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Lessons learned from the first worldwide accessible e-learning in Landscape Ecology

Abstract

Massive open online courses (MOOCs) are distance learning tools for individualized learning. They allow students to learn at their own pace in a virtual classroom. We describe success and pitfalls of the MOOC Landscape Ecology[1], designed as an undergraduate University course taught by an international consortium of Professors covering theory and application of the field. The paper describes course performance with summary metrics, illustrates contents and didactic tools, and provides a list of suggestions for instructors who engage in distant learning. We identify the following five key success factors for this and related MOOCs: (1) commitment and passion of an international consortium of lecturers; (2) a sound mixture of theory and practice; (3) numerous field-videos; (4) content and skill-oriented practicums (here using R, GIS, remote sensing); and (5) interactive formats where students discuss and share their opinions. In all runs of our MOOC we experienced some difficulties with peer-assessed writing tasks due to widely differing “review cultures”. The instructor-paced MOOC attracted over 3500 students in 2018 and 2019, and had comparably high completion rates (14% and 11%, respectively), compared to typical MOOC completion rates ranging from 5% to 15%. Completion rates in our self-paced run in 2020 were 8-9% only.

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1 https://www.edx.org/course/landscape-ecology

1 Introduction

1.1 Background

Massive open online courses have been on the rise for several years now, with an estimated >11000 MOOCs in 2019, and an annual growth rate of over 2000 courses per year (Shah, 2018). MOOCs are distance learning tools that last from a few weeks to several months. They are usually open to anyone. Some courses can be taken without previous knowledge, while some specialized classes require/ suggest previous training or knowledge. MOOCs offer many advantages for individualized learning and provide exciting audiovisual learning environments with a mix of (tutorial) videos, short texts and quizzes; some are even interactive (Zhu et al., 2018). They allow students to learn at their own pace at home, on the train, in the garden, during lunch, in the evening, alone or with friends, wherever and whenever they want. The Corona Pandemic 2020 has shown that distant learning tools have too often been neglected in the past, and are welcome forms of supplementary instruction.

Despite the many advantages described above, critics warn against too much distance learning. They hypothesize that lack of face-to-face contact lowers learning success, or that some learner types, i.e. students needing a real-world and a team atmosphere, have difficulties following a distant learning course. While MOOC developers are collecting large amounts of data on student performance to test these hypotheses, it is undisputed that MOOCs are known to have high drop-out rates, frequently 95% and higher (Henderikx et al. 2017; Maartje et al. 2017). Although drop-outs are not a new phenomenon in education (see Tinto, 1975 and 1982), they seem to be more pronounced in distant learning. Despite the fact that continuous monitoring of learning success is easier to implement in distant learning due to automated control mechanisms, we observe that students "hide" more easily than in the physical classroom.

Numerous papers investigate reasons for this obvious drawback of distant learning (e.g. Eriksson et al., 2017; Xing et al., 2016). Others employ well-known and new pedagogical and didactic principles coupled with empirical research to provide recommendations for successful MOOCs. A good example of recommendations comes from Conole (2015), who suggests seven core aspects of a successful MOOC design ("the Seven Cs"). We follow her concept to present our MOOC in this paper. Other strong papers on the design of MOOCs include the design consideration of Zhu et al. (2018), or the ADDIE approach of Branch (2009). Hew (2016) highlights key determinants of successful MOOCs, the most important being the teacher's passion and implementation of a problem-centered approach. The use of videos to improve learning success of distant learning is studied in Bonafini et al. (2017). The paper of Loizzo et al. (2017) - based on qualitative interviews with students - focuses on the "consumers perspective", i.e. the learning paths and motivations of adult learners when completing (or not completing) a distant learning course. These and many other papers were kept in mind when we designed our Landscape Ecology MOOC.

1.2 Goals of the current report

Building on Conole's (2015) seven components of a successful learning design of MOOCs, the aim of the paper is to shed light on successes and pitfalls of our MOOC Landscape Ecology. Accordingly, it represents our collective reflections on the course using metrics and statistical material of several runs. At the end of our report we present some suggestions for the instructor community and highlight what has, and has not, worked. The reasons we selected Conole's (2015) recommendations as the framework for our reflections are three-fold: (1) the recommendations are based on well-established pedagogical and didactical principles of learning; (2) they go beyond technical issues of distant learning; and (3) they emphasize the interactive potential of MOOCs, a topic we were very keen of implementing in our MOOC.

It is important to note that the MOOC Landscape Ecology represents a distant learning of a specialized field-oriented discipline with the challenge to "bring the field experience to the virtual classroom" (see 3.2 for more details). Only a few universities world-wide have chairs or offer instruction in Landscape Ecology. By definition the field deals with spatio-temporal changes of the biological, physical and societal components of cultural and natural environments. Thus, it brings together numerous disciplines, such as Landscape Architecture, natural sciences, Geography, and social sciences (Kienast et al. 2007). Landscape Ecology is generally taught in Geography, Environmental Sciences, Biology and Planning Departments. It is not as broadly taught as its neighboring discipline Landscape Architecture. In many curricula Landscape Ecology is an elective or not even formally taught. This means that the present MOOC is a welcome supplement for students and faculty in the above-mentioned fields.

2 Basic properties of the MOOC Landscape Ecology

The MOOC Landscape Ecology was developed with a grant from ETH Zurich[2] and WSL[3], with the desired goal of presenting Landscape Ecology as an interdisciplinary science in a worldwide context. The course has been taught in 2018 with 990-1390 students, and in 2019 with 1790 to 2480 students. The number of verified students that desired a certificate by year was 81 (2018) and 127 (2019), respectively. The 2018/19 courses were instructor-paced. During the various Covid-19 lockdowns in spring 2020 the course was offered as self-paced class with another ~3000 students. To avoid too much mixing of experiences with instructor-paced and self-paced course runs in this paper, we mention the self-paced course of 2020 only very few times notably when comparing the drop-out rates.

All course runs were offered on edX[4] , one of the largest platforms for MOOCs. The functionalities on this platform are well developed, with many didactic possibilities. During the course, instructors have many options to react individually to the students, to respond to discussion points, etc. EdX is a mixed platform concerning free and fee-based content. As a rule learners do not see all content in the free mode, which can be a problem, if the course philosophy is "all content free of charge" for all students (our philosophy). On edX the minimum fee *to see all contents* is currently 50 US$, which can be a lot for individuals from developing countries. ETH Zurich has a deal with edX that all ETH courses are free of charge and students can see all contents. If a free-of-charge course is the ultimate goal, instructors may have to switch to alternative platforms.

According to Conole's (2015) 12-dimensional classification of MOOCs, the current MOOC can be characterized as follows:

1. *Open* in the sense that only open source tools are used;
2. *Medium-sized* with a few thousand participants;
3. *Broad topic* within a specialized audience;
4. Based on t*ext and audio-visual* tools;
5. Fostering *communication and collaboration* among peers;
6. Both *reflective and reactive* components;
7. Both *prescribed* learning pathways and *creative* pathways;
8. Quality material which is assured by a *large team of professors* developing the course and its case studies;
9. Ability of students to *obtain* an *official certificate*;
10. Not formalized across institutions, i.e. only accredited to the ETH Zurich where it is a course of the first author of this paper; and
11. Dedicated *tutor support* through its moderated blog.

3 Success and pitfalls when realizing a MOOC along the 7Cs of Conole (2015)

When academic instructors design courses, they all too often forget - in their enthusiasm for *"their"* subject - that it is not only the content that counts, but also whether the content fits the students' background, experience and their professional environment. To cope with these challenges, Conole (2015) suggests 7 components of a successful learning design. In our MOOC we considered many of her and other author's suggestions when implementing the course. Thus, we present success and pitfalls of the MOOC in the context of Conole's (2015) 7Cs.

2 www.ethz.ch
3 www.wsl.ch
4 www.edx.org

3.1. Conceptualize

To conceptualize a course Conole (2015) suggests creating a vision for the course and imagine the needs, diversity, and skills of the learners through prototypical persons. This, according to her, would facilitate articulation of course core principles and content. In our case a few additional considerations led to the current content and design of the course, i.e. the broad research activities of the core instructor team, current textbooks on the market, and the broad literature on landscape ecology. For the Landscape Ecology course, we imagined an average international Bachelor student with some knowledge and skills in Geography, Biology, Math and preferably some GIS knowledge. After completing the course, students should be able to work independently and with a variety of technical skills on problems from landscape and spatial planning. The course addresses important topics such as: What is a landscape? How has it developed? Which habitat configurations promote biodiversity? How do we perceive landscapes? In order to address a wide international audience, the MOOC is advertised internationally with a professionally produced trailer[5].

As important as the content is, the passion of instructors for the teaching content is essential for the success of a MOOC (Hew, 2016). To incorporate this passion into the MOOC material, we motivated many colleagues with our idea of presenting case studies from different continents embedded in a solid theoretical framework, a concept that the International Association for Landscape Ecology (IALE) promotes in its global activities. All invited faculty members are renowned professors of Landscape Ecology, and many of them have close ties to the International Association for Landscape Ecology (IALE). Thanks to a grant from the ETH/WSL, a specialist was employed for about 18 months to technically implement the course and provide the instructors with logistical support and guidelines for the (didactic) design of the case studies.

Table 1: Topics of the MOOC Landscape Ecology, which was created under the direction of the authors. The case studies were developed in close cooperation with renowned professors from all over the world.

Topic	**Discipline**	**Instructor**
Introduce Yourself /Introducing Landscape Ecology		Felix Kienast, Switzerland
Drivers of Landscape Pattern	Land use/cover	Felix Kienast, Switzerland
Theory: Landscape Modelling	Quantitative landscape analysis	Loïc Pellissier, Switzerland
Case study: Oil exploration and rare plants conservation (Utah)	Spatial ecology, optimization	Thomas C. Edwards, USA
Theory: Landscape Metrics	Quantitative landscape analysis	Felix Kienast, Switzerland
Case Study: Landscape Impacts of Transportation Infrastructure	Wildlife ecology, road ecology	Sima Fakheran, Iran
Theory: Remote sensing	Ecological remote sensing	Loïc Pellissier, Switzerland
Case study: Urbanization in the Maledives	Applied ecological remote sensing, planning	Loïc Pellissier, Switzerland
Theory: Landscape Perception	Social science aspects in Landscape Ecology	Felix Kienast, Switzerland
Case Study: Renewable Energy and Landscape Conflicts	Spatial planning	Felix Kienast, Switzerland
Case Study: Soundscape Ecology	Soundscape analysis	Marcus Maeder, Switzerland
Theory: Ecosystem Services and Valuation	Ecosystem Services	Felix Kienast, Switzerland
Case Study: Land ethics	Philosophy/Ethics	Janet Silbernagel, USA
Theory and Case Study: Urban Ecology in Bangalore	Urban Ecology	Harini Nagendra, India

5 https://youtu.be/xdDR2mHT_hc

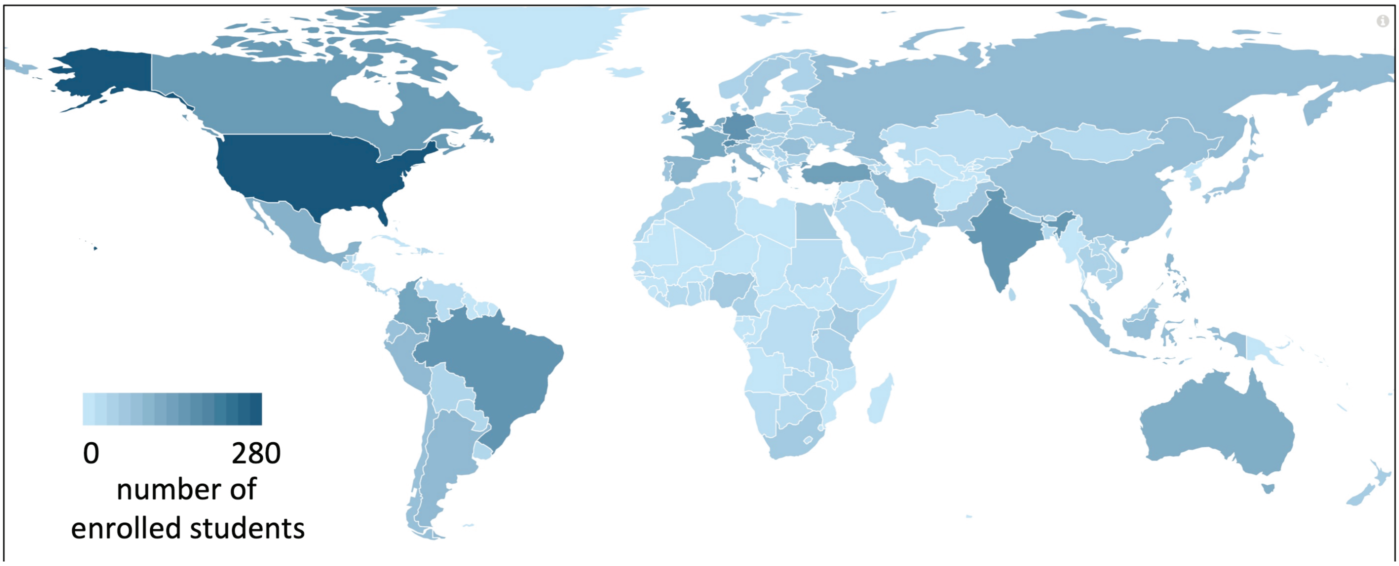

Figure 1: Origin of the students in the Landscape Ecology MOOC of 2019 (Total participants 990-1390 depending on the point in time in the course)

The course presents theory and application in 14 units, which are completed in about 2-3 hours each. Considering that for some more complex tasks students need several attempts or have to repeat course contents, it is appropriate to award 2 ECTS points (1 ECTS = 25-30 hrs student workload) in the European Credit Transfer and Accumulation System. Each of the theory blocks is complemented by an international case study in which students apply their theoretical knowledge, reflect, read scientific articles, argue or solve real cases in the landscape field (see Table 1 for a list of topics; Appendix A1 for a detailed list of learning objectives). The case studies deal with, for example, non-renewable energy extraction and protected plants, urban ecology in Bangalore, or ethical questions of nature and landscape conservation. In 2019 we added the challenging topic soundscape ecology[6] .

So what do course metrics tell us about *success or failure of our course concept*?

First, the international character of the course: This is reflected in its audience: Figure 1 displays the number of students per country of origin. In 2018 and 2019 we had students from more than 130 countries. Among the countries with more than 20 students are the United States, Switzerland, United Kingdom, Germany, India, Canada, Turkey, Colombia, Iran, Australia, Mexico, just to mention a few. Students from Africa are least presented with only 7% of the total students. This is about as high as India, Brazil, and Canada. The map also reflects where Landscape Ecology is a strong discipline or IALE has a strong regional affiliation. The course is used systematically in a flipped-classroom mode by the first author, while other teachers use selected instructional elements in their own classrooms.

The marketing for the course took place about 2 months before the opening of the MOOC. edX advertises the course to participants of other courses, the authors posted personal e-mails and twitter messages on their own networks, and important multipliers such as IALE, IUFRO, Landscape Observatory, etc. advertised the course through their own communication channels.

Second, age and education of our audience: In terms of age distribution, Figure 2 highlights that the course reached the envisaged age group (peak ages), and also included numerous participants from secondary education or professionals. The distribution is very similar in both years the course has been offered. The educational background of the students is also very similar in both courses, with 30-40% at Bachelor level, 30-40% at Master level, ca. 10% secondary education finished, and ca. 10% at PhD level.

6 Soundscape ecology deals with the sounds in our environment and tries to identify typical sound patterns that can be related to the physical, biological or the cultural environment. The field has many overlaps to art.

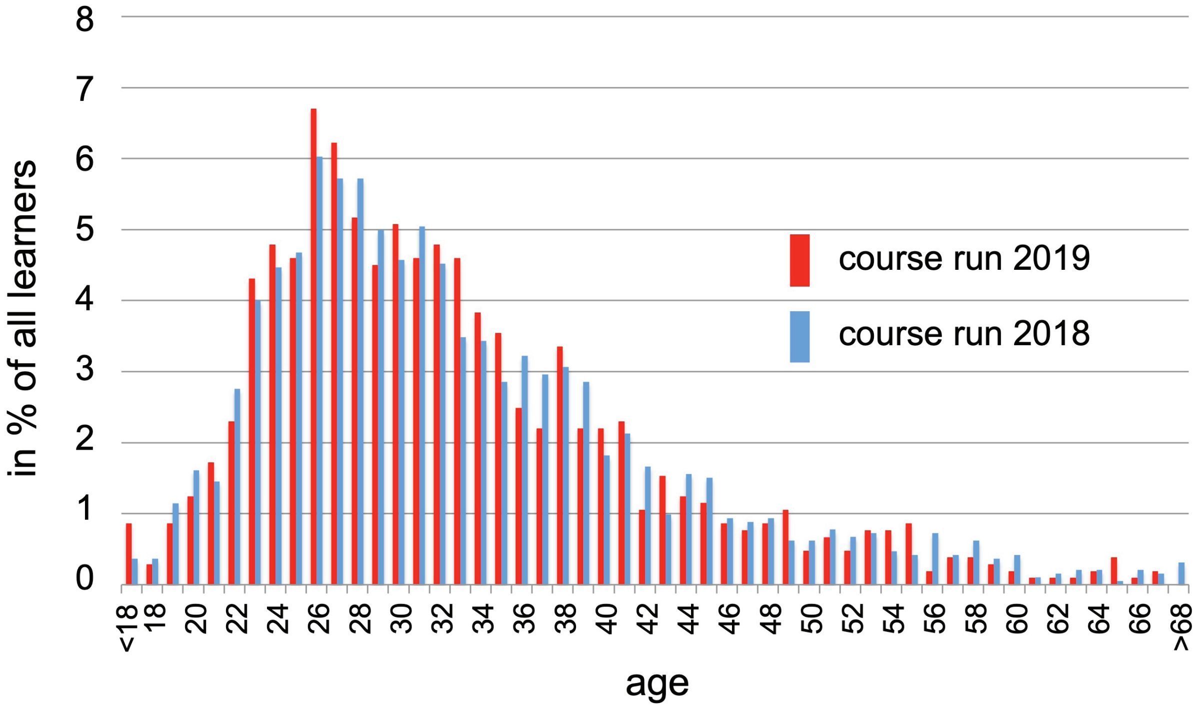

Figure 2: Age distribution of the learners in both course runs (2018/2019).

3.2 Create - Communicate - Collaborate - Consider

These 4 C's deal with the way the topics are presented and how students interact. In the MOOC Landscape Ecology we considered a wide range of didactic tools for learning. We even tried cooperative learning tools, a distinct challenge in distant learning with international students from various cultural backgrounds. As basic instructional tools, the MOOC offers video sequences, video interviews, and reading texts. The video selection is quite large and tries to portray the mood and flavor of a field-based discipline where outdoor experience and field data play a crucial role. Further basic didactic tools are automated quizzes. Advanced instructional tools are practicums teaching content & technical skills such as R, GIS or remote sensing. In these units individualized grading is impossible due to the high number of students. Thus students evaluate their own results by comparing them with results given by the instructors. As a novel element to MOOCs, we introduced some cooperative and interactive learning tools:

1. *Discussion forum*: Students are encouraged to use the forum and post their ideas, assessments, and solutions, which are then open to comment by their peers. For example, the present MOOC uses the discussion forum for the topic ecosystem services, where students discuss pros and cons of urban gardening. In the unit on soundscapes, students have to use the discussion forum to discuss different sound types (geophonie, anthropophonie, biophonies). Discussion participation is mandatory to get the scores for this exercise.

2. *The interactive world maps (see Figure 3)*: Here students upload their results - be it their favorite landscape, particularly important protected areas in their country or areas where land use threatens rare species or habitats. This interactive tool is very popular among the learners. The example in Figure 3 highlights the task to describe the driving forces of a landscape in the unit "drivers of landscape pattern". Students are asked to comment on the following topics by selecting a landscape of their choice and uploading a picture: a) What are the climatic boundary conditions? b) What is the general vegetation zone? c) Which is the predominant natural vegetation in this climate zone? d) What are possible influences of the landform, e.g. does the vegetation change in response to the aspect or how does the relief influence the microclimate? e) What

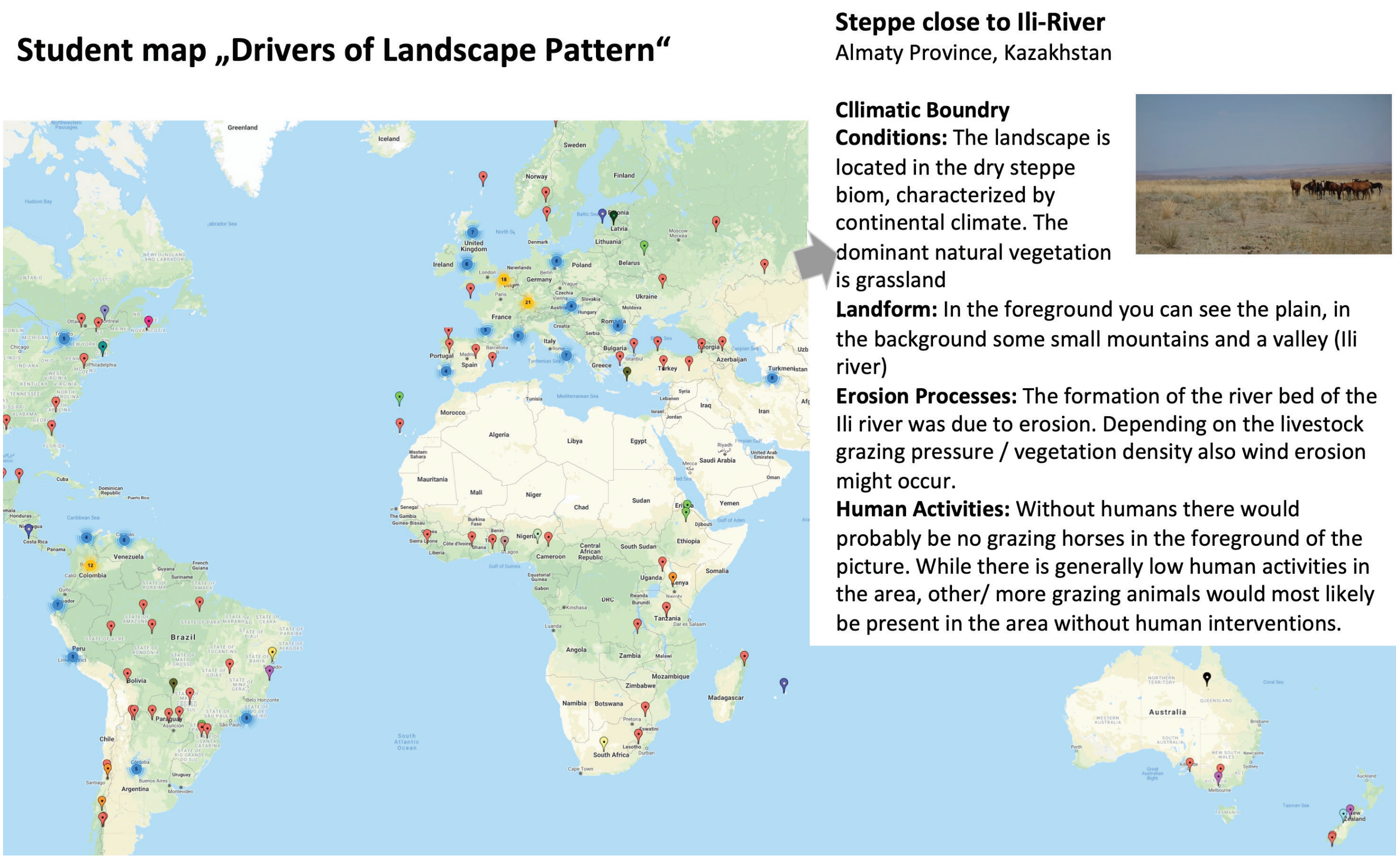

Figure 3: Example of a world map where students upload content. In this example the students describe the Drivers of Landscape Pattern in their home region. The symbols on the map represent the locations of 1 or more student contributions, details (as shown in the text box) are displayed when clicking on a symbol.

erosion processes sculpted the landscape? f) What role did humans play, e.g. what part of the vegetation has been changed by humans? g) Are there patters caused by disturbances present? h) Is there a mosaic in the vegetation? Are these different stable states or different stages during a succession?

3. *Essay writing:* An important and fully cooperative training element for precise thinking and formulating ideas are the so-called 6SA Essays, a method developed at the ETH Zurich to present complex issues briefly and convincingly (Jentges and Kölbel, 2016). These essays are peer-assessed by the participants, an activity that caused some (minor) frictions among the students and clearly showed some cultural limits of peer assessment (see also Discussion).

3.3 Combine and Consolidate

In the “Combine and Consolidate” categories, Conole (2015) argues, instructors should reflect on the overall course profile, the use of the different didactic elements and tools, and then implement the course. To do so, she suggests either: (1) an activity profile showing how much time participants spend on the various learning activities (information handling, forum communication, drill, practice etc.); or (2) a course view map in the form of a storyboard that yields information on the activities of the students through time. For the evaluation of the MOOC Landscape Ecology we amalgamated (1) and (2) to a combined activity/performance profile (Figure 4).

It appears our wide variety of didactic elements (upper part of Figure 4) motivated students worldwide to be active while keeping them engaged in the MOOC (lower part of Figure 4). When looking at the didactic elements according to Bloom’s taxonomy (Bloom et al., 1956), the quizzes reach the basic categories on Bloom’s pyramid up to “understand”; most GIS and R exercises involve the “apply & analyze” categories and the essays reach the categories like “analyze” and “evaluate”.

Topic	Introduce yourself	Introduction to Landscape Ecology	Drivers of Landscape pattern	Landscape Modelling	Oil exploration and rare plants	Landscape Metrics	Landscape Impact of Transportation infrastructure	Remote sensing	Urbanization in the Maledives	Landscape Perception	Renewable Energy	Soundscape Ecology	Ecosystem Services	Land Ethics	Urban Ecology
Week	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
Activity ***Work load (h)***	*0.5*	*2*	*2*	*2.5*	*3*	*2*	*2.5*	*1*	*2*	*1.5*	*2*	*2.5*	*1.5*	*2.5*	*2*
Watching videos (numbers)		1	4	3	6	2	5	3	1	7	2	1	8	6	2
Quizzes - review questions		x	x	x	x	x	x	x	x	x	x	x	x	x	x
Text clouds/drag-drop picture quizzes		x	x			x					x				x
R analysis				x	x		x		x		x				
GIS mapping exercise				x	x		x		x		x				
Larger text readings		x					x					x		x	x
Upload of content to a world map	x		x		x		x	x	x		x			x	x
6SA peer assessment		x					x				x			x	
Other text upload (in week 13 an interview with a stakeholder)														x	
Discussion (in week 11 mandatory for verified users)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

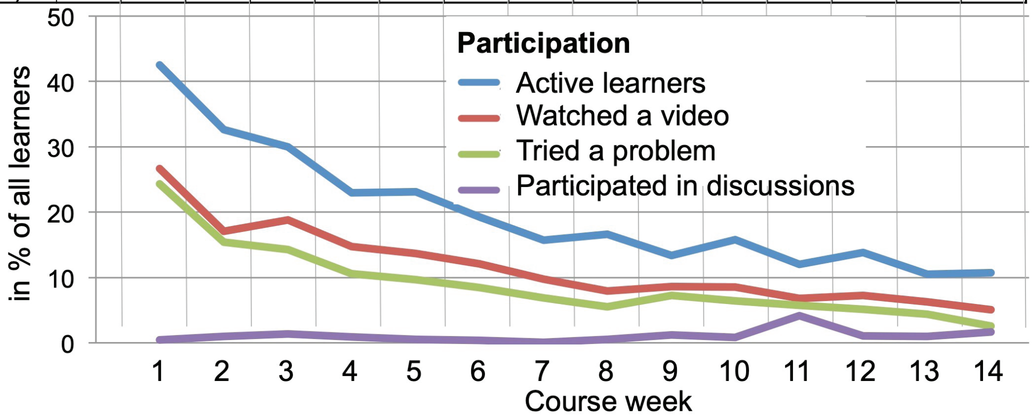

Figure 4: Activity/performance profile of the 2019 MOOC on Landscape Ecology. The upper part of the Figure yields information on didactic elements and tools of the course (videos, quizzes, map uploads etc.) and how they are distributed in the different units, each column represents one week. The lower part of the Figure shows how active students were over time ("active learners", "watched a video" etc.), where each point in the curve represents one week. Numbers are given in percent of all learners. The category "active learners" is not additive, i.e. a student that tries a problem and watches a video is counted as 1 active learner.

The decay curve of active participation (lower part of Figure 4) is typical for many MOOCs and is discussed later in the discussion section. The observed activity rate is at the top level compared to other MOOCs with 11-14% active students at the end of the course (2018: 14%; 2019; 11%). In other words, if we take into account that only half of the enrolled people have started the course at all, the observed activity rate means that every 4th learner that was active at the beginning was active at the end.

The course ran instructor-paced in 2018 and 2019. Due to Covid-19 impacts the course was re-run in self-paced mode in spring/summer 2020. We could not detect big differences in the two modes, except for the drop-out rates. The self-paced mode offers students a little more self-responsibility and fast students with little time can complete the course in a few weeks. In the instructor-paced mode, the interactive parts of the course are more concentrated and not dispersed over time. The activity rate in self-paced mode was considerably lower than in the instructor-paced mode (8-9% at the end of the course).

Participation indicators do not yield any information on the learning quality. The latter is measured with the correctly answered quizzes, randomly checked uploaded texts and 6SA essays and the number of students that pass the course with an official certificate[7]. Averaged over all learners that tried the quizzes, a total of 84% (SD = 8%) of the questions were answered correctly. In the end-of-course survey, 83% of the respondents (N = 146) indicated that the many instructional tools helped them to assess their learning process properly. Out of the 208 certified learners in the 2018 and 2019 course, 133 (64%) passed the threshold to obtain an official certificate. The random checks yielded a satisfactory quality of the uploaded texts.

4 Discussion

Our discussion of the MOOC Landscape Ecology is two-fold: (1) we compare our findings with those of other authors; and (2) we evaluate the performance using the student feedback. We also make some recommendations for instructors contemplating a MOOC. A striking fact in our MOOC is the relatively low dropout rate and a relatively high commitment of the students. The number of active participants over time (Figure 4) mirrors the findings of Evens et al. (2016), who analyzed persistence patterns in 44 MOOCs consisting of over 2900 lectures. According to Evens et al. (2016), the biggest decline in participation usually occurs in the first 20% of the offered units, which occurred in our MOOC as well. The reasons for this are common: lack of interest, competing interests, filled agenda, among others. Interestingly enough, only 43% of the enrolled learners even started the course - more than half subscribed and never touched the course again. Compared to what the literature (e.g. Bonafini et al. 2017) reports on dropouts and completion rates (usually 5-15%) the Landscape Ecology MOOC is at the top level with an activity rate of 11-14% active students at the end of the course (2018: 14%; 2019: 11%; 2020 (self-paced):8-9%). The higher drop-out rate in the self-paced course is probably due to lacking weekly reminders with highlights from the course, a lower activity in the Discussion forum because learners are all at a different stage of the course, and lacking deadlines for coursework.

7 to pass the course students need 50% correct responses in 10 (11) out of 14 (15) units (brackets are the 2019 course)

However, we attribute low drop-out rates - at least in the instructor-paced runs - to the following seven facts:

I. Landscape Ecology is a specialized discipline with few, if any, competing MOOC-style products to choose from. Zhu et al. (2018), and a query with edX (April 2, 2020), show that biology, environmental sciences, and landscape sciences together account for only about 5% of the MOOC courses. This is probably one reason why students are more attracted to this course than to courses with a higher number of course offerings.

2. The age class distribution (Figure 2) and the relatively high number of PhD and Master students suggest that we probably “fished” from a pool of students with above-average interest in the topic.

3. Landscape Ecology has a well-connected community that allowed us to advertise through Bulletins and social media platforms of the International Association for Landscape Ecology. University faculty members also promoted the course. As shown by Lopez-Goni and Sanchez-Angulo (2018), social media play an important role in scientific community building and information exchange, especially among young students.

4. High instructor accessibility and passion, given the course was designed as a collaborative project among international faculty. Hew (2016) confirms that passion and accessibility of staff are crucial success factors for MOOCs.

5. Internationally relevant topics and contexts that students can apply now or later. Hew (2016) confirms that a problem-centered learning design increases learning success of MOOCs.

6. A wide variety of videos and other alternating content types (images, diagrams, text etc.) contributing to a lively course and - as Diver and Martinez (2015) show - reduce drop-out significantly.

7. Opportunity for interaction among students (map uploads, peer assessment of texts, blog) which according to Sunar et al. (2017) lead to lower drop-out rates and better learning outcomes. However, our experience with peer assessment

of the essays is, at best, cautiously positive (see discussion below).

The end-of-course evaluation survey must be interpreted with care since only ca. 126 students participated in the survey. This is ca. 50% of the active students at this point in time, but only 5% of the registered users. Even though the response rate was low, the respondents overall gave very positive course assessments. Over 80% of the respondents rated the course with a 5 or 6 on a 6 point scale, with 1 being the worst grade and 6 the best. The testimonials in the discussion section and in the openly formulated questions give a more detailed picture: Learners appreciate the “theory-practice” tandem concept, its practical relevance, the many exercises and the global networking with other students. High positive ratings were given to the practicums in R, GIS and remote sensing, although they were demanding for some, and the technical difficulties due to various computer configurations of the learners were a great challenge for the instructors administering the course.

A considerable number of learners appreciated the international character of the course and the variety of subjects/concepts that could never have been presented by a single instructor only. This highlights the fact that MOOCs should be designed by international consortia. Many students found that they improved their writing skills with the 6SA writing tasks, but complained that the evaluation of the essays by peers was sometimes difficult and not objective. Indeed, peer evaluation of the writing tasks and the fact that this evaluation counts for the final grade was one of the highly criticized aspects of the MOOC. It also required several interventions by the instructors. Indeed, we had to remind our audience several times of the code of conduct and that one should give constructive criticism, mention strengths and weaknesses of a text, try to be a critical friend and avoid rather extreme criticisms (see also P.U.R.E approach of giving feedback by Bonafini et al. 2017). Kulkarni et al. (2013) also identifies some difficulties with peer assessment, i.e. “peers’ working from their own country were rated 3.6% higher than those from elsewhere”. This finding indicates that peer assessment should be handled with care and that the students should be reminded that different “school cultures” exist, each dealing differently with criticism.

5 Conclusions

Our experience with the MOOC Landscape Ecology is generally a positive one. Instructors interested in designing an own course should, however, consider the comments made in the Discussion section and the suggestions below:

- Design a course with a clear learning strategy behind it, following e.g. recommendations by Conole (2017). Avoid “just going online” with an existing University course;
- Organize a large worldwide team of specialists who teach individual units - it enables the team to find relevant learning objectives for the entire course, increases course acceptance in different regions world-wide, and fosters world-wide applicability of the content;
- Prepare as many videos as possible for field-based courses to bring nature and landscape into the classroom. However, be aware that this is costly but worth the effort in a “field-based” discipline;
- Keep repetitive exercise questions to a minimum, and instead motivate students with creative tasks that encourage innovation, creativity and individualized problem solving;
- Promote technical skills to the students;
- Encourage students to contribute actively, with information uploads (in our case e.g. with maps or descriptions of different phonies in the Soundscape class), and organize discussion platforms open to all students. This type of information exchange is a big benefit of distant teaching and contributes to a sense of community to the students while enabling exchange among different global settings;
- Foster clear writing by the students, using tools such as the 6SA essays identified here. Be careful with tasks (e.g. peer to peer corrections) that may

cause disputes among students and are not equally handled in the different "school cultures;"

- Design a "How do I review a colleague's essay" section where students learn how to respectfully review their fellow student's paper by identifying and improving the negative aspects and highlighting the positive aspects in a motivating way;
- Convince the supervisors at your University or School that you need to have a full-time assistant for 1.5 years with good technical skills and at least one additional assistant by the hour during the implementation of the course. This improves instructor accessibility and passion, two critical drivers of a successful MOOC; and
- Whenever possible, run the course in instructor-paced mode: Weekly e-mails from the instructors mentioning highlights of the course, examples from students or reminders reduce the drop-out rate and encourage student commitment to the course.

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Appendix

Table A1: Learning objectives in the MOOC Landscape Ecology.

Topic	Learning objectives: **At the end of each unit students should be able to....**
Introduce Yourself / Introducing Landscape Ecology	• define landscape and landscape ecology, • explain why it is important to consider scale and hierarchy in ecological studies, • analyze data to examine the effect of scale in ecological studies, • discuss the changes in land use over the past century and its effects on landscapes and ecosystems.
Drivers of Landscape Pattern	• describe the most important factors that cause landscape pattern, • explain the different temporal and spatial scales of landscape forming processes, • understand the interaction of different causes of landscape pattern, • analyze a landscape in respect to the forces that shaped the landscape.
Theory: Landscape Modelling	• explain the basic idea of the different model types used in landscape research, • explain the complete modelling process from data collection to model evaluation, • run a species distribution model (empirical model) in R studio and understand its output.
Case study: Oil exploration and rare plants conservation (Utah)	• organize landscape-scale spatial data related to man-induced landscape impacts (energy extraction) and biodiversity (rare plants) within a GIS. • Analyze spatial data by... ... understanding and differentiating between individual SDMs and SDM ensembles ... generating descriptive statistics of the plant and energy data elements ... cross-classifying these statistics in relation to land ownership; and ... creating spatially explicit map products of energy and plant locations.
Theory: Landscape Metrics	• explain how spatial data is collected and processed to landscape metrics, • use and interpret landscape metrics to describe different aspects of landscape patterns and • apply relevant landscape metrics to answer practical conservation questions.
Case Study: Landscape Impacts of Transportation Infrastructure	• understand the complex impacts roads have on ecosystems, particularly on wildlife. • explain how the impacts can be quantified using methods such as the Habitat Evaluation Procedure (HEP) or the Spatial Road Disturbance Index (SPROADI) • combine individual metrics to an integrated landscape-scale measure of road disturbance. • argue why and how ecological consideration should be included in road planning.
Theory: Remote sensing	• explain the main principles of remote sensing on the basis of spectral properties of different objects and land covers, • compare different platform types and their advantages, • understand what spatial, spectral and temporal resolution in terms of satellite image data is, and • explain different fields of application of remote sensing and formulate an example where remote sensing can be applied.
Case study: Urbanization in the Maledives	• load satellite images data into R and build a historical pixelwise database of reflectance. • explore the nature of different bands and their physical properties, such as resolution and visualisation of multi-layer imagery. • create a spectral profile that shows different features of the reflection of various land cover types.

Theory: Landscape Perception	• explain and compare different methods to quantitatively assess the perception of landscapes, • explain how knowledge on landscape perception can be integrated in landscape planning, • explain how landscapes can help restore mental fatigue, • explain what quantitative factors influence the attractiveness of a landscape.
Case Study: Renewable Energy and Landscape Conflicts	• visualize spatial data on a map using R. • use R functions to overlay, combine, erase, or modify spatial data layers, resulting in new output layers. • evaluate landscapes in respect to their suitability for recreation, wind energy based on spatial data analysis. • explain potential landscape conflicts that arise from different perceptions.
Case Study: Soundscape Ecology	• learn about basic theoretical concepts of Soundscape Ecology • listen to a particular landscape and learn to categorize and analyze the sound of the environment • try to reflect sounds by taking into account ecological and cultural properties of a landscape
Theory: Ecosystem Services and Valuation	• explain the concept of ecosystem services, • understand the different approaches to value goods that are not traded but offered by nature for free and • critically reflect the approach to put a value on nature.
Case Study: Land ethics	• differentiate the North American model of conservation from that of your home country • evaluate the Land Ethic application in relation to protected areas or private lands • formulate whether future conservation should be based on ethics or economic valuation.
Theory and Case Study Urban Ecology in Bangalore	• apply the concept of ecosystem services to cities, • explain why green spaces in cities are important for the inhabitants and urban ecology, • understand the importance of urban ecology in a future global context.