"I remember your lecture": role-playing games and unconventional teaching reinforce learning outcomes

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Abstract

To familiarize students with today's challenges in the field of ecosystem management, the environmental sciences master program offers a course for students called Foundations of Ecosystem Management. The aim of this course is to create an effective learning experience and develop critical thinking capacities for future natural resource managers and academics. The course is structured into various parts where students first elaborate on the definition of the theoretical foundations and concepts. In a next step, they use this definition to work on real-world case studies. During their groupwork, they construct a role-playing game that addresses the most prominent issues in the system and thereby learn to understand and deal with the complexity of the management issues. At the same time, students are trained in soft skills like teamwork, self-reflection, debriefing, and facilitation. In this paper, we present the structure of the course and results from an online survey done by students from the last 5 years. We assessed how well former students remember the course and the theory they learnt and how they perceived the teaching approach. We found positive results: students appreciate the different teaching approach and most of the students, including students from earlier cohorts, state that they still remember the concepts. Students report that they have applied the concepts and approaches from the course in other contexts outside the classroom. We, as teaching staff, reflect on the course, the learning experience, and the results from the online survey, and present four teaching principles that underline what has worked in the course: i) self-authorship, ii) education through active and experiential learning, iii) competence-oriented learning on soft skills: self-reflection, teamwork, and facilitation, and finally iv) inter-cultural learning.

1 Introduction

Current environmental crises are wicked problems. They cross disciplinary boundaries and transcend differing perspectives and values of multiple stakeholders, which renders pathways towards any single solution intractable (Rittel & Webber 1973). It is in this context, that the field of ecosystem management has been developed. Ecosystem management deals with multiple disciplines across multiple temporal and spatial scales, as it seeks to understand natural and social systems, and the feedbacks and interlinkages between them. This management approach requires a holistic view that does not seek definitive solutions, but instead, follows an adaptive process of collective learning, exploring, and experimentation.
In order to familiarize students with such a management type, the Chair of Ecosystem Management at ETH Zurich offers a course for master students called Foundations of Ecosystem Management. The course provides an introduction into this field by examining

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wicked problems in the context of natural resource management, which arise by conflicting multiple societal demands. Students first co-construct definitions of the core concepts in the field of ecosystem management. Subsequently, they work in small groups on real-world case studies from the teaching staff's ongoing research activities or collaborations with other research groups. These case studies are drawn from a diverse array of environmental issues from across the globe; from reforestation processes in the Highlands of Scotland to ecosystem services in coffee agroforestry landscapes in India. The students create a role-playing game (RPG) to address issues of their case study. This provides an opportunity not only for the students to learn about the challenges in the ecosystem management field, but also to train their soft skills (e.g. Fowler et al. 2016) such as teamwork, self-reflection, debriefing and facilitation.

In this paper, building on the perspectives of the students that participated in the course, we provide our reflections of the course and the learning experience as teaching staff. We present the structure of the course and discuss results from an online survey where we assessed the experience of former students. Our aim is to present the unconventional teaching approach of the course and to highlight its strengths, but also the limitations of this approach. Our analysis is complemented throughout the manuscript with statements from the online survey and from the official course evaluation forms of ETH Zürich that are conducted every second year (we used the evaluations from HS16 and HS18).

2 The structure of the course Foundations of Ecosystem Management

The main goal of the course Foundations of Ecosystem Management is to create an effective learning experience and develop critical thinking capacities of future natural resource managers and academics. As such, the teaching staff introduces students to the broad variety of conflicts that arise in projects focusing on sustainable management of natural resources (Table 1).

Students start the course by playing an existing role-playing game (RPG) that recreates some of these conflicts. This helps them to familiarize with the type of problematics at the core of the course and the methodology that can be used to address them. This highly interactive session is followed by lessons about ecosystem management and wicked problems, during which, students co-construct together with the teaching staff an introduction to the theoretical foundations and concepts in the field. These lessons are all about facilitating a process whereby, with no additional information provided, the students use their existing knowledge interactively to develop their own collective interpretation of ecosystem management. This interpretation coalesces around 12 principles (Secretariat of the Convention on Biological Diversity 2004) that they themselves develop and define. Further, the creativity of students is prompted through group exercises such as Ecosystem Management on Mars.In the second part of the course, students start their hands-on work in different real-world case studies. These are selected and introduced by the teaching staff, who provide students with a short overview of the ecosystem under study, its dynamics, and the mayor conflicts associated with it. Based on this information, students identify an interesting research question and create a RPG to address some of the pressing management issues in their case study. Students work in small groups of 5-8 people and start by gathering information about their case study using the suggested literature. Additionally, the teaching staff invites experts from the case studies to participate in one of the class sessions, thus giving students the opportunity to explore and discuss directly with stakeholders the different visions, discourses, and practices of the system under study (Figure). These experts come from the teaching staff's network of partners within and outside academia (e.g., WWF, Papiliorama, CIRAD, IRD, Forestry Commission Scotland, and others). When it is not possible for stakeholders to join the class in person, Skype sessions with these stakeholders are organized. Other stakeholders are represented by video and audio interviews. This interactive exploration allows for the development and validation of students' mental models. Initially, the students are perplexed by their complete lack of familiarity with

these case studies, and then, as they delve into them, alarmed by their complexity. Yet, the teaching staff provides methodological tools that allow students to navigate uncertainties and complexity of their case study such as the Actor-Resources-Dynamics-Interaction (ARDI) methodology (Etienne, Toit & Pollard 2011). These tools are presented in brief theory sessions at the beginning of the lecture and are applied right away in the group work. Soon, students begin to build cumulative knowledge, and through peer group discussions and debates, they start to make sense of the complexity by constructing a simplified conceptual model of the system in the case study.

Figure 1: Students interviewing a case study expert

The next step is the most challenging, but also the most exciting, and that is to convert the conceptual model into a RPG. To achieve this, the teaching staff provides the students with further methodological frameworks, derived from the ARDI methodology, that facilitate the identification of mechanisms and components that will make up the RPG. The final prototype of the game reflects the students' understanding of the system and is a valuable tool to explore its dynamics and different scenarios within it. In a final task, students demonstrate their RPG during a crash test, where they not only present their game, but are challenged to carry out a whole simulation of a short participatory workshop. The aim of this activity is for the student to reflect on the methodological approaches learnt in the course from an on-the-ground implementation point of view. Throughout the process of the game development, students are encouraged to present the game to external people (e.g. friends, family). Through these experiences they learn how a simple model like a RPG allows anyone to experience and interact directly with a system and understand conflicts in resource management. Each game construction session and crash test ends with a debriefing discussion. This provides an opportunity for the teaching staff to discuss, together with the students, how they experience the process and the sessions, and it allows to draw conclusions from group work, concepts, work strategies, and solutions to the issues at hand. The whole role-playing game exercise is often hectic but exciting, and it offers the opportunity to explore and identify the multiplicity of strategies that could respond to the different ecosystem management issues represented in the case study.

After this main part of the lectures is over, the students start working on a report, where they present the elaboration of the conceptual model, the RPG design, and the results and reflections form the crash test and the groupwork. In the following lectures, the students learn about participatory processes and their challenges from the teaching staff, but also from practitioners of ecosystem management who present their work in the course. During these lectures, there is a lot of space for the students to ask questions and be critical. Finally, the

lecture series ends with a plenary synthesis where the teaching staff and the students collectively debrief the whole course. A specific description of selected tasks given to the students can be found towards the end of this paper in Table 2.

	Lecture	Main topics	Main activities
Introduction	1	Introduce students to challenges in EM and used methodology	Students participate in a session of the RPG ReHab, facilitated by the teaching staff, to explore the difficulties of managing natural resources with conflicting agendas and the limits to collective action.
Core topics	2	Defining ecosystem management	Student group discussions with the task of defining EM followed by presentations of the group work to the rest of the class. Plenary discussions to define the principles of EM.
	3	The wicked problem concept	Short presentation of the wicked problem concept through the teaching staff, followed by group discussions and Ecosystem Management on Mars exercise, where students apply the wicked problem concept.
RPG design	3	Case studies	Teaching staff introduces case studies from around the world with short presentations. Afterwards, students choose their case study and form groups.
	4	Exploring the case studies	Students meet in their groups, discuss the literature about their case study, brainstorm, and interview case study experts
	5	ARDI: building a conceptual model	Short presentation of ARDI framework through teaching staff. Students use this framework for their case study in group work.
	6	From conceptual models to RPG	Teaching staff introduces the main steps and elements of the RPG design. Students apply this on their case studies.
	7	RPG design	Students design a RPG prototype of their case study.
	8	RPG design	Students continue the design of the RPG prototype of their case study.
	9	Crash test	Each group introduces its RPG prototype and runs a crash test followed by a debriefing discussion.
Follow-up to RPG design	10	Writing reports and reflecting on the crash test	Students have time to write their report for their case study: the conceptual model, the RPG design, and results and reflections from the crash test and the group work.
	11	Debriefing the crash test	Plenary discussions on lessons learnt and implementation of outcomes from the crash tests.
Real-world EM and course synthesis	12	Monitoring, impact assessment and participatory process analysis	Teaching staff presents methods to evaluate progress and to assess the impact within EM approaches.
	13	Ecosystem management for real	Teaching staff invites different EM practitioners who present their work and participate in a Q&A session with the students.
	14	Course synthesis / debriefing	Plenary discussions to evaluate the EM concept and the approaches developed in the course.

Table 1: Course syllabus. Structure of the course Foundations of Ecosystem Management (Abbreviations: EM = Ecosystem Management, RPG = Role-Playing Game)

3 Students' perspectives on the teaching approach

This section will highlight the perspective of the students from the course Foundations of Ecosystem Management. We assessed the experience of former participants from 2014-2018

by conducting an anonymous online survey. We analysed whether the teaching approach of the course lead to an effective and long-lasting learning. The survey contained questions that covered different aspects of student learning. The first set of questions assesses the student's view on the course itself: how the student perceived the learning methods and whether they remember the concepts they learned in the course. With the second set of questions, we assessed how students feel about the soft skills taught during the course by asking them whether their group work was more efficient after participating in the course, and how they felt about facilitating a stakeholder workshop. Finally, we asked if they continue, outside of the course, to use the knowledge from the course. The students answered these questions on a 5-point Likert answer scale ranging from "strongly disagree" to "strongly agree" with a neutral answer option in the middle. At the end of the survey, students had the possibility to leave a voluntary comment. We received a total of 54 surveys from students of all 5 years and from 8 different case studies.

3.1 Students assessing the novelty of the teaching approach of the course and how well they remember the concepts and their case study

Over 90% of the students that participated in the survey considered the learning method used in the course as a novel way of learning (categories "agree" and "strongly agree", Figure 2a):

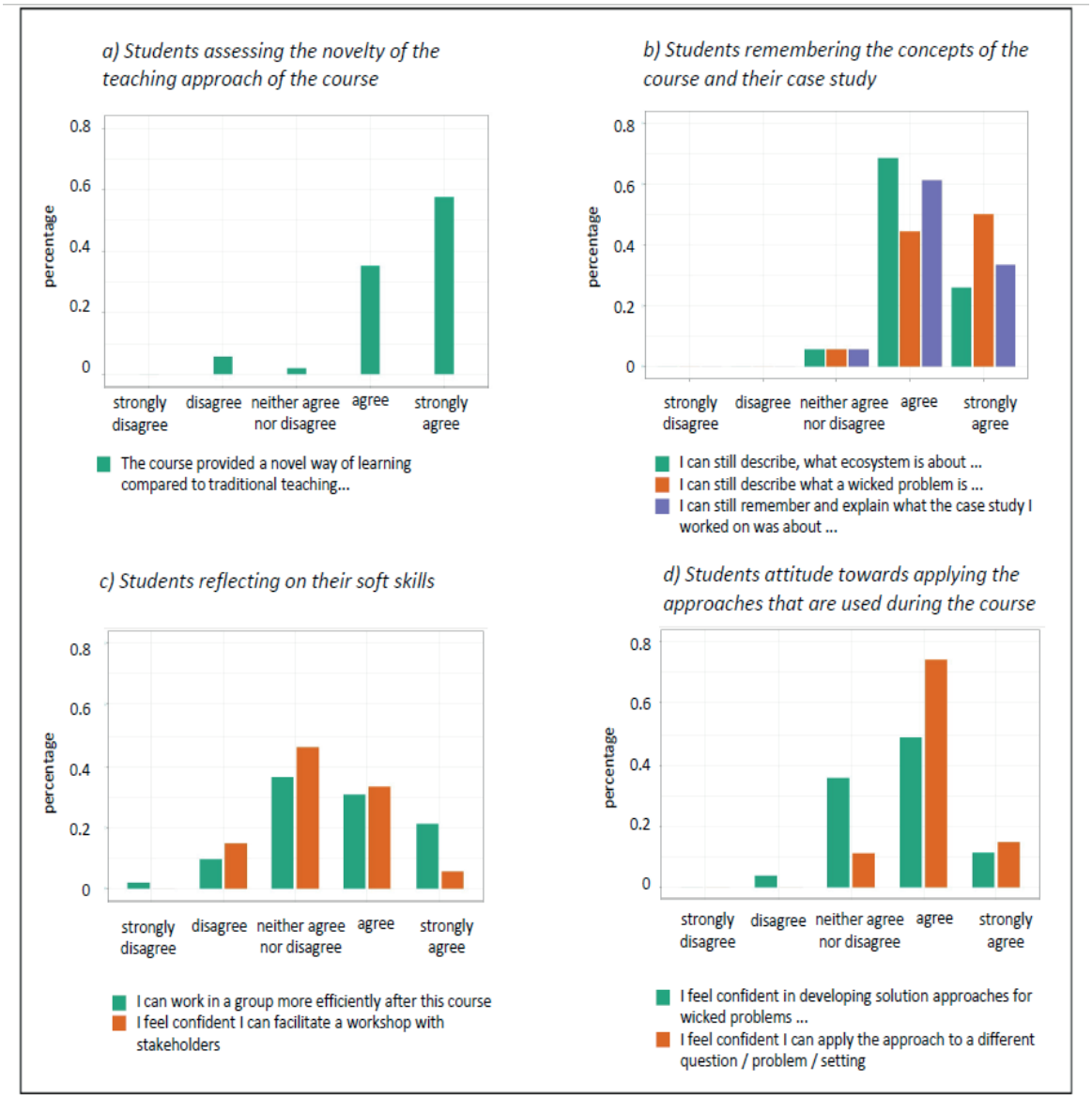

Figure 2: Results from the online survey from all participants (n = 54).

"very different teaching style" (student, HS16). In the survey, students reported that they had understood the concepts of the course well.
Over 90% of all participants stated that they are still able to describe what ecosystem management and a wicked problem is (categories "agree" or "strongly agree", Figure 2b green and orange bars). Even students that attended the course several years ago, were still able to do so: "it is one of the courses of university that I remember best." (student, HS14). In the same way, 94% of the students stated that they can recall their case study, the issues and processes that they were working with, and the conflicts they were trying to find a solution for (categories "agree" or "strongly agree", Figure 2b, purple bars).

3.2 Students reflecting on their soft skills

Besides the fact that the teaching staff wants to transmit the concepts of ecosystem management and a new methodology to the students, it is also important for them to train the students in soft skills. The results from the survey (Figure 2c) show that a substantial number of students do not feel confident (categories "strongly disagree", "disagree" and "neither agree nor disagree") working in groups (48%, Figure 2c, green bars) and in leading a workshop (61%, Figure 2c, orange bars). However, some students state clearly that the course provided an opportunity to acquire these skills: "I especially appreciated the development of soft-skills and the innovative approach this course offers" (student, HS18) and "the soft skills learned during this course actually helped a lot for other courses" (student, HS18).

3.3 Students' attitude towards developing solution approaches for wicked problems

We also asked students how confident they feel in using the approaches of the course elsewhere (Figure 2d). 88% of the students stated that they felt confident (answers "agree" or "strongly agree") in using the approaches of the course in a different setting (Figure 2d, orange bars). 60% of the students also stated that they felt confident (answers "agree" or "strongly agree") in developing solution approaches for wicked problems (Figure 2d, green bars). Nevertheless, a considerable number of participants "neither agree nor disagree" with this question. Yet, most of these responses came from students from 2017 and 2018 (Figure 3), who just recently learned about the approach and therefore their confidence in using it might be lower. They noted, however, a potential for using it in the future: "[…] I really appreciated learning about a method that can be useful in the professional world." (student, HS18).

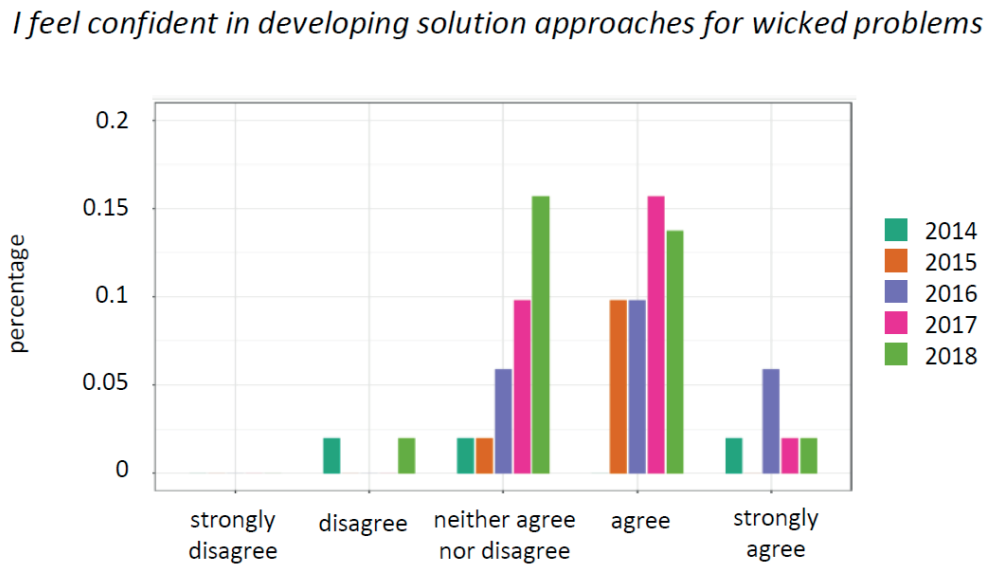

Figure 3: Results from the online survey to the statement: "I feel confident in developing solution approaches for wicked problems". The participants are grouped according to the year they attended the course.

Finally, the students overall seemed to be very satisfied with the course. 26 respondents (n=54) of the survey added a voluntary comment about the course. Most of the comments were very positive: “it was one of the best courses I ever attended at ETH, if not even the best” (student, HS14). Among others, they encouraged the continuation of the course in the future: “Very impressive and professional teaching team” (student, HS17) and “[…] recommend the course to all the newcomers” (student, HS 14).

4 Four teaching principles for effective and long-lasting learning

The course Foundations of Ecosystem Management is based on our own experiences in the field of ecosystem management and has been continuously adapted based on the lessons learnt during the last 5 years of teaching and fieldwork. Upon reflecting on the design and history of the course, we propose four principles that summarize the foundations of our teaching approach: i) self-authorship, ii) education through active and experiential learning, iii) competence-oriented learning on soft skills: self-reflection, teamwork, and facilitation and iv) inter-cultural learning. The theoretical background of these principles come from different sources and we believe they provide an effective way to deliver the concepts, tools, and skills necessary for the next generation of ecosystem managers. In this section, we use these principles to frame the results from the online survey. We also provide examples of specific tasks and assessment criteria that illustrate how we implement the four principles within the course (Table 2).

	Tasks for the students	Assessment criteria from the teaching staff
Self-authorship		
	“Construct, first in groups of 2-4 students and afterwards with everyone in the classroom, your collective interpretation of ecosystem management without using any external material but your own perceptions.”	We compare in a plenary, together with the students, the collective interpretation created by students with the published principles on ecosystem management (Secretariat of the Convention on Biological Diversity, 2004). Like this, there is a critical and collectively assessment for consistency, novelty, and missing elements. Through the comparison, we demonstrate that their interpretation is very similar to the principles identified by experts.
Education through active and experiential learning		
	“Work in small groups and apply the principles you developed about ecosystem management on the following example: how should we manage Mars to achieve a ‘Mars terraformation’”?	We assess if students are able to construct a problem tree and identify the direct and indirect drivers of landscape change. Also, we evaluate if they can contextualize and mobilize the principles of ecosystem management to discuss landscape management on a totally hypothetical case study.
	“Construct a role-playing game to explore and address important issues in your case study area.”	We assess the developed RPGs during the final crash test. We evaluate the functioning of the game, how it can help to explore scenarios (i.e. not a unidirectional game) and whether it fosters discussions about the issues and the management of an ecosystem. Students participate in their classmates’ crash tests and also give feedback about the RPG and the session. Students compile all the feedback, reflections and a documentation of the process in a final report.

Competence-oriented learning on soft skills: self-reflection, teamwork, and facilitation	
"Organize yourselves within your groups to work on your case study: define a timekeeper, facilitator and secretary for each group meeting and conduct a debriefing discussion at the end to evaluate your process."	We ask the students to critically and honestly evaluate their groupwork as a part of the final report. In this way, students assess this task themselves.
"Organize the final crash test of the RPG you developed, including a debriefing discussion, where participants have the opportunity to discuss what they have experienced and learned."	We, as well as the other participants of the crash tests, provide the students with feedback on their crash test (see specific evaluation criteria from the teaching staff in the annex Table A1). The students are then required to include this feedback in their final report.
Inter-cultural learning	
"Conduct interviews with the experts of your case study (in the classroom or online) to obtain the necessary information about the system. Use this information as well as published literature to map power relationships in the system, to understand the position and interest of different stakeholders, and decide who should be represented in the game and who should be invited to a workshop of the RPG you developed."	We assess this task indirectly through the RPG and its development process: when students have an in-depth understanding of their case study and the different stakeholders, the RPG reflects power imbalances in the system and the winners and losers in each of the explored scenarios.

Table 2: A specific description of selected tasks given to the students that address the four teaching principles and their assessment criteria from the teaching staff.

4.1 Self-authorship

Self-authorship is fundamental for student learning (Baxter Magolda 2009) and represents an important aspect in the course Foundations of Ecosystem Management. Students create a RPG and have ownership over this tool. In the same way, we promote students' self-authorship of what they learn in the course through the peer-peer and plenary discussions where the students define ecosystem management and wicked problems (Table 2). Forcing students to draw on their own knowledge makes them realise how much they already know, yet, also forces them to critique their understanding through the participatory peer discussions. Finally, and importantly, the collective interpretation they develop is their interpretation – they have ownership of it, and therefore believe in it. The rest of the course builds upon this foundational interpretation. In addition, students help in co-designing the content of the course together with the teaching staff through these exercises. The participants of the course state that "[…] the different teaching offers the opportunity to make your own thoughts and make up your own opinion on a subject that is very complex." (student, HS18). We therefore belief, that the overall very positive results from the online survey is partly explained by students having a self-authorship of the content of the course.

4.2 Education through active and experiential learning

A second important element in the course is active learning. Active learning has a powerful impact on learning outcomes (Wieman, 2014) and we include active learning activities throughout the course. Firstly, the students construct and discuss the concepts of ecosystem management and wicked problems in active group discussions (Table 2). This way of teaching

is appreciated by students: "[…] push the tables aside and form a circle. This style of lecturing is very much appreciated and not common at ETH" (student, HS16).
Secondly, active learning happens during the design of the role-paying games. The initial construction of conceptual models behind these games is done in highly interactive group meetings, where students are encouraged to organize themselves, to share, and show their ideas (Figure 4). The following gamification process requires a simplification of the conceptual models while retaining the essence of the system. Students craft a game board and develop

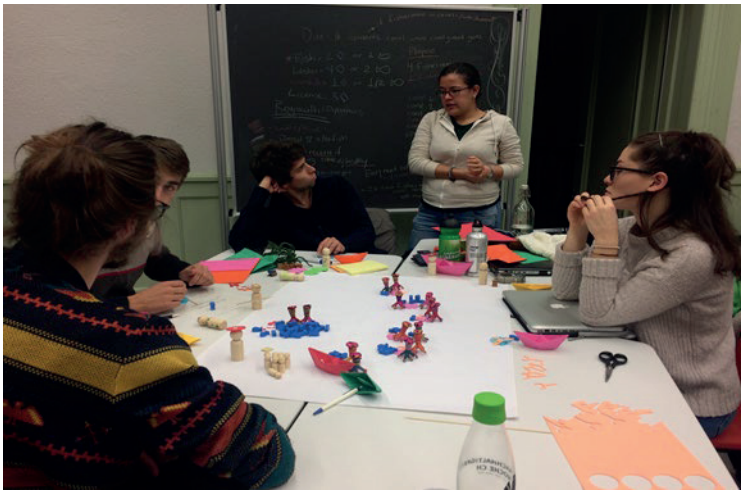

Figure 4: Students working on their case study in a group meeting (credit: Anne Dray)

game mechanisms. Consequently, they play the prototypes themselves in order to test the mechanisms. Throughout this active process, students gain knowledge about their case study, about the dynamics of natural resources, the socio-economic interactions, and the different opinions stakeholders have. In short, RPGs are a "powerful engagement tool" (Garcia, Dray & Waeber 2016) and are "the perfect way to get in touch with the topic" (student HS16). Our results from the online survey show that students remember their case study, as well as the concepts of ecosystem management and wicked problems well. We believe that the active learning style has led to this positive result.
In the same way, as we aim to foster active learning through peer discussion and the work on the case studies, we also aim to foster the creative thinking of the students. DeHaan (2011) argues that these two aspects underline the creative thinking capacities of students. We further foster creative thinking in the course through exercises such as Ecosystem Management on Mars (Table 2), where students need to think out of the box. Fostering creativity is important, as it is the basis of innovative thinking, which in turn, leads to new and useful solution approaches and tools (DeHaan 2011).

4.3 Competence-oriented learning on soft skills: self-reflection, teamwork, and facilitation

Skills in facilitation are too often neglected in scientific approaches. Academics tend to favour the development of substantives models (content) over transdisciplinary ones. Ecosystem management, however, demands the consideration of people as actors within, and drivers of, environmental systems. In our course, we therefore aim to train the students in facilitation by guiding them through the theory behind group behaviour processes and letting them explore it while they work on their case studies. In every session, students work on their facilitation skills, either through observation or practice, which prepares them to facilitate the created RPG of their case study during the crash test (Figure 5).

Figure 5: Students playing a role-playing game during the crash test (credit: Anne Dray)

Students also learn the importance of self-reflection, and how to give and receive constructive feedback on each other's' attitude within the group. Students learn how to move from group work to teamwork: "One of the best learning experiences I ever had on a course, especially pertaining to consciously reflecting group work and group dynamics." (student, HS 17). The teachers themselves do what they teach, in that they demonstrate, in the way they run the course, the very same philosophy. They explicitly elicit student expectations at the outset and revisit these expectations periodically through the course. They create space for students to give feedback in a nurturing and respectful manner, and they act on this feedback to adapt the structure of the course to the flow of the students' learning processes.

The training in soft skills is a major component of our course. However, the results from the online survey show only moderately positive results. With these results, we recognize that more needs to be done to foster such critical skills within our course, and the overall learning experience of students at ETH Zurich. We already addressed this shortcoming during the course in 2019: we included a specific session on how to conduct a constructive debriefing discussion after a RPG workshop and provided the students with an example of a debriefing protocol. However, our results state clearly that a 14-week course is not enough to equip students with hands-on skills to work better in groups and become confident facilitators in stakeholder workshops. This result highlights the need to include, within existing courses, modules to build more practical skills and develop soft skills as part of the learning experience that will be useful in their professional life (Andreu-Andrés & García-Casas 2014).

4.4 Inter-cultural learning

The course introduces students to multiple case studies from across the world. The diversity of stakeholders within each case study represents differing, often conflicting, perspectives; a situation that reflects real-world settings. In consequence of the analysis of their case study, students begin to understand the range of priorities and values that different people attach to resource and landscape elements, as well as different approaches to management. The focus in the future will be on case studies emanating from the field, rather than case studies dwelling from past experiences. In this way, students get an opportunity to interact with stakeholders that have an immediate interest in the topics. In our opinion, such collaboration between stakeholders and students fosters a meaningful inter-cultural learning. At the same time, knowing that their product can possibly be used in the field, triggers students' motivation to work on their case study: "I had [for] the first time the impression to get in contact with the real world" (student, HS16).

5 Conclusion

The course Foundations of Ecosystem Management for master students is taught using a different teaching approach compared to most other master courses in the curriculum of environmental sciences. Group discussions are used to elaborate the theoretical background of managing ecosystems and role-playing games to make students familiar with the complexity of problems that occur in such settings. The result form an online survey conducted with participants of the course from the last five years indicate that this teaching approach is highly appreciated and has promising results; most of the students, including students form several years ago, state that they still remember the concepts of the course. Moreover, outside the course, students applied the concepts and approaches learnt in the course. The course trains the students in facilitation and fosters effective group work, soft skills that are highly valued by students and will be useful to them in their professional life. Based on the results from the survey, we provide four teaching principles which represent our voices as teaching staff and build on the perspectives of the course from the students. We found, that using these principles creates an effective and long-lasting learning experience for students which leaves us confident in our approach and encourages us to keep applying it in the future.

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Appendix

Briefing	The roles, rules, objectives, elements and tokens are clearly explained, in a concise manner.
Facilitation	The game master allows all players to participate and be engaged. The game master clarifies the rules when needed, but he/she is not too intrusive (does not influence players' decisions). The game master pays attention to the time constraints.
Players engagement	The game fosters communication amongst players. Players are engaged throughout the rounds (no signs of boredom/fatigue). The game allows for multiple/diverse strategies to be tested.
Game rounds	The game fosters tensions/conflicts amongst players. The game allows for new/alternative scenarios to be implemented.
Debriefing	Players can reflect on their emotions, strategies, performances in the game. They can explain what they learned from the game. Observations (indicators and verbatims) are mobilized to reflect on what happened during the game and foster exchanges amongst players.
Ergonomics	The game is visually appealing. The tokens are easy to understand/manipulate. Handout, players profile, information sheets are used to facilitate understanding.
General comments	

Table A1: The teaching staffs' evaluation form for the final crash test of the games the students developed.