Matching Course Assessment of a First Year Material Science Course to the Blended-Learning Teaching Approach

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Abstract: First year mechanical engineering students fear material science as one of the fundamental courses with high work load. As one of the most of important learning outcomes students are enabled to apply complex science of materials on the appropriate selection of engineering materials in different designs. Here knowledge on the correlation of materials properties, microstructure and their intended manipulation is substantial. The ability to combine these three columns of material science are not well constituted in one final exam. Therefore peer-to-peer lecture film supported inverted classroom scenarios were established to work in the course. These are provided via a highly structured moodle course following the blended learning approach. The special design of the moodle course gives students the chance to cumulatively accomplish micro-grades via multiple activities, such as tests, lectures, presentations, forum discussions and written homework and additionally glossary entries. Micro grades are then summed to obtain the overall course grade. Improved learning outcomes are demonstrated in high quality class discussions and most -important to students- in better grades (average B) compared to those being assessed by one final exam only (average C+). The majority of students agreed on enhanced study skills when forced to study throughout the entire semester and solve hands-on problems instead of learning theory intensely towards the end of the semester. The learning structure as well as graded activities match the learning outcome – both being crucial elements of the course.

Key words: Assessment, blended learning, inverted classroom, lecture films, material science.

1. Introduction

To prepare engineering students for their role as a maker of things they should investigate and learn with a strong practical motive. During the first compulsory first semester course Material Science it is necessary to critically discuss materials, properties, alternative materials and processes as well as the underlying physics and chemistry. Therefore, at HTW-Berlin, Germany Material Science is taught during the first semester to undergraduate study subjects such as mechanical, automotive and economical engineering at HTW Berlin based on the “design-led” teaching approach [1]-[3].

Generally, reporting on student learning is an ongoing challenge educators. Grading that provides quality information about student learning requires clear thinking, careful planning, excellent communication skills, and an overriding concern for the well-being of students [4]. Criteria - based approaches to assessment and grading in higher education are known to be educationally effective, because shifting the primary focus to standards and making criteria secondary could lead to substantial progress [5]. However, it is widely and controversially discussed due to the lack of common understanding in practice. Marbouti *et al*. [6] modeled educational benefits of standards-based versus the traditional score-based grading showing the quality of students` proficiency towards achieving well defined course objectives [7]. Moreover standard-based grading provides clear, meaningful, and personalized feedback for students related to achieve the course learning objectives and help to identify students` weaknesses in the course [8].

A balanced mixture of standard and score-based grading is shown to be highly successful in the blended learning environment of the first year Material Science course at HTW that is based on “inverted classroom” scenarios [2], [9]-[12] - a method to let the students study the science on their own and then take time to discuss their questions leaving time to work on extended hands on lectures or exercises in class. Main learning resources are scientific peer-to-peer lecture films [13] and micro module lectures provided via the content management system Moodle. Additionally a variety of teaching materials (worksheets and worked solution, mindmaps, glossary entries, memory sheets, online tests and web-based-trainings WBT) support the learning procedure [2], [14]. This enables students coming from different scientific and ethnic backgrounds to study during online periods on equal footing. In class hands on exercises, discussions, group work and difficult questions were mastered. Peer instruction [13] is used to assess the learning progress prior to each class. Learning materials were partly contributed by students during material science projects. This peer-to-peer approach [15] and peer reviewing [16], [17] allows for high teaching standards [2].

In this context the assessment of students learning outcome on one single final exam as usual does not strike as appropriate. The grading system chosen directly connects the course assessments to the course learning objectives and are not only a series of separate course assignments [18]. Parts of this study has been published before [2], but now shows latest data.

2. Course Structure and Grading Method

To meet the alignment of course assessment and learning outcome cumulative step-by-step grades were established over the 12 to 16 weeks of the semester. Presence time was 1 day, 4 hours/week. HTW regulation allows for 20% e-Learning in a presence course, therefore the blended learning concept applies well. Moodle provides an excellent basis to establish graded activities that are followed each lecture or theme (Fig. 1). All semester activities count to 50 points, the final Moodle-based exam based on tests during the semester counts only for 10 points. Therefore the following activities were weighted appropriately and implemented as compulsory summing to 60 possible points in total:

- 3 Quizzes = 12 questions (each 1)
- 9 Medium tests 20-40 questions (each 2)
- 1 Final test (70 questions) (10)
- 4 Glossary entries (each 1)
- 14 graded lectures (each 3 to 5)
- 3 homework assignments (each 2)
- 2 Forum entries (each 2)

To leave an alternative the students were allowed choose one single final exam (score based) isochronal to the final Moodle course test worth also 60 points (Fig. 1). One week prior to the final exam the students had to finally announce whether they wanted to be assessed based on their cumulative Moodle results or take the final exam. Students found this advantageous because they could make their choice until the end of the course depending on their grade points. To prevent students from stopping to work in the middle of the semester most of the points were assigned in the last 3 weeks before final exam (60 points) or final Moodle exam (10 points). Students transferring in the middle of the semester, repeating students and those coming from different study subjects without access to present lessons were graded based on the single exam.

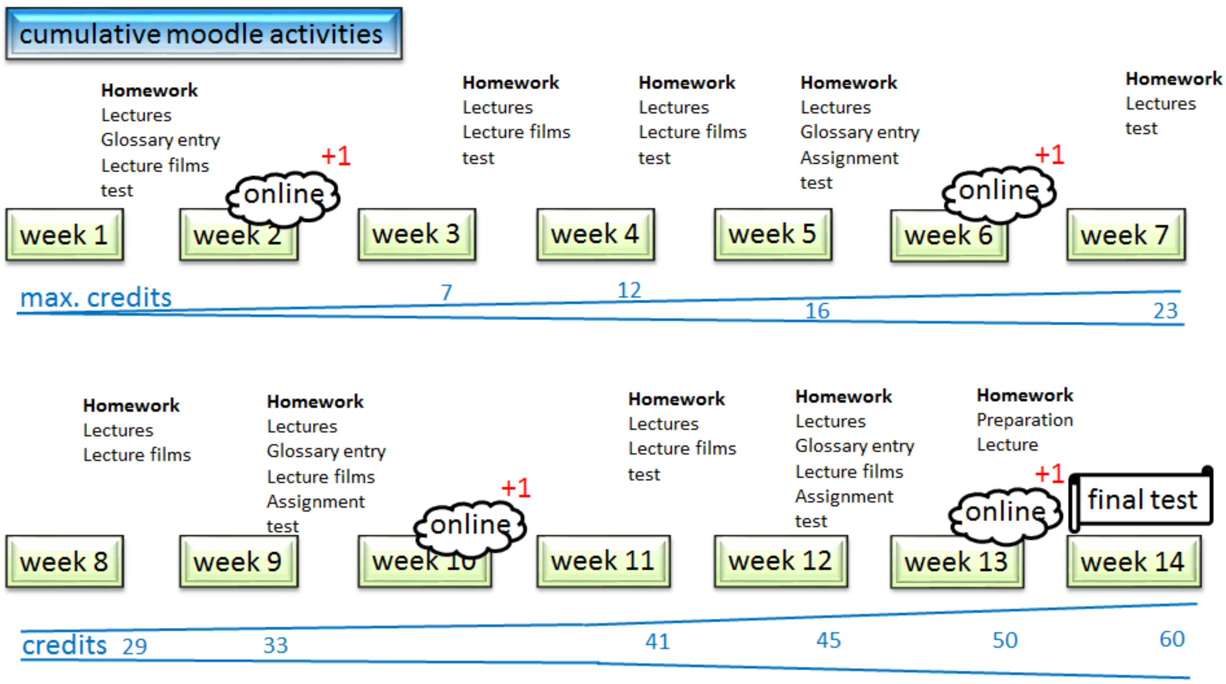

Fig. 1. Workflow, Grading and Assignments in the Moodle based materials science course (5 ECTS) [2].

Final grades in material science of winter semester 2015/16, with a final exam in the end of the semester as means of assessment, were compared to grades students achieved in the cumulative Moodle course of summer semester 2016 and 2017 as well as winter semester 2016/17. Beforehand students needed to sign a form that their grade will be calculated from their results throughout the semester and a non-disclosure agreement for the teaching materials throughout the course.

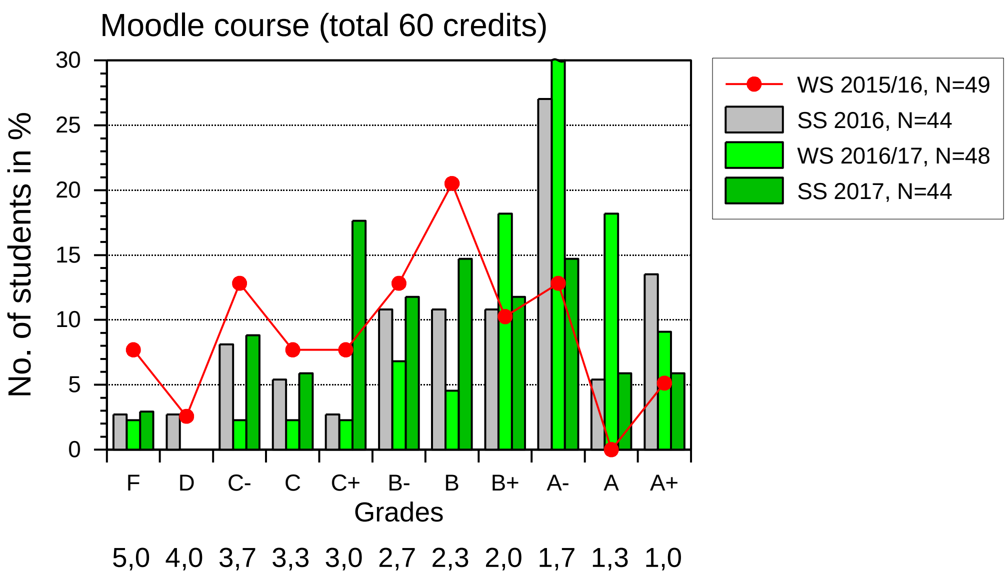

Fig. 2. Results of the moodle based grading in material science, red WS15/16 (assessment by only one final exam), grey and green (assessment by cumulative moodle course).

Averagely students scored 40 (C+) out of 60 possible points in 2015/16, 49 (B) in 2016, 54 (A-) in

WS2016/17 and 36 (C) in SS2017) (Fig. 2). The median differs more: 43.5 (B) in WS2015/16, 49 (A-) in SS2016, 53,5 (A-) in WS2016/17 and 40 (C) in SS2017 not counting for massive improvement. However, most important is the grade distribution: The cumulative Moodle course assessment offers more students access to good grades, such as A- to A+ compared to the course assessment via final exam. Moreover, students with migration background scored higher and achieved a better understanding of the theoretical background in Material Science than students who only studied to take one single final exam (Fig. 3).

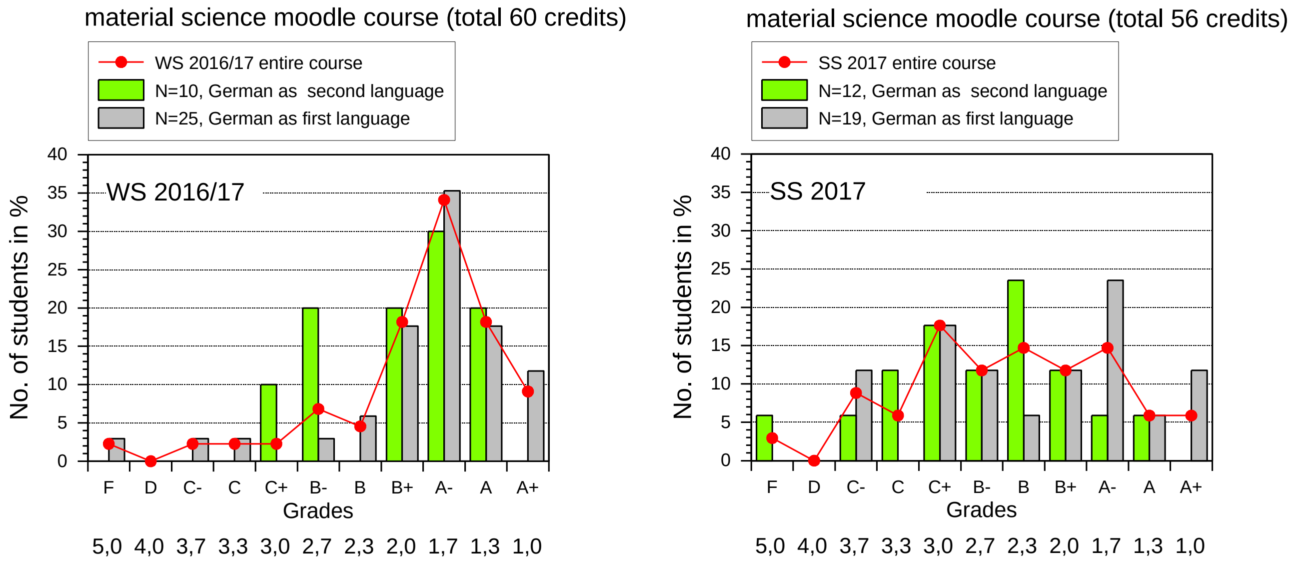

Fig. 3. Results of compulsory final online exam in material science, red WS15/16 (assessment by only one final exam), grey and green (assessment by cumulative Moodle course).

3. Evaluation and Discussion

Generally all students between SS2016 and SS2017 chose the course assessment via cumulative Moodle activities. Only in SS2016 2 students chose a final exam. Grades divided into more than 25 single micro grades that are weighed and summed offers the lecturer to be less biased during grading [15] and therefore students grades are more substantial. Drop outs do not fail the Material Science course but rather, mathematics or mechanics.

Students` opinion:

Lecture videos and micro modules as main source of the “inverted classroom concept” are appealing to students because they are independently reusable with no regard to place and time. The individual learning velocity is supported by the possibility to repeat whole lectures as well as cut-outs. Generally students rated homework useful to get self-organized and learn complicated scientific issues. It helped to get the bigger picture of material science. Some students did not like homework, because they were forced to study instead of just pushing the work load ahead of them. The highest advantage of the cumulative grading system was found to be the transparent level of credits throughout the semester. At any time throughout the semester the students knew the grade they were achieving reassuring them of their learning skills or pointing to weaknesses. And even more important is that the expected workload was equally distributed throughout the course and did not accumulate towards the end of the semester.

Teachers` opinion:

Negative:

Students who only want to pass the course might not work constantly towards once they achieved minimum requirements. To prevent this behavior the number of points adding to the course increases towards the end (that is: course minimum was achieved only after ¾ of the course time). But, it takes effort to motivate this specific group.

The workload of the lecturer does not double but honestly rather triples for this course. Preparing Moodle activities, especially lectures necessary to generate a stand-alone Moodle course along with lecture films meeting different learning styles and the needs of a diverse first year material science class is outrageously time consuming. Additionally, the time spent on emails answering question, giving advice or organizing and the daily design as well as correcting and commenting on assignments has to be taken seriously into account.

Positive:

Students were very motivated to learn during self-study periods; in class they generated a pleasant atmosphere, shared their knowledge helped each other and contributed to solving problems enabling each other to apply their knowledge even on complex material science problems. The depth of scientific knowledge with which students responded in forums was very high. In addition their discussion skills with regard to scientific knowledge were enhanced. In general, students were given more responsibility for their learning progress during the semester which encourages critical thinking [15], [19]; that results in deeper learning outcomes [20], [21].

Students who risk to fail the course were identified early and their further learning process was accompanied more closely. The lecturer knew the students` learning progress and was able to provide help at the exact level the small student group needed providing immediate support. Most Moodle activities are available throughout the entire semester with clear problems to solve, allowing for unprepared or weaker students to perform well.

Students with migration background and language problems in class in general showed good to very good results in tests and assignments when they were given enough time to overcome their language problems [2]. Especially these students put a lot of effort into their studies, most likely because they had a chance to do well in this course. The overall class response and effort reduced the diversity in learning outcome during the semester and enhanced homogeneity [2]. Also, students who had to work or take care of family members could participate without knowledge loss, because the Moodle course offers time and place independent studying.

4. Conclusion

The blended learning concept of a first year material science course offers cumulative grading as an alternative to traditional final-test grading. Therefore micro-grades via multiple activities are summed to obtain the overall course grade. Inverted classroom scenarios based on micro lectures and peer-to-peer lecture films were established and provided via Moodle giving students the chance to study independently and self-motivated throughout the entire semester with facilitation by the lecturer. Class discussions were of high quality and grades improved along with learning outcomes compared to previous semester. Students were enthusiastic during class being able to solve enhanced problems and contribute to many issues in depth. Because they had to study throughout the entire semester instead of only learning intensely towards the end most students rated their study skills as highly improved.

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References

[1] Ashby, M., Shercliff, H., & Cebon, D. (2013). *Materials Engineering, Science, Processing and Design*. ISBN-13: 978-0080994345.

[2] Pfennig, A. (2018). Improvement of learning outcome in material science through inverted classroom techniques and alternative course assessment. *JFLET Journal of Foreign Language Education and Technology, 3(1)*, 148-162.

[3] Pfennig, A., & Böge, A.(2015). A material science course based on a blended learning concept using an interdisciplinary approach at HTW Berlin. University of Applied Sciences, Berlin, Germany.

[4] Guskey, T. R., & Pollio, H. R. (2012). Grading systems - School, higher education, grading systems - school, higher education - students, grades, teachers, and learning, education encyclopedia - StateUniversity.com.

[5] Sadler, D. R. (2005). Interpretations of criteria-based assessment and grading in higher education. *Assessment & Evaluation in Higher Education, 30(2)*, 175-194.

[6] Marbouti, F., Diefes-Dux, H. A., & Madhavan, K. (2016). Models for early prediction of at-risk students in a course using standards-based grading. *Computers & Education, 103*, 1-15.

[7] Heywood, J. (2014). The evolution of a criterion referenced system of grading for engineering science coursework. *Proceedings of IEEE Frontiers in Education Conference*. Madrid, Spain.

[8] Atwood, S. A., & Siniawski, M. T. (2014). Using standards-based grading to effectively assess project-based design courses. *Proceedings of the American Society for Engineering Education Annual Conference*. Indianapolis, IN.

[9] Berrett, D. (2012). How 'flipping' the classroom can improve the traditional lecture. *The Chronicle of Higher Education*.

[10] Brame, C. J. (2015). *Flipping the Classroom*.

[11] Fischer, M., & Spannagel, C. (2012). Lernen mit Vorlesungsvideos in der umgedrehten Mathematikvorlesung. *DELFI,* 225-236.

[12] Braun, I., *et al*. (2012). Inverted classroom an der Hochschule Karlsruhe - ein nicht quantisierter Flip, Beitrag zu Das Inverted Classroom Model: Begleitband zur ersten deutschen ICM-Konferenz. Jürgen Handke, Alexander Sperl (Hrsg.), Oldenbourg Verlag.

[13] Simon, B., Kohanfars, M., Lee, J., Tamayo, K., & Cutts, Q. (2010). Experience report: Peer instruction in introductory computing. *Proceedings of 41st ACM Technical Symposium on Computer Science Education* (pp. 341-345).

[14] Pfennig, A., & Hadwiger, P. (2015). Improving study skills by implementing peer to peer lecture films. *E-Learning'15*. HTWBerlin, Germany.

[15] Colorado State University. (2015). *Using Peer Teaching in the Classroom*.

[16] Ware, M. (2015) Peer review: Benefits, perceptions and alternatives. *Publishing Researching Consortium*.

[17] Wilson, J. (2012). Peer review. *The Nuts and Bolts, A Guide for Early Career Researchers*.

[18] Carberry, A. R., Siniawski, M. T., & Dionisio, J. D. N. (2012). Standards-based grading: Preliminary studies to quantify changes in affective and cognitive student behaviors. *Proceedings of IEEE Frontiers in Education Conference.* Seattle, WA.

[19] Lord, T. (2012). 101 reasons for using cooperative learning in biology teaching. *The American Biology*

Teacher, *63(1)*, 30-38.
[20] Cuseo, J. B. (1992). Tips for students when forming learning teams: How to collaborate with peers to improve your academic performance. *Cooperative Learning and College Teaching*, *7(3)*, 11-16.
[21] Goto, K, & Schneider, J. (2010). Learning through teaching: Challenges and opportunities in facilitating student learning in food science and nutrition by using the interteaching approach. *Journal of Food Science Education*, *9(1)*, 31-35.

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