Blended-Learning Educational Concept for Earth Observation at University Level

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Abstract

The field of Earth observation has been undergoing a tremendous transformation for several years. From commercial data that used to be processed only by a circle of specialists, we are now in an era where numerous high-quality satellite data can be made available for free and used by diverse user groups in many applications. It is therefore of fundamental importance for new users to understand and use these data in an application-specific way, and teaching concepts need to be adapted accordingly. Specifically for the field of radar remote sensing, several activities already exist that intend to adjust educational offers with needs of the market place and to provide hands-on material for self-paced learning in many fields of application. At university level however, many courses still happen in a traditional classroom way, the lecturer being the principal source of information. We present here a blended-learning approach aiming the integration of high-quality eLearning material in traditional face-to-face courses to enhance the teaching and learning experience. The approach can be resumed in two main goals: 1) the specific integration of eLearning elements on a learning platform for a better preparation and follow-up of the course content by the students; 2) the creation of new eLearning content by the students in a peer-to-peer approach. For the first goal, existing content from Massive Open Online Courses (MOOC) are broken down into learning modules and supplemented with external digital learning content in order to best match the needs of the face-to-face course week by week. This prevents students from being overwhelmed by the enormous volume of online educational resources of the MOOCs and allows a better preparation of students for the current content of the lecture. For the second goal, a further deepening of what has been learned takes place through active co-creation of new digital content. This is based on the principle of the pyramid of learning that the best way to remember something is to explain it yourself. In this way, students who create new content from what they have learned should be able to remember it much longer as if they just listen to it. This blended learning educational model is conducted successfully since two years at university level with bachelor and master students and is being enriched regularly with new material, both from the open educational resources and students contributions.

Keywords

Blended-Learning, Earth observation, Peer-to-peer, university

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Acronyms/Abbreviations

MOOC *Massive Open Online Course*

LMS *Learning Management System*

1. Introduction

Like many other sectors, the field of Earth Observation is currently undergoing a BigData revolution: a continuously increasing number of missions and an exponentially increasing amount of data allow collecting information to learn more about our planet every day and tackle current political and climate challenges [1]. The Copernicus missions with their associated services are a good example thereof. Whereas satellite and Earth observation data were formerly reserved for a small circle of learned specialists, the current free and open policy of many of those data allows their handling and interpretation by diverse user groups and decision-makers in many different applications.

To cope with this paradigm shift and teach current and future users adequate skills that prepare them for the marketplace, educational concepts at all levels need to be adapted. Especially in the field of remote sensing, eLearning educational offers have developed significantly and allow apprehending this challenge [2]. Current activities aim at adjusting the educational offers to the needs of the marketplace by providing hands-on material for self-paced learning in various application fields [3,4] and learner-specific training relying on ontology-based educational curricula [5,6]. Those activities are mainly designed for a large audience and encompass basics and advanced knowledge in several online courses and tutorials.

In parallel, current educational offers at the university level include academic and practical courses evolving in a traditional classroom way, a lecturer mostly delivering information to the students. Even though the learner-instructor interaction is of high importance and has been reported to play an important role in the learning motivation of the students [7,8], the exponential development of tools and knowledge in the field of remote sensing requires these traditional educational models to evolve and consider new ways of imparting knowledge and skills to students.

In this approach, we present a blended-learning educational model that is applied at the university level in an introductory course to radar remote sensing, attended by both bachelor- and master students. The approach allows enhancing the educational experience by giving students the opportunity to learn from other scholars as well as to discover a multitude of tools that prepare them adequately for the marketplace.

This article is structured as follows: Section 2 presents the overall concept of our blended-learning approach from the didactical point of view, Section 3 addresses its technical implementation and Section 4 discusses remaining challenges.

2. Blended-Learning Concept

The proposed blended-learning approach revolves around two main didactical challenges: 1) even out heterogeneous foreknowledge of the students attending the course and 2) solidify what has been learned.

To achieve the first goal, an important role is given to self-study time. During that time, the students are encouraged to learn more about the specific topic of the course by themselves. To ensure that all students have similar and reliable sources of learning and possibly even out heterogeneous knowledge basis, existing material from different MOOCs are used, together with non-rated tests on a learning management system (LMS) for self-assessment. To help focusing the learning on the topics that are covered during face-to-face time, the MOOCs materials are selected and provided topic-by-topic on a weekly basis. This allows the students to prepare the material before the face-to-face course and therefore to address more advanced topic during course. Together with the MOOC contents, related links and additional material are provided to allow deepening the course topic afterwards. To keep up to date with latest advancements in the field of radar remote sensing and data processing, the eLearning content is updated regularly with new material.

To ensure that the students remember what they have learned for a longer time, the principle of the pyramid of learning is applied, which states that the retention rate about a topic is higher if you teach this topic yourself [5]. Indeed, explaining a topic requires to have deeply understood it yourself, and preparing how to teach it allows embedding it in your memory, establishing connections with related topics. To achieve this goal, students are therefore required to produce new teaching material during the course. This material is then intended to be incremented in the self-study material to be used as supplementary eLearning material by the next student generation. This allows therefore an update of the eLearning resources with material from peers. The created material by the students should respect specific formats and specifications as well as quality criteria to be used by later student generations. However, this form of learning motivates students in this sense that the produced material is not just for the sake of getting a grade but will be further used by other students to better understand the subject.

Figure 1 presents a schematic overview of our blended-learning concept. While the eLearning component in self-study only shows a relatively low level of understanding (x_E) as there is only a learner-content interaction, the use of this component to enhance face-to-face time with advanced subjects guarantees a better and deeper understanding of the content (x_B). The production of eLearning material by students increases even more the level of understanding of the students (x_S) and allow to update the eLearning material and subsequently to enhance the face-to-face time by allowing addressing further, more advanced topics.

3. Implementation

The technical implementation can be resumed in two principal actions: 1) the provision of the eLearning materials and self-assessment tests on an LMS on a weekly basis, and 2) the creation and integration of students works for future students generation.

3.1. MOOC Content on LMS

Many excellent eLearning resources exist in the field of remote sensing, especially in radar remote sensing. For our approach, we used the content of two specific MOOCs available on the EO-college platform (https://eo-college.org/): *Echoes in Space*, and *Basic Principles of Radar Backscatter*. While the first offers a complete tour in the history, principle and applications of radar remote sensing technology, the second is a mini-MOOC focusing principally on signal properties and its interaction with the Earth's surface. Both MOOCs are well adapted for an introduction in the topic of radar remote sensing, and provide enough supplementary material to address more advanced topics. However, both courses cover more topics than required for an introductory course at university level. To tailor the MOOC contents for the university course, a selection of relevant topics has been made and corresponding content (text, video material, interactive graphics, quizzes, etc.) has been extracted and made available for the students on the university LMS.

We used the LMS Moodle (https://moodle.de/) provided by our university. To ensure a breakdown of the MOOC content in weekly available topics, we created specific lesson pages on the LMS for each topic (see Figure 2a). The access to each lesson was permitted on a weekly basis, one week before the face-to-face course dealing with the corresponding topic. This allows for enough preparation time by the students. Between each lesson, self-assessments tests were created on the LMS, based on MOOC quizzes, for the students to check their achievements. The next eLearning lesson is only unlocked if at least 50% of the tests questions is answered correctly.

As the preparation of the course in self-study time requires in general more time, a reward system has been installed, for which students achieving all eLearning lessons and passing successfully all self-assessment tests would get

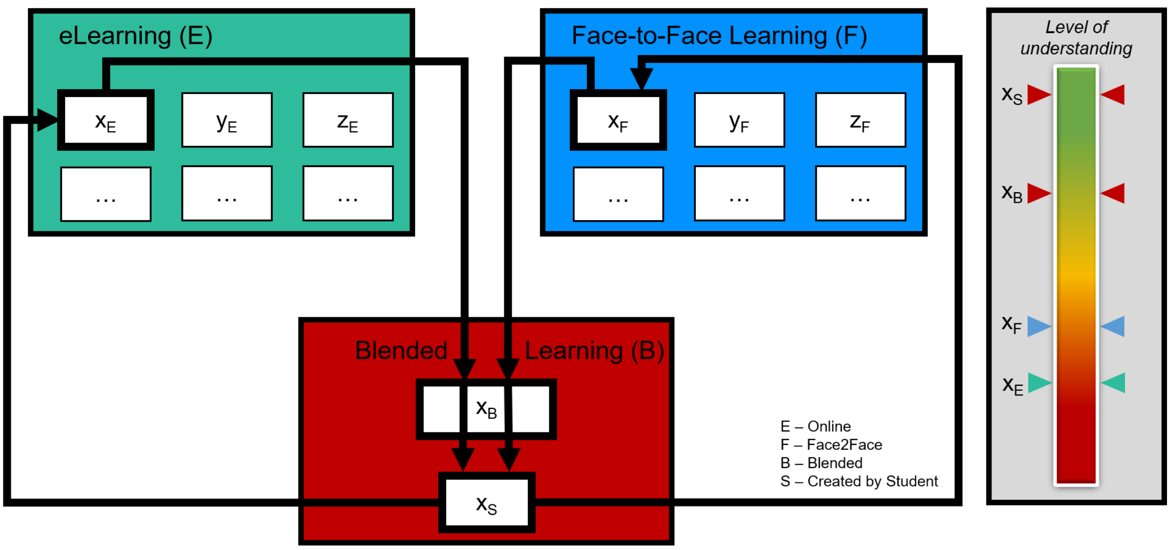

Figure 1. Schematic representation of the proposed blended-learning approach

a certificate they would have gotten if performing the whole MOOCs on the EO-College platform directly. This certificate is recognized internationally and can be used in job application documents. This reward system is intended to encourage the students to learn independently and prepare the course, but has no influence on the course's final grade.

3.2. *Creation of eLearning material*

The creation of new qualitative eLearning material by the students necessitates the fulfilment of both, technical and didactical prerequisites. eLearning material can take a lot of forms: from simple textbook or slide-show to more complex animated graphics, video tutorials, or executable code. Very specific instructions need therefore to be communicated to the students to ensure that both content and form are satisfying and useful for future learners. To this goal, an extra introductory course for the creation of eLearning material was proposed at the beginning of the term, as well as additional contact times in between. Additionally, video tutorials on the creation of infographics and animations using specific design software solutions was produced in supplement of already existing online tutorials, to show their easy adaptation for the field of radar remote sensing. Finally, quality hardware was made available for the students for the creation of video tutorials. No specific limitation is given to the form of the created material, i.e. the students are free to create either a practical video tutorial or a more theoretical animation. Evaluation criteria of the produced material were only the correctness of the content, the easy-of-use, as well as the design and visual quality of the content. Those criteria are fundamental for ensuring the further use of the eLearning materials by a broader community of students.

If passing those criteria, the created eLearning material is then inserted into a dedicated blog-website (see Figure 2b). The choice of a dedicated website instead of the LMS and already existing lessons results from the fact that we want to foster inter-student interaction and build a student community, where they can receive peer-to-peer feedback and learn from each other, even after the course is finished. The blog is organized in the different topics addressed during course and practical exercises. A direct access link to the blog is given on the LMS to facilitate access and use of the blog content during self-study.

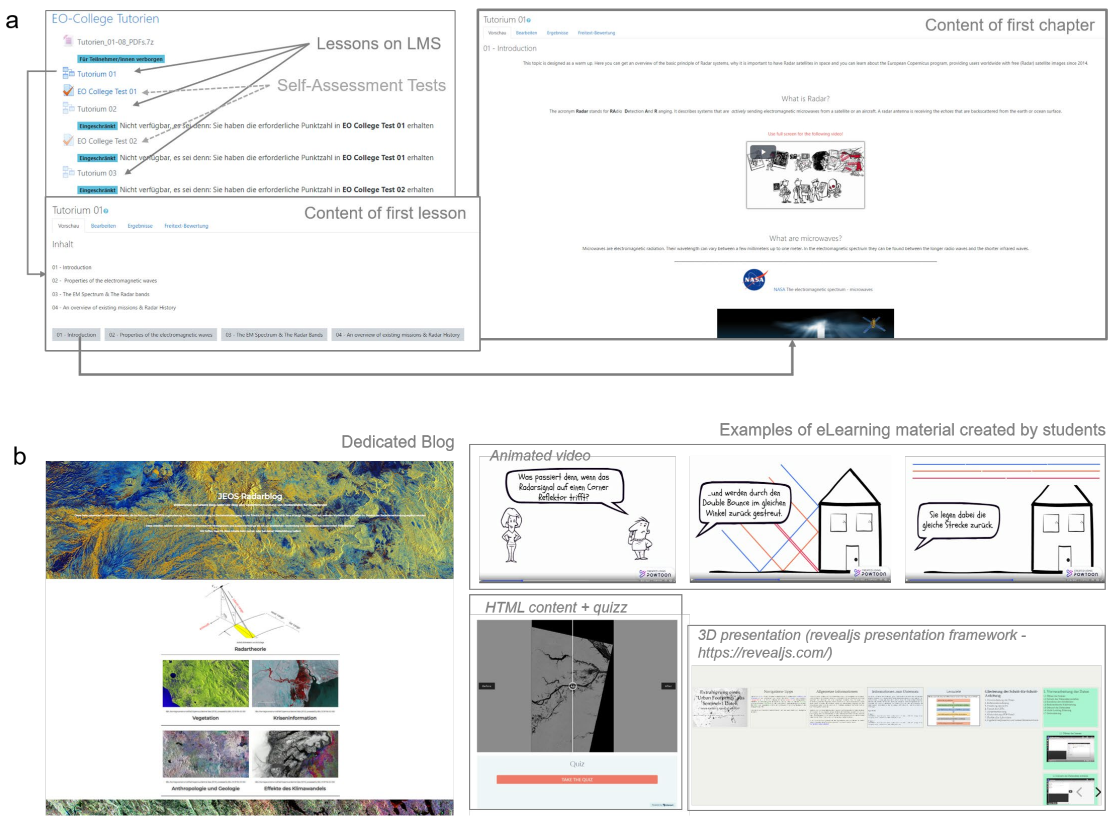

Figure 2. Implementation of the blended learning approach; a) selected MOOC content in the LMS in the form of lections and self-assessment tests; b) dedicated blog for the students and selected student material

4. Discussion

The proposed blended-learning concept is applied for the second year at university level in an introductory course for radar remote sensing, which is attended by both, bachelor and master students. This chapter aims at showing the lesson learned and possible future improvement of the concept.

As both bachelor and master students attending the course have different background, the additional use of MOOC content in self-study was intended to level out heterogeneous knowledge of both student groups and allow each student to progress at his specific pace, while keeping a regular schedule. Whereas no particular difference has been noticed in the grades of the students, being normally distributed for both degrees, a difference has been observed in the degree of interaction and level of the questions arising during face-to-face class. Students having prepared the course in advance using the eLearning materials asked in general more questions going beyond the sole topic of the course. Subsequently, interaction during face-to-face time was enhanced and the treated subjects on a higher level, which finally encouraged all students to prepare the course properly in order to keep up. This is a particularly interesting fact, as most of this approach has been implemented during the Covid-19 pandemic situation, where interaction was not particularly facilitated through online teaching. The installed reward system with certificate about course achievement worked well and showed that most students used the eLearning material. However, this could be biased by the fact that students also used the eLearning material for exam preparation instead of preparing the course on a weekly basis.

Concerning the creation of new eLearning materials by the students, a thorough adjustment of the necessary achievements for passing the module has been mandatory. Whereas in the first year of implementation many students faced incomprehension towards the benefits of creating their own teaching material and considered it the job of the lecturer, no particular complaint was noticed in the second year of implementation. This could partly lies in the fact that the first year could not benefit from previous student works for learning or solving practical exercises, whereas the second year could use the created material from the previous year and considered it as useful. Besides, the ongoing pandemic situation showed students the necessity to acquire additional digital skills beyond traditional presentation methods. Finally, in the second year of implementation, we defined clearer instructions, created additional digital tutorials and offered more possibility of contact time for the production of the eLearning material so that students felt more encouraged and supported in their creation process.

All eLearning materials as well as a link to the dedicated students' blog were made available on the LMS of the module, with all other course materials (scripts, data, specific announcements). This was appreciated by the students, as they could find all course related information in one place. The integration of the students' material into the weekly eLearning material is not planned at the moment, as we want to foster peer-to-peer interaction between different student generation. The integration of students' material into the weekly eLearning content would not permit to distinguish clearly if a content has been made by students or was already a MOOC content. Furthermore, a comment function is given in the blog for students to discuss amongst peers and benefit from each other's experience. As the implementation of this approach is only in its second year, few material is available at the moment, but more material will come and even more students will have access to the blog and would be able to give feedback and use the material for their own learning.

The implementation of the blended-learning approach showed an additional benefit, which becomes now a new challenge: through the increased level of the course, practical exercises using simple software solutions come to their limits and more advanced exercises could be dealt with during course. Those necessitate however programming knowledge that most bachelor students acquire only at a later stage, starting their master study. To this goal, a rethinking of the structure of bachelor modules is mandatory, or simple programming solutions should be found to allow the advanced theoretical knowledge to be used in practice.

5. Conclusions

This paper presented a blended-learning approach in an introductory course for radar remote sensing, using existing material from different MOOCs and permitting students to create new content on their own to improve their understanding of the subject. Whilst the learner-instructor interaction is still present during regular classes, students prepare both theoretical and practical content using existing material provided by several Massive Open Online Courses (MOOC) and regularly updated content. Furthermore, to enhance students' interaction with the course content and improve their understanding, they produce new eLearning content by their own, which can then be used by the next student generations. The approach has been implemented successfully for the last two years at university level and shows an increased interest and a deeper understanding of the students for the principles and applications of radar remote sensing. Remaining challenges are the fostering of inter-students interaction amongst several student generations, and the adaptation of practicals to more advanced exercises necessitating programming knowledge.

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