey, in cooperation with DAAD (German Academic Exchange Service). Holding classes have been achieved in block seminars given in Istanbul. The course includes concepts of force, moment, as well as statics in a rigid body, bars and trusses.

Mechanics of Materials MEC 201

As a lecturer I have prepared the content and held classes in block seminars about how to solve engineering applications for 1 term (25 students) at the Turkish-German University. The course introduces elastostatics in 1D, beam bending, rod torsion, strain, stress, Hooke's law.

Numerical Methods for Engineers MAT 309

As an instructor I have designed and prepared the content as well as held classes in block seminars about how to motivate and apply numerical methods for solving equations, ordinary differential equations, set of partial differential equations, for integrating, and also for interpolation and approximation for 1 term (10 students) at the Turkish-German University. The course introduces various numerical methods and their implementations in Python.

Graduate Courses

Tensor Calculus

As a teaching assistant I have prepared, read, and evaluated the assignments for 1 term at the TU Berlin (51 students). The course presents the tensor calculus, oblique and curvilinear (general) coordinate systems, Christoffel symbols, covariant derivative in space, balance of mass, momentum, energy in general coordinate systems, constitutive equations of simple materials.

Continuum Physics

As a teaching assistant I have prepared, read, and evaluated the assignments for 1 term at the TU Berlin (18 students). The course introduces advanced analytical solution methods for initial boundary value problems in continuum mechanics for Navier–Lame equations, plasticity in 3D, Navier–Stokes–Fourier material, Maxwell fluids, singular balance equations, Maxwell equations in electromagnetism.

Mechanics of Composite Materials

As an instructor I have overtaken an existing course for 2 terms at the TU Berlin (approximately 20 students). The course introduces composite materials, laminate theory, stability and buckling in sandwich structures, numerical solution using finite element method.

Computational Engineering

As an instructor I have designed and created my own course for the summer school in Berlin, duration of 4 weeks and 18 hours a week. Lectures were in English for mostly L2 English speaking

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15 students from five continents. The course introduces elasticity, plasticity, electromagnetism, and their computations in the finite element method with implementing in open-source codes written in Python.

Theory and Computation of Composite Materials

As an instructor I have designed and created a course for the summer school in Berlin, duration of 4 weeks and 18 hours a week. Lectures were in English for mostly L2 English speaking 15 students from five continents. The course introduces classical laminate theory, production of composite materials, hands-on lab work, 3D printers (FDM and SLM), anisotropic linear elasticity, geometric and material nonlinearities; computations in the finite element method with implementing in open-source codes written in Python.

Computational Reality

As an instructor I have designed and created my own course and lectured for 7 terms at the TU Berlin (approximately 18 students). A detailed description of the course is given in the next section.

Supervision

I have acted as advisor in more than 30 thesis as part of an engineering study as well as internship programmes. Supervision is mostly one-to-one on a weekly basis. The finished works are publicly available.[2]

Quality Assurance by Evaluation

For all courses that I was involved at the TU Berlin, the so-called ELV-Team[3] evaluates the course by receiving feedback from the students in an anonymous way by asking standardized questions about the readers. Especially free text comments are highly valuable since I can obtain a direct critics about my methods. I am fond of reporting that the encouraging words increase over the years. Especially my own course receives a tremendously positive feedback.[4]

Moreover, I am pleased to have invited some colleagues for a feedback. Their feedbacks help me to amend my style. In lectures, I try to open some discussions about the newly explained terminologies in order to test the understanding directly.

[2] www.lkm.tu-berlin.de/menue/forschung/abschlussarbeiten_und_projekte/
[3] www.tu-berlin.de/evaluation/evaluation_von_lehrveranstaltungen/menue/das_owl_projekt_elv/
[4] Please contact me for getting a copy of evaluation results.

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Concept and Realization of the Course: Computational Reality

Applied mechanics—based on continuum mechanics and rational thermodynamics—allows to derive governing equations for nonlinear and coupled problems for solid bodies and fluids. The abstraction seems to be rather complicated; however, it is the simplest convenient way of seeing different phenomena under the same formalism. By starting with the balance equations the so-called weak form is generated for various problems from mechanics, thermodynamics, and electromagnetism. Solutions for the engineering problems are computed by using finite element method in space and finite difference method in time. All constitutive equations are derived by using thermodynamical principles. The emphasis of this course is on a theoretical understanding of problems in continuum mechanics and their computations. In each week one application is implemented and solved so the theory is introduced in an accumulative way starting with mechanics, continuing with thermodynamics, and ending with electromagnetism. All applications with the derivations are published as a book[5] and every section has the following structure:

- introduction of the subject by giving a connection to the last section and using an application as a concrete example,
- detailed derivation of governing equations from the balance laws,
- discussing and deriving constitutive equations (material equations),
- generating the weak form by using the variational formulation with finite difference method (FDM) in time and finite element method (FEM) in space,
- writing the code,
- discussing the results.

The best learning occurs by experiencing, hence, engineering problems are discussed and computed by using open-source packages. Nowadays, there are many well-established open-source packages working in every operating system. Future's engineers have to be equipped with abilities such as analyzing and then solving a never approached problem. A commercial software is a good tool for standard solving procedures, where the user chooses one of the existing models. However, in research institutes engineers deal with new types of problems. For example, in the case of a deforming solid body, a viscoelastic material model can be chosen in a software. If the user wants to try a non-existing material model, newly proposed by the group of material scientists, the implementation becomes challenging. In this course we show a generic approach and present how to implement any material equation. Packages of SciPy[6] as well as packages developed under the FEniCS project [7] are utilized in Python,[8] which is an engineer-friendly and easy computer language. FEniCS handles all the work of standard procedure of finite element method such that there is time for comprehending the underlying physics and discussing the equations itself, not the implementation. A plan for 15 weeks is compiled in Table 1.

[5] link.springer.com/book/10.1007/978-981-10-2444-3
[6] www.scipy.org/
[7] www.fenicsproject.com
[8] www.python.org

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Table 1: Approximate plan of the course: Computational Reality

Week	Subject	To do
1	Elastostatics, theory and application	
2	Introducing FEniCS and Python, code for elastostatics	Assignment 1
3	Nonlinear elastostatics, theory and code	
4	Hyperelasticity, theory and code	Assignment 2
5	Linear rheology, theory and code	
6	Plasticity, theory and code	Assignment 3
7	Linear and nonlinear fluids, theory and code	
8	Fluid-structure interaction, theory and code	Assignment 4
9	Applied thermodynamics; releasing different projects	Choose your project!
10	Theoretical thermodynamics in fluids, theory and code	World cafe I
11	Theoretical thermodynamics in solids, theory and code	
12	Electromagnetism for rigid bodies, theory and code	World cafe II
13	Electromagnetism for deformable bodies, theory and code	
14	Piezo- and pyroelectricity, theory and code	World cafe III
15	Presentations of the projects	Written report

Grading of students is accomplished by averaging the marks for assignments, project report, and the presentation. All work is done in small groups. After choosing a project—every group works on a different project—they immediately start with the project and report their outcomes in world cafe meetings, which is based on the Jigsaw Classroom technique. Consider of having 21 students in 7 groups of 3 people in each group. Every group prepares a short presentation about their ongoing project and present this simultaneously. Since every group has 3 members, in the classroom 3 groupings are built, where in each grouping 7 students from different groups come together. Starting simultaneously the same presentation is held in each grouping by another member of the same group. Students discuss among them and this exchange is not evaluated. World cafe enables some achievements in each meeting and a good opportunity to act as an advisor if needed. Students are more interested and even obtain useful feedback as well as solutions to their problems in the ongoing project. The method is highly efficient, only in 90 minutes, 21 students hold a presentation and improve their soft skills such as listening, engagement, and empathy, see the time plan in Table 2.

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Table 2: Time plan of a world cafe session for 21 participants as 7 groups in 3 groupings

Duration in min	Action	Medium
5	Explaining the sense and the basic rules	-
9	Group #1 has a member in each grouping and starts presenting at the same moment (incl. questions)	Laptop
1	Announcement of the last minute for closing remarks and the final question	-
9	Group #2 has also a member in each group, they start to show their presentation	Laptop
1	Announcement of the last minute for closing remarks and the final question	-
50	Groups #3–7 do analogously	Laptop
10	If there are any advices in terms of soft skills, the instructor can address the issues. Closing remarks and encouraging for further progress.	-
Sum: 85	-	-