Improving Learning Outcome for GSL (German as a Second Language) Students in a Blended Learning Cumulative Assessment Material Science Course

Anja Pfennig*

HTW Berlin, University of Applied Sciences, Wilhelminenhofstraße 75A, 12459 Berlin, Germany.

* Corresponding author. Tel.: 0049 30 5019 4231; email: anja.pfennig@htw-berlin.de

Abstract: First year students especially with migration background and language deficiencies rate material science in mechanical engineering as one of the fundamental courses with high work load and necessity of language skills due to the descriptive nature of the course. Therefore a blended learning course structure using based on inverted classroom teaching scenarios was established. Heart of the self-study period are visualizing peer-to-peer lecture films supported by micro-lectures along with various online teaching materials. Although students with migration background generally scored lower in tests due to the lack of language skills improved learning outcomes are demonstrated in high quality class discussions and in overall understanding. This paper introduces the learning structure and graded activities, evaluates the course and compares results of native German-speaking students to those of students with migration background.

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

1. Introduction

Diversity among engineering students is growing more and more acknowledgeable in higher education – especially in first year classes where in applied universities students from many backgrounds form new heterogeneous classes. Differences in education are as common as various social aspects hindering full time studying. Students may enroll directly from high school, they may have had job training, or went for dual careers. Many students already founded families taking care of little children or supporting elderly family members. High school students generally have had good education in math, physics and chemistry whereas students with job histories mainly have advantages in applied subjects such as technical mechanics, design or material science. Because as a future maker of things students should investigate and learn with a strong practical motive and learn to match material properties in a design with the underlying physics, chemistry and material science background knowledge. Therefore, at HTW-Berlin, Germany Material Science for mechanical, automotive and economical engineering students is taught based on the "design-led" teaching approach in a blended learning course setting including inverted classroom teaching scenarios [1]-[6]. Although new evidence assigns success only for MINT courses neglecting progress for economic related teaching the "inverted classroom" method [2]-[9] enables students to discuss early and communicate in a scientific related course such as material science in equal measure. Students study the science on their own without time limit and then take time to raise questions and discuss details, solve hands-on problems,

perform group work and master difficult problems in class.

Reporting on student learning challenges educators especially in highly divertive classes. Only if the grading provides quality information about student learning, is carefully planned and excellently communicated it is successful [10]. Objective grading also requires an overriding concern for the well-being of students [10]. Generally criteria‐based assessment approaches are known to be educationally effective in higher education. However, shifting the primary focus to standards and making criteria secondary could lead to substantial progress [11]. Today standards are widely and controversially discussed, but there is a lack of common understanding in practice especially with regards to learning styles, learning basis, teaching material and learning outcome. The quality of students` proficiency towards achieving well educationally benefits from standards-based assessment in contrary to the traditional score-based [12]. Standards-based assessments provide clear, meaningful, and personalized feedback for students related to learning objectives and help to identify students` weaknesses in the course [13] if the course objectives are well defined beforehand [14]. Time limited exams with strong focus on verbal expression not mathematically precise description in internationally acknowledged formulas penalize students with language difficulties. All tasks, such as homework, presentations, answering questions and group discussions are of disadvantage to these students and to those with outside of university duties. Therefore the blended learning environment of the Material Science course introduced earlier [2]-[4] offers a promising alternative.

2. Course Setting

Averagely 30-40% of the students in a first year mechanical or automotive engineering class at the applied university HTW Berlin enroll directly from high school, 10-20% after a certain time, 30-60% were educated on the job and then got work experience between 2 to 6 years. 5-10% achieved the German "Fachabitur" after grade 11 or 12 without a high school diploma. These students may enroll at applied universities after a minimum of 3 years of job training and 4 years of continuous employment on the job. Because of their personal history many students are in their mid-twenties and already founded families taking care of little children. A number of students support elderly family members or even take care of them. Because math, physics and chemistry are known and still remembered well high school students generally perform well in these science based courses. Students with job training are doing well in applied subjects such as technical mechanics, design or material science. These students relate science quickly to engineering problems and have a practical conception. They do well in groups and quickly organize themselves. Over time these student groups intermix with each other supporting with the missing skill to achieve well in the material science class. However, global changes and the 2015 refugee politics of the German government effected German applied high schools and the percentage of students with migration backgrounds changed tremendously. A large percentage of students with migration background enroll in mechanical engineering. These are mostly highly motivated students with engineering skills but severe lack of German language and also have to get used to social conventions as well as different teaching and learning approaches. In summer semester 2018 56 % of the first year material science students were non-native German speakers who gained their university entrance qualification outside of Europe.

Material Science at HTW Berlin offers a balanced mixture of standard and score-based grading and has been introduced in detail earlier [2]-[5]. The blended-learning course setting is based on "inverted classroom" scenarios [2]. To meet the needs of the highly diverse first year mechanical engineering class main learning resources are scientific peer-to-peer lecture films [4], [6], [9], [15]. Analogous with the learning outcome and face-to-face teaching micro module lectures strongly clustered by themes are provided via the content management system Moodle. A variety of teaching materials such as worksheets and worked solution, mindmaps, glossary entries, memory sheets, online tests and web-based-trainings

WBT support the learning procedure [2]-[5], [16]. Learning materials were partly contributed by students during material science projects meeting students learning needs. This enables all students coming from different scientific, family, cultural and language backgrounds to study during online periods on a level playing field. In class there is time for explanations of difficult questions, hands on exercises, discussions and group work. Peer instruction [17] is used to assess the learning progress prior to each class. The peer-to-peer approach [18] of participating in production of teaching materials, such as micro lectures and lecture videos and peer reviewing [18], [19] allows for high teaching standards [2], [4] even in a highly divertive class.

Advantages of the course is the renunciation of one final exam and the possibility to cumulative gain grade points throughout the semester focusing on different skills (standard based grading). In an engineering context the scientific background is the measure of the course and should overcome other problems. The course structure provides an extra degree of freedom to study and achieve acceptable grades even without perfect language skills [5] or a study-only private environment. The cumulative portfolio grading directly connects the course assessments to the course learning objectives and is not only a series of separate course assignments [15]. Parts of this study has been published before [2], but now shows latest data.

Face-to-face time of the first year material science course is 4 hours/week. In alignment with the learning objective of the course the assessment focuses on different skills and the learning progress rather that a one-time result. The decentralized course assessment cumulatively added activities over the 12 to 16 weeks of the semester with regard to the learning outcome (Fig. 1). Moodle provides an excellent basis to establish graded activities that are followed each lecture or theme [2], [4], [5].
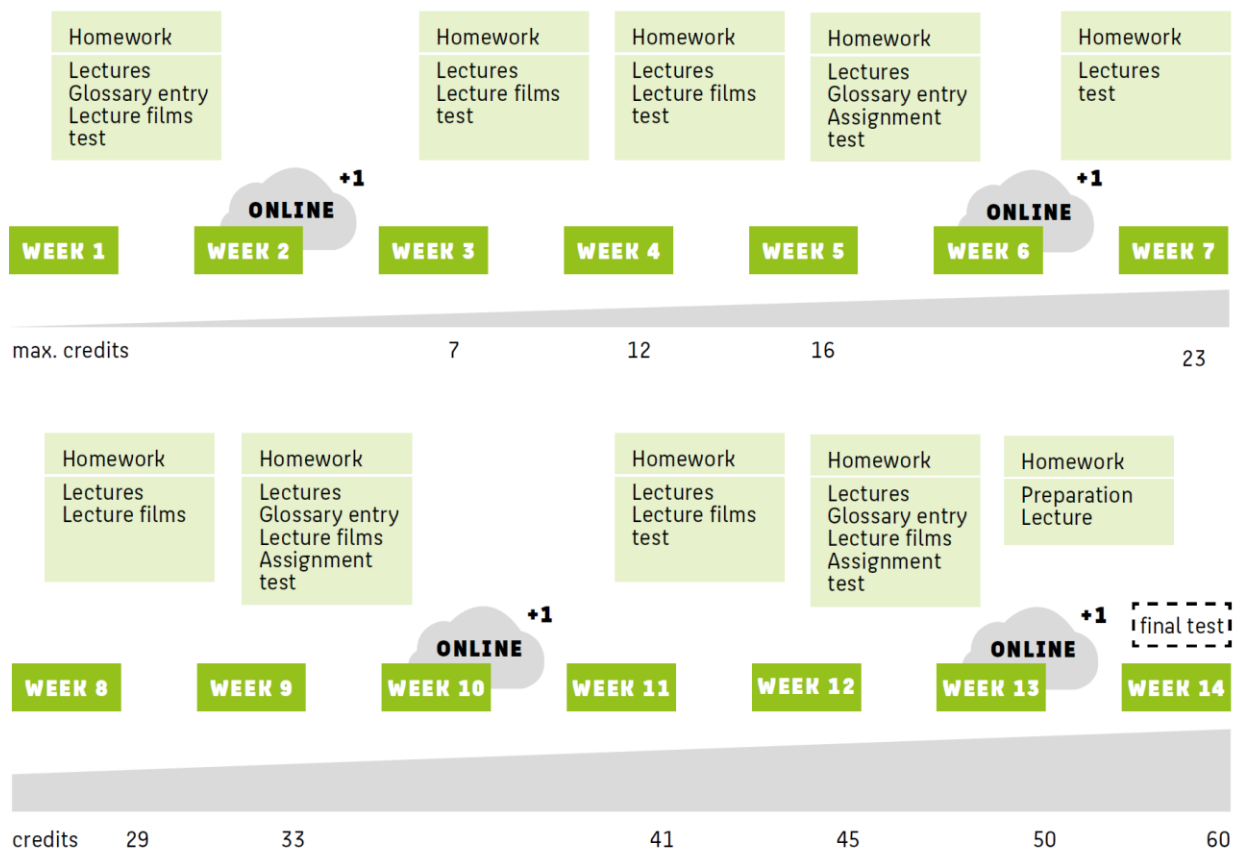

Fig. 1. Graded activities (portfolio) and course design of materials science course (5 ECTS) [2], [4], [5].

All semester activities (quizzes, tests, glossary entries, homework, group assignments, forum entries, graded lectures) were weighted appropriately and implemented as compulsory summing to 60 possible points in total. Semester activities are worth 50 points, the final Moodle exam based on tests during the semester counts for 10 points (in sum 60). Progressing points were assigned 3 weeks before final exam (60 points) or final Moodle exam (10 points) to prevent students from stopping to study after they reached the necessary 30 points to pass the course [5]. Before final grading students needed to sign the cumulative assessment and a non-disclosure agreement for the teaching materials throughout the course.
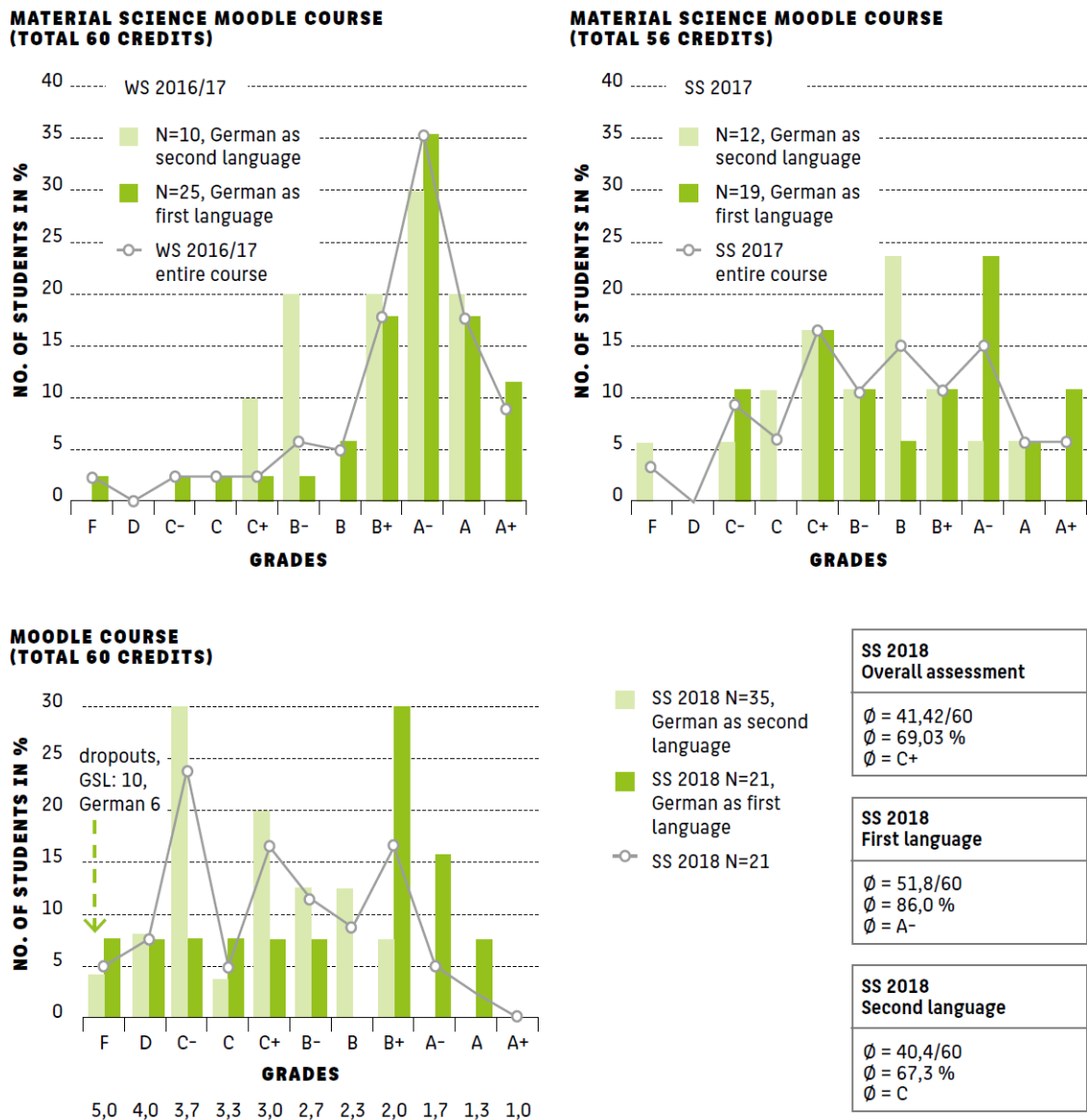
3. Course Results

Fig. 2. Results of material science blended learning portfolio assessment SS2016 to 2018 [5] accounted for German as a second language, grey WS15/16 (final exam), green (cumulative activities).

Comparing data from 2015 until now the average course score is between 36 (C=lowest) in SS2017 and 54 (A-) in WS2016/17. The scores in WS2016/17, SS2017 and SS2018 are low but compare (Figure 2). The grade point average does not differ much from result of former classes with traditional assessment.

However, due to the special situation in Germany since 2015 refugees mainly from the Arabic peninsula, Syria, Lebanon, and partly from the Maghreb, Tunisia, Morocco and Egypt are involved in asylum affairs. In summer semester 2018 these students were allowed to enter without the otherwise necessary DSL-2 language certificate. These students generally show a high engineering achievement potential. But due the lack in language skills and cultural dependent learning abilities their learning progress and success is constrained severely (Fig. 2).

4. Evaluation of Course Design in a GSL Environment

Students in general prefer the cumulative assessment method, mainly because the studying time did not push towards the end of the semester, but was equally distributed in time throughout the course. Students coming from a different language background than German found lecture videos –even in German!- and micro modules as main source of the "inverted classroom concept" appealing because they offer study freedom [4] (Figure 3). From the assessment point of view weighed and summed micro grading offers the lecturer to be less biased therefore students grades are more substantial [17], [20]. Our results support this statement with the possibility of Moodle to grade homework, glossary entries and tests anonymously. As stated earlier deeper learning outcomes were achieved [2], [4], [21], [22], because students were given more responsibility for their learning progress during the semester critical thinking [17], [21]. At-risk students possibly failing the course were identified early and their further learning process was accompanied more closely [2], [4].
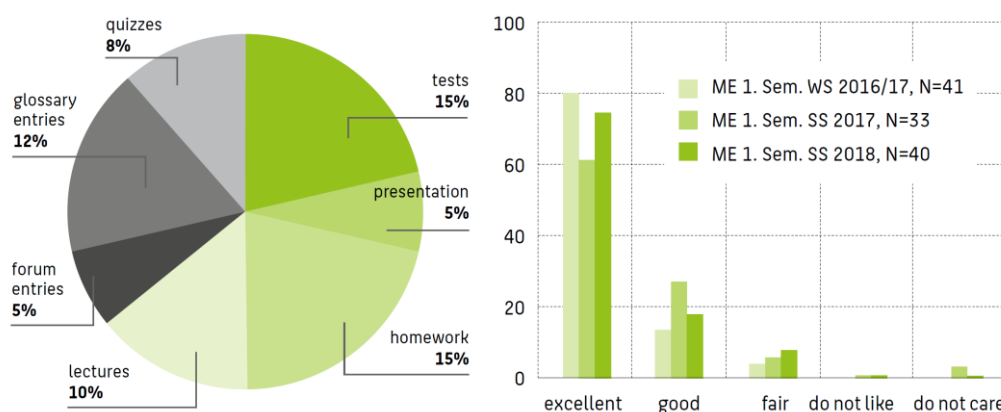

Fig. 3. Percentage of grades (left) [5] and rating of the material science course cumulative blended learning course (right) with regard to inverted classroom teaching and blended learning scenarios SS2016 to SS2018.

Material science is a descriptive subject covering models, intrinsic explanations and scientific descriptions more than internationally well understood formulas. The portfolio grading offers students the possibility to study in their own velocity at home, comfortably with students mates offering help –if needed- immediately. Therefore, students with low language skills who may not follow a face-to-face class benefit from the self-studying periods, because they would not become frustrated with not understanding and participating in class. Still approximately 30% of the students with low language skills showed up during face-to-face time of the inverted classroom scenarios because they appreciated the individuality of small group work. Most students were prepared and had a list of written questions they longed to be answered. They were able to solve even more complex material science problems because the pleasant atmosphere during the small group work enabled students to apply their knowledge without being discriminated. They also scored well at these particular tests the evening after the face-to-face time. Also, during small group

project based work in class the lecturer may explain in detail according to the special individual need and level of comprehension of different students. It was possible to explain details slowly, partly using translations and sketching most important issues. The teaching becomes more personal and individual.

As stated earlier [2], [4], [5], students benefit and score higher achieving a better understanding of the theoretical background in Material Science than students who only studied for one single final exam. In the troublesome summer semester 2018 even fewer students failed the class when their background was non-native German speaking. Even if there no immediate success showing the final grade of the course students benefit from their common learning skills in subsequent classes as mentioned often in questionnaires. Still, the biggest advantage of the new grading system was found to be the individual reusable, time and place independent teaching materials and the transparent level of points throughout the semester which offers direct knowledge of the achieved grade [4], as testemonials of students coming from a different language background support:

- "We have enough time to look up unknown words and repeat sentences as often as we need this."
- "I have the possibility to talk to friends with the same language background and understand better"
- "I do not have to catch everything I need to study in class, I can spend as much time as I need and do not only have a half page full of notes I do not understand at home."
- "It is great that I know exactly how many points I need in the different activities to pass the course. It feels good to succeed during the semester and not only towards the end"

From "problem based learning" courses it is known that students are often insecure on the scientific details to learn. Therefore guidance and transparency is very important in this course setting. The course setting has to be explained in detail, deadlines have to be given in advance, the learning-outcome needs to be clear for each theme of the course and students need to know why they learn these exact topics. Hands-on exercises and class projects have to be in alignment with the teaching material and content of the self-study period. Most important: the lecture videos have to be in alignment with the teaching material, the present lecture tasks and with the learning objective. Only then, students benefit from digital teaching material. To tell them "somebody has uploaded something good – work on this", will fail!

This specific course setting is time consuming, regarding the preparation and maintenance of Moodle activities necessary to generate a stand-alone course. Also, the preparation of necessary lecture films and the individual addressing of students needs resources [2]. However, lecture films, inverted classroom scenarios and the portfolio standard based grading offers a solution to successfully teach GSL first year students.

5. Conclusion

The material science course at HTW-Berlin successfully implements the design driven teaching approach along with inverted classroom scenarios based on micro lectures and peer-to-peer lecture films. Visualizing difficult scientific background knowledge offers native German language students but especially non-native German students with severe language deficiencies an equal starting. All learning materials were established and provided via Moodle and therefore time and place independent giving students the chance to fulfil the course´s learning outcome during self-study periods. The course design is accompanied by a cumulative micro-grade assessment via multiple activities, such as tests, lectures, presentations, forum discussions, written homework and glossary entries. These grades are summed to obtain the overall course grade improving students` grades during the semester because the final grade is not based on one 90 minute final exam but rather on multiple different assessments meeting the semester course progress. This enables students to participate regularly at multiple activities during the semester that are summed to obtain the overall course grade. The majority of students agreed on enhanced study skills and freedom

when forced to study throughout the entire semester instead of learning intensely towards its end. Especially students with migration background benefitted from this new approach because they did not have to struggle with language deficiencies in class but were able to study (with peers) according to their individual learning progress and velocity. The small group hands-on lectures during face-to-face time also allows for answering questions according to the individual need. Although students with migration background generally scored lower in tests due to the lack of language skills improved learning outcomes are demonstrated in high quality class discussions and in overall understanding.

Conflict of Interest

"The authors declare no conflict of interest".

Author Contributions

The author conducted the research, analyzed the data and wrote the paper. The author had approved the final version.

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Anja Pfennig was born in Büdelsdorf, Germany 1970. She studied minerology at the University Bonn, Germany, where she graduated in 1997. Her Ph D. is in the field of ceramic moulds for liquid metal casting was earned in 2001 from the University of Erlangen, Germany. She then worked for Siemens Energy in charge of ceramic shields and transferred to Berlin in 2008 where she currently teaches material science at the Applied University Berlin, HTW. A. Pfennig research expertise is corrosion fatigue. Her interest in teaching is new teaching methods and e-learning to enhance learning output and cope in future positions.