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Peer-to-peer lecture films - a successful study concept for a first year laboratory material science course

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Abstract

Material science is believed to be one of the more complicated subjects in mechanical engineering because the scientific background is generally not taught at school during job training. First year students of mechanical and automotive engineering at HTW Berlin are required to take 2 classes in material science. Laboratory exercises accompany the education, but basic knowledge upon theory is necessary to work practically. Lecture films show the laboratory routine prior to lab hours and show students what they are going to experience and learn. These films were initially inspired by students and conducted during a one term semester project supervised by lecturers and film experts (peer-to-peer approach). It was found that students watching the films were prepared better and gained more knowledge during practical work than those who did not have access to the films. Watching the introductory films lead to more download activity and actual studying of the lectures provided to prepare the experiments and furthermore lead to slightly better testing results. Peer-to-peer lecture films were also successfully implemented teaching general phase diagrams and the iron-carbon-phase diagram.

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1. Introduction

Material Science for mechanical engineering students at HTW Berlin is taught via the “design-led” teaching approach (Ashby, 2013), (Pfennig, 2013). Because the motivation by the challenges of the design is often lost in the conventional “science-led” teaching approach, the “design led approach” faces the engineering product, introduces

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its properties and later relates these to microstructure, atomistic structure and progresses to the physics and chemistry of materials. Therefore the teaching goal is the understanding of material science, but moreover to educate students and prepare them for their role as a maker of things (Ashby, 2013).

Lecture information and a wide range of teaching materials are provided in the moodle-based material science course (ExcelLuS, 2015). This course basically addresses first year students in mechanical engineering, economical engineering, and automotive engineering. The concept follows a blended learning scenario where scientific backgrounds are self-studied via online-lectures. These small units, micro-modules, have precise titles and summarize the most important issues necessary to follow lectures and conduct laboratory experiments.

Students enrol into HTW applied university come from multiple different educational backgrounds, which is a benefit and a great challenge at the same time. It is necessary to study the scientific background of material properties to understand the material test results gained in the lab course. Discussions are encouraged, but each student is responsible for her/his own. Therefore a great variety of teaching material is provided. Mindmaps summarize the content of the micro module lectures. Micro module lectures combined with self-testing questions cover the most important issues. Web Based Trainings (WBTs) offer individual studying and demonstrations enhance memorizing and understanding. Short course mindmaps aim at memorizing technical terms and understanding the correlation of the micro modules. Full content self-tests as well as assignments with worked solutions allow for students to control their learning progress and for the lecturer to assess skills and knowledge.

Still, so far students did not find these appealing to pick and study properly when preparing for the lab course. Hence, most lab courses were very challenging, often chewy and disappointing for lecturers. The joy of hands-on courses could not be felt. Based on students` initiative films were produced to make materials science lectures come to life.

2. Material science lecture films

Up to now there are 36 lecture films ready available on moodle HTW and youtube for students enrolled in material science classes:

- Phase diagrams (10 lecture films) (2:35 hours)
(<https://www.youtube.com/playlist?list=PLUOIZMSZYz5zha5EbwAKrQ8w8W65ST3fN>)
- Iron-Carbon phase diagram (11 lecture films, 2:47 hours)
(https://www.youtube.com/watch?v=_RdbQFk4jWU&list=PLUOIZMSZYz5yHjaqEAaPj77ignXqACXaD)
- Corrosion (4 lecture films) (10:10 min)
(<https://www.youtube.com/playlist?list=PLUOIZMSZYz5ww5xRMQdzIUooNifYEemvZ>)
- Materials Testing (5 lecture films) (11:42 min) (Fig. 1)
(<https://www.youtube.com/playlist?list=PLUOIZMSZYz5ww5xRMQdzIUooNifYEemvZ>)
- Heat treatment (3:08 min)
- Ultrasonic testing (1:22 min)
- Microstructure (1:44 min)
- Tensile strength testing (1:19 min)
- Hardness (3:09 min)
- Composites – fiber reinforced polymers (6 lecture films) (35:31 min)
(<https://www.youtube.com/playlist?list=PLUOIZMSZYz5xoSdJuRuKCOxIDqnryBRpK>)

In progress: a) Polymers (5 lecture films); b) elastic/plastic deformation (7 lecture films).



Fig. 1. Materials testing lecture films in material science blended learning course (Pfennig, 2015).

3. “peer-to-peer” approach

Class results indicate that involving students directly into teaching activities can be very effective in getting students to engage in critical thinking (Colorado State University, 2015), (Lord, 2012); thus, producing deeper learning outcomes (Cuseo, 1992), (Goto and Schneider, 2010). Well known methods are for example: “think pair share”, peer instruction: Whitman and Fife (1988), reciprocal peer tutoring (Simon et. al., 2010) or undergraduate teaching assistance (Fingerson and Culley, 2001).

Since 2014 the 3I-model has been developed within the externally funded OLP project at HTW Berlin (OLP Online Lehre Plus /Online Teaching Plus, 2015). This model defines video as a channel in teaching by its intention:

- inform
- instruct
- give impulse.

Both, the screenplays of the students and the peer-to-peer lecture films are good examples how to instruct in an effective way especially regarding the peer-to-peer aspect.

3.1. Model Overview

- Information: Short video inputs to replace the traditional frontal type of teaching basic knowledge for inverted classroom setups (OLP, 2015).
- Instruction: “How-to videos” to qualify students to work with machines/setups respectively theoretical models for quantitative or qualitative research.
- Impulse: Short documentary videos for advanced students serve as an additional motivation and affirmation. These videos encourage the individual to critically examine his or her own views and promote cross-border collaboration.

All the teaching benefits are included when students are involved in the film making according to the peer to

peer teaching approach which applies well for films as lecture. Effective operation of the lecture films is based on student's experience and their special needs when preparing for the graded lab courses. Therefore 6 students worked on a full concept and implementation and integration of the lecture films in the moodle course available to all students taking lab courses in material science. The short films introduce the specific labs, the task and the working routine without presenting results or findings. Voices were only used to support the pictures and explanations were given from the background. The lecture screen play was proof read by lecturers and the film making was supervised by an OLP-film team of the HTW (OLP Online Lehre Plus /Online Teaching Plus, 2015). The same procedure was applied for the making off the lecture films introducing "corrosion" and "fibre reinforced polymers".

4. Results and evaluation

To introduce the laboratory experiments lecture films appeal to many students and are therefore a probate media to encourage students to self-study und gain good results during lab courses and theoretical background testing. These films may also provide excellent requirements when inverting the classroom (Berrett, 2012), (Brame, 2015), (Fischer and Spannagel, 2012), (Braun et. al., 2012). It seems that watching the introductory films lead to more download activity and actual studying of the lectures that were provided to prepare the experiments. Notes and handwritten summaries were brought along, mindmaps and summary sheets were downloaded and memorized. The additional learning material helped the students to understand the science behind the results they produced in the lab. Pre-test results prior to lab entrance were partly improved and the groups worked homogenously with lots of inspiration. The students asked important questions, initiated discussions, were eager to dispose their knowledge and learn more of the details and even those students, who did not attend the lecture classes increased their understanding of complicated correlations.

Not under evaluation is possible boredom during the viewing of the films. But, since the laboratory films are strictly under 5 min and actual experiments are shown, without mentioning of results of course, we do not think that a lack of interest was an issue. Moreover, once the students started to watch the films they completed it – with exception of the end titles (Fig. 2).

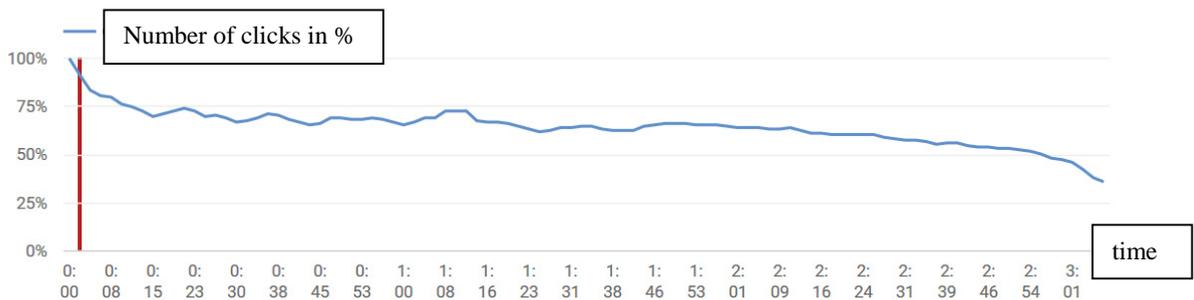


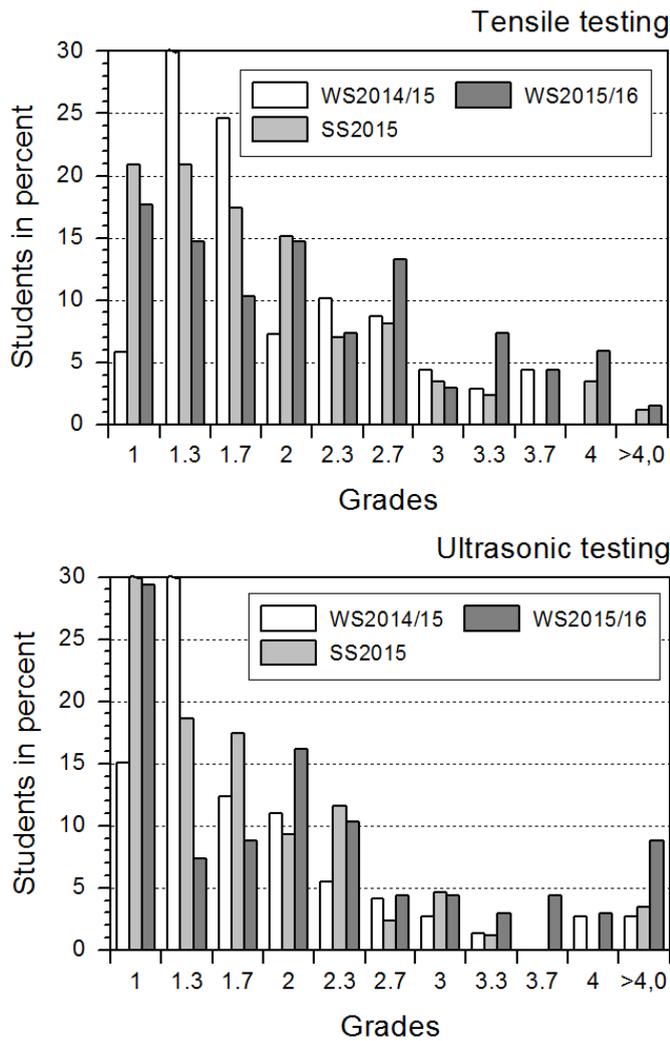
Fig. 2. Average length of video "hardness testing" watched in SS2015.

This concept applied first in spring semester 2015 (Pfennig and Hadwiger, 2015) with only little data with no statistical significance available evaluating the learning outcome of the students. The overall results slightly increased (grade average in WS2014/15: 1,92 (64 students) compared to SS2015: 1,87 (84 students) (Table 1). But, not all experiments were subject for better results, such as "hardening" due to the fact of being the first experiment of the semester and the films have not been taken as a serious method of preparing (Fig. 3). Lower grades in WS2015 (1,99) are due to large differences of the results obtained from mechanical engineering (1,80) and automotive engineering students (2,17), Table 1).

Table 1. Average grades resulting from different experiments 2014/15, 2015 and 2015/2016

Semester	Hardness	Heat treatment	Microstructure	Ultrasonic testing	Tensile testing
WS 2014/15	2,05	2,01	1,86	1,81	1,97
SS 2015	2,25	1,83	1,78	1,67	1,83
WS 2015/16	2,34	1,93	1,75	2,14	2,16
Mech.eng.only	2,43	1,91	1,77	1,90	1,66

A slight shift towards better grades after watching and working with lecture films was noticeable for ultrasonic testing, heat treatment and microstructural analysis (Fig. 3).



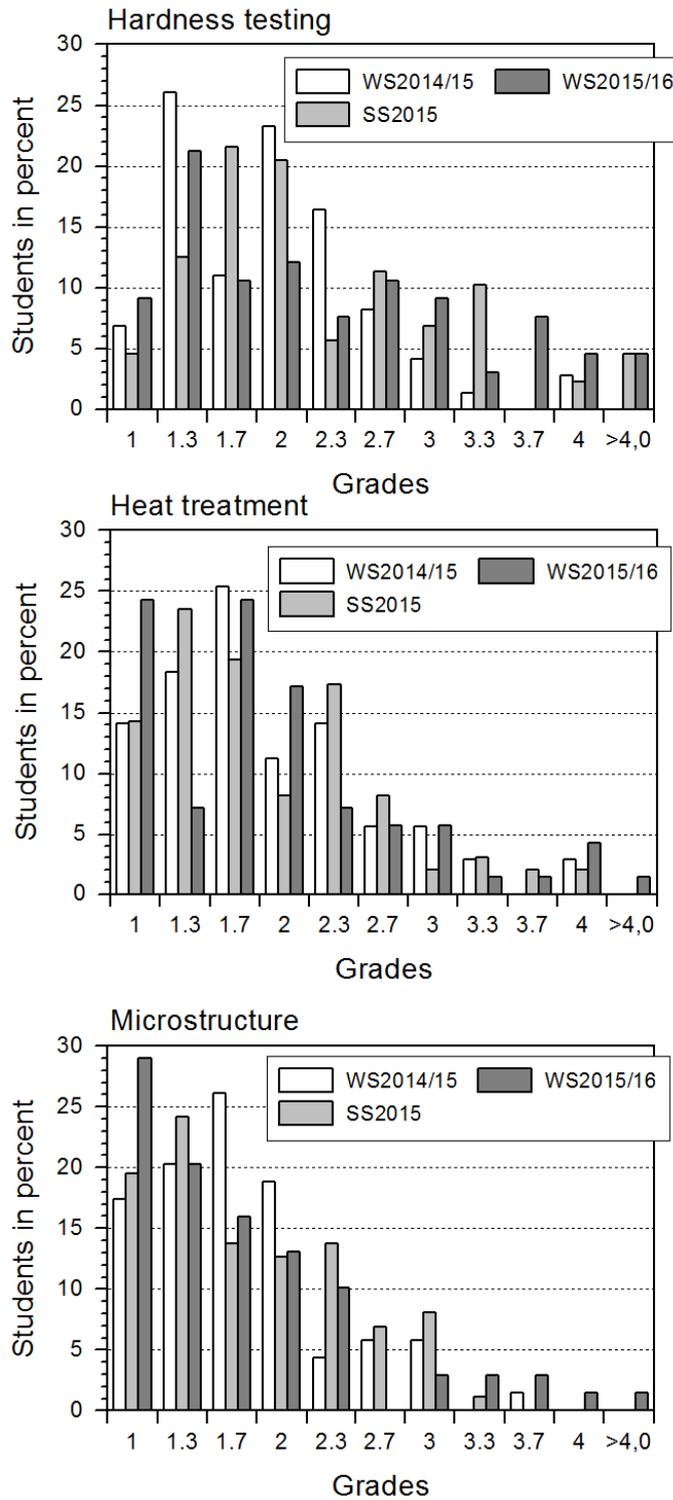


Fig. 3. Number of grades for 5 different experiments of students taking a lab course at HTW comparing fall semester 2014 without and spring semester 2015 as well as fall semester 2015/16 with lecture films.

Students involved in the making of the film, found that they gained substantial knowledge in materials testing, the reason for applying a specific testing method and the results. The students found themselves capable of choosing the suitable parameters and analysing the data to give profound information on the mechanical properties of the materials tested. Moreover the students were able to explain the test samples behaved the way they did during testing, which they have not been able to earlier when taking the course.

5. Conclusion

Lecture films were produced as guided student projects to introduce laboratory courses in an interdisciplinary concept of teaching materials science. This peer-to-peer approach of involving students into the implementation of teaching material was assessed as beneficial in terms of student grades, concentration and attentiveness as well as ongoing lecture procedures in the material testing laboratory. Students knew how to work the equipment and fewer mistakes occurred during the experimental procedures. They were prepared better for the questioning prior to the experiment and most of them had taken serious notes improving their learning skills. Data from the course showed enhanced download activity of learning materials after watching the introductory film. This concept will be extended to the regular material science courses as it has already been shown successful for corrosion and hybrid materials. Next step will be “polymers” and “hardening mechanisms”.

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