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Inverting the Classroom in an Introductory Material Science Course

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Abstract

Inverting the classroom in material science is a method to let students study the science of engineering materials on their own and then take time to discuss their questions and do extended hands-on lectures or exercises in class. A sufficient number and variety of teaching materials aims at different learning skills of the students and meets the diversity of a first year class. Therefore teaching materials and micro-module lectures to individually chose, combine and study from a distance are provided in a newly established moodle-based course. Along with exercises and worked solutions, students can check their learning progress via self-testing. Peer instruction (Simon et al., 2010) is used to assess the learning progress prior to each class. In blended-learning scenarios students use different materials to study and understand the science in theory and then the classroom lectures offer the opportunity for students to comprehend the principle of different aspects in material science and apply their knowledge. Not all of the themes taught the first semester are suitable to apply the inverted classroom approach, but it has been proven to be successful and increase the fun of teaching throughout the first year.

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Keywords: inverted classroom; flipped classroom; blended learning; lecture films; peer-to-peer; first year student.

1. Introduction

Starting in winter semester 2014/15 the first semester material science has to be passed as a course, but the grades are not included into the bachelor`s degree for mechanical and automotive engineering at HTW Berlin (BerlHG, 2016). This challenges the lecturer, because he or she will face a number of students only interested in

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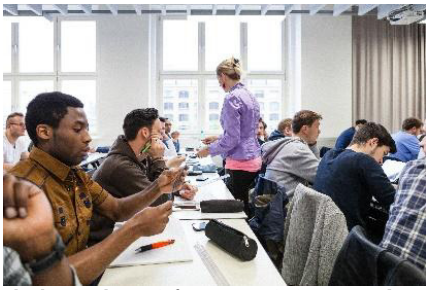
passing rather than learning about the important basics required to pass the second semester or the compulsive laboratory courses. Inverting the classroom (Berret, 2012), (Brame, 2015), (Fischer and Spannagel, 2012), (Braun et al., 2012) seemed to be the appropriate medium to gain student`s attention, motivate them right from the start to continuously study and acquire good exam results assuring each to easily pass the graded exam the second semester.

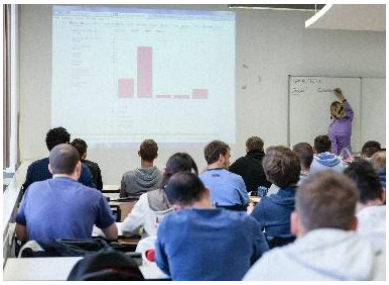
The flipped classroom constitutes a role change for instructors, who give up their front-of-the-class position in favour of a more collaborative and cooperative contribution to the teaching process. …The flipped model puts more of the responsibility for learning on the shoulders of students…. Activities can be student-led, and communication among students can become the determining dynamic of a session devoted to learning through hands-on work. What the flip does particularly well is to bring about a distinctive shift in priorities— from merely covering material to working toward mastery of it (Educause, 2016).

Moreover students got to know each other much better, were fond of the course, found materials science entertaining and had personal success when understanding complicated contents. The quality of the work comprised in class was successfully high with students working seriously on their tasks resulting in better grades than the previous semester. Lectures are the appropriate platform to exercise, ask questions and discuss matters with student colleagues and lecturers. Methods such as “Think-pair-share” or “peer instruction” (Simon et al., 2010) via the open-source “invote” program (www.invote.de, (invote (2016)) work very well to get a quick overview of students` state of knowledge before questions are answered and students begin working on their assignments (group, pair, single) (Fig. 1).



“think-pair-share” (Pfennig, 2015), (Simon et al., 2010)

peer instruction (Simon et al., 2010), “invote” (Pfennig, 2015)



answering questions

Fig. 1. Students` learning session in class after preparing scientific backgrounds at home.

2. Concept of inverting the classroom in materials science

During summer semester 2015 we got very good results when students were to prepare lectures, watch introductory films (OLP, 2016) and do homework exercises prior to the lecture in presence. An important issue of the concept is, that the students were able to study individually, self-directed, location-independent, asynchronously and according to their individual tempo. In class we had time to discuss problems, work on exercises and engineering related problems, share difficulties and thoughts with classmates and especially experience that the background information (self-taught at home) delivered a great deal of understanding of the correlation between materials properties and microstructure. Study materials are:

- Micro module lectures intermixed with problems and worked solutions
- Worksheets and worked solutions
- Lecture videos (actual semester) and teaching videos (Pfennig and Hadwiger, 2015)
- (interactive) Mindmaps
- Memory sheets to memorize most important aspects
- Online tests (for self-testing and assessing through lecturer)

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