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The European Workshop: a course aimed at educating students to cross boundaries

Karen P.J. **Fortuin***, Simon R. **Bush****, Astrid **Hendriksen****

*Environmental Systems Analysis Group and **Environmental Policy Group,
Wageningen University
P.O. Box 47, 6708PB Wageningen, The Netherlands
Email: karen.fortuin@wur.nl

Abstract

The current problems engineers are facing are so complex that they require boundary-crossing skills, such as the abilities to change perspective, to cope with complexity and to synthesize knowledge of different disciplines or areas of expertise in a critical and creative way. This paper addresses how educational programmes at universities can better equip students to adequately cross boundaries and find sustainable solutions for complex environmental problems by giving an example of a course that has been offered for several years to master students at Wageningen University. In this course, called the European Workshop (EUW) thirty students with different disciplinary and cultural background work together on a consultancy project in a well structured way. Teachers' and students' reflections are used to analyze four key components which make up the didactic model of the EUW: the organizational 'matrix structure', a two week field-trip, a customized SharePoint website, and the facilitation role of the teachers. The paper concludes that the EUW as a didactic model to educate students to cross boundaries was very successful. It also showed how bridges and barriers can be overcome in an interdisciplinary project.

1. Introduction

Environmental engineers are currently facing very complex problems in both the scientific and the professional world. They are asked to assess global, regional and local problems and provide solutions in an integrated way. Major questions involve, for example: How can society switch from fossil fuels to renewable resources? How can the decline in biodiversity be halted?, How can production chains with minimal waste be developed? or How can innovative sanitation concepts be realized? To be able to find sustainable solutions for these complex issues engineers need what are increasingly referred to in the literature as 'boundary crossing skills' next to domain specific knowledge, communicative and social skills. They need to be able to cross the barriers or bridge the gaps that exist between theory and practice or between disciplines [1, 2]. Cash et al. [3] describe these boundaries as "socially constructed and negotiated borders between science and policy, between disciplines, across nations, and across multiple levels", which they go on to argue " … serve important functions (e.g. protecting science from the biased influence of politics, or helping organize and allocate authority), but they can also act as barriers to communication, collaboration, and integrated assessment and action" (p. 1). Thinking collectively about complex problems requires crossing boundaries both horizontally across disciplines and vertically across experts, policymakers, practitioners, and the public [4].

How to cross these boundaries is an ongoing debate. Mollinga [5] argues that what is needed are *boundary concepts, boundary objects* and *boundary settings.* Cash et al. [3] stress that

boundary work involves simultaneously *salient, credible* and *legitimate* information for multiple audiences. However, to facilitate crossing boundaries, you need people who are both interested and capable - something that cannot taken for granted, as experience in, for instance, interdisciplinary research projects show [6-9]. While there is a body of knowledge illustrating professional needs and experiences in crossing both vertical and horizontal boundaries [4, 10-12] little attention has been given to how to teach those skills. This paper explores how educational programmes at universities can better equip students to adequately deal with these complex environmental issues and to contribute to sustainable development. In other words, the main research question is: What educational approaches improve students' boundary crossing skills?

The integration of issues related to sustainability into higher education poses a series of challenges to conventional pedagogy. Steiner and Posch [13] argue that complex, integrative concepts such as sustainability require a careful balance of interdisciplinarity, transdisciplinarity and self-regulated learning. Students and teachers wishing to focus on sustainability challenge conventional modes of education, and require new methods to integrative learning. Efforts to adjust curricula to meet these challenges and deliver graduates that are able to approach problems in an integrated way are increasingly common [see for instance 9, 13, 14, 15-17]. These range from programme level to class-based working groups, simulations or case studies. Central to many of these are research-based or action learning models, promoting creative, self-regulated learning. While many of them focus on examples taken on small groups outside the classroom environment, there are few that address complex problems through collective learning.

Based on the experiences of the 'European Workshop' (EUW), an interdisciplinary course at Wageningen University, this paper assesses innovative learning approaches in the context of MSc programmes in environmental sciences and related fields and contributes to the dissemination of effective approaches. The EUW course is focused around a consultancy project in which the students are challenged to apply knowledge gained in previous courses and think across traditionally disciplinary and topical boundaries while working in an intercultural setting. It is scheduled at the end of a first year of course work and before embarking on a second year thesis and internship. The course has run for several years and has evolved into its current focus and structure. This paper reflects on the EUW as a didactic tool. Through this reflection, we aim to contribute to the understanding of how all elements of the course contributed to the team effort within a successful interdisciplinary research project and to the individual students' boundary-crossing learning process.

The following two sections first elaborate on the EUW as a didactic model. The course objectives and structure of the EUW are then elaborated, introducing the various stages and key components of the course designed to enhance boundary crossing skills coordinated through collaborative and interdisciplinary research. Our evaluation of the EUW is first based on our (i.e. teachers) reflections of what constitutes successful interdisciplinary research and learning. Second, the reflections of two cohorts of students are used to determine what the most important and effective learning processes are of the course. Finally, our conclusions will be relevant for both interdisciplinary research projects and courses that aim to enhance boundary crossing skills.

2. Joint interdisciplinary research as a didactic model

The EUW was introduced as part of the MSc programme Environmental Sciences at Wageningen University to provide all students the opportunity to gain experience in transferring theoretical knowledge into practice: a crucial skill for educating agricultural and environmental engineers. Since dealing with complexity and uncertainty is a central issue of environmental sciences programmes it was decided that this should be an important element of the EUW as well. As part of the EUW a consultancy project was developed in which Environmental Sciences students were challenged to work in an interdisciplinary research project to find sustainable solutions for complex environmental problems.

Another element that made this project even more challenging was that the Wageningen students come from all over the world, bringing into the programme a very rich cultural diversity.

It was thought that working together on one project could enable the students not only to cross boundaries between theory and practice and between disciplines, but also between the different cultural backgrounds. Combined these three boundaries form the basis of the programme and also the key elements with which we evaluate the EUW. In doing so, we make a distinction between knowledge, attitude and skill. This allows us to examine the extent to which they transcend the disciplinary knowledge gained in other courses, are aware of different perspectives, and acknowledge the additional value of using these perspectives in formulating solutions to complex environmental problems. To approach and investigate an issue from different angles is not something students develop naturally and requires explicit attention in education. A positive attitude or *habitus* towards crossing boundaries is needed [1].

Table 1: Crossing boundaries in the EUW

1. Crossing disciplinary boundaries
    a. Know: being aware of different perspectives
    b. Attitude: see the value of using different disciplinary perspectives
    c. Skill: make use of different perspectives; make use of different disciplines and make connections between them
2. Crossing cultural boundaries
    a. Know: being aware of differences in cultural perspectives
    b. Attitude: see the value of using different cultural perspectives
    c. Skill: being able to collaborate, negotiate and make decisions in an intercultural setting
3. Crossing boundaries between theoretical knowledge and practice
    a. Know: being aware of differences between theory and practice
    b. Attitude: being flexible and open to uncertainty
    c. Skill: being able to deal with complexity and uncertainty

Experiences from interdisciplinary research projects show that educating people to address complex problems proves more difficult according to the number and type of gaps or barriers that need to be bridged or overcome [6, 8]. Morse et al. [9] evaluated an interdisciplinary research project consisting of a team of PhD students. Based on their evaluation and a literature review they identified ‘bridges and barriers’ for interdisciplinary research on three levels: the individual or personal level, the disciplinary level and the programmatic level. Interesting finding is that experience with interdisciplinary projects is considered an important bridge for interdisciplinary cooperation [see also 6]. This experience made us decide to let our MSc students participate in a real interdisciplinary research project, which allows to train them to do be better prepared for interdisciplinary projects in their future careers.

Below we briefly explain the nine recommendations Morse et al. formulated for “exploiting the bridges and overcoming the barriers to conducting interdisciplinary research” (see Table 2) [9]. We took these recommendations as a starting point for our evaluation of the EUW research project, because we think that they seem appropriate in the context of our MSc project. We used these recommendations to frame our analysis of the students reflection papers presented in section four of this paper.

Table 2. Recommendations for interdisciplinary research [9]

1. Establish an accountability strategy
2. Develop formal and informal communication strategies
3. Select team members thoughtfully and strategically
4. Address temporal and spatial scale issues
5. Recognize and respect timing issues
6. Define focal themes and research questions jointly and clearly
7. Emphasis problem definition and team proposal writing
8. Target interdisciplinary training
9. Identify mentors to focus on team integration issues

Interdisciplinary research projects are very often team projects. Morse et al. [9] point out that therefore every team member need to know what he/she should do, and what he/she can expect from the other team members. This explains the necessity of a clear accountability strategy in which the timeline of required activities and responsibilities of the participants are made explicit. Such an accountability strategy could, for instance, include specific activities, deadlines of sub-projects and the tasks, roles and responsibilities of the team members.

They also identify communication between participants as crucial in interdisciplinary research projects where team members use different disciplinary “languages” based on their background. A good and effective communication strategy is thus essential. To communicate transparently can be learnt from each other during the research project. This will also help to better understand the value of the different contributions. Learning can be either formal or informal. The latter secures an atmosphere that enhances trust and cooperation. Team members should actively participate to define the problem, write a team proposal including methods for data collection, formulate data analysis and synthesise conclusions and recommendations in order to come to consensus and understanding about what the project entails [see also 6].

Such team project should focus on a clear and bounded but tangible theme. Such a focal theme facilitates integration if it is clear to all participants how this focal theme is related to their own contribution. Discussion of the project goal and research questions among all participants will enhance the commitment of the participants.

Team members of an interdisciplinary research project are often selected because of their disciplinary background. However, personal characteristics might be also taken into consideration because they influence how decisions are made under pressure at different stages of the research project. It is also increasingly recognised that individuals who are flexible and creative and like to try innovations, flourish in interdisciplinary projects [6, 9]. The composition of the research team is therefore a key step in determining the success of the project but also the degree to which team members will be able to contribute an understanding of the problem, which also incorporates knowledge outside their discipline. Anticipating such challenges Morse et al. [9] recommend selecting team members whose visions move beyond disciplinary problem solving skills, whose dedication to see projects through to the end and whose problem-solving skills enable creative thinking.

Disciplinary gaps are rooted in differences between scientific paradigms and the different scientific languages. These gaps also need to be bridged. Morse et al. [9] note that another particular challenge for interdisciplinary projects also include coping with the diversity in temporal and spatial scale units that are used in different scientific fields, and the different time and efforts needed to complete a specific research tasks. Explicit attention for such differences is required. To overcome these barriers requires agreeing on both temporal and spatial scales of analysis that allow for a common unit of analysis. In many cases they argue this may require identifying scales that do not conform to traditional units, such as political boundaries, and instead focus on natural units such as watersheds, thereby providing a basis to promote creative, integrative thinking.

Finally, Morse et al. [9] focus on the development of training to help participants overcome disciplinary barriers and improve integration in the overall research project. They argue that appointing mentors that facilitate research, and the integration process in particular, is an important component of any interdisciplinary research project.

3. The European Workshop: an interdisciplinary research project

In this section we outline the structure and four components of the course. Because of the dynamic nature of the course, the structure and key components have evolved over a number of years to enhance crossing boundary skills through both research and education. The following provides a description of the current course design and a reflection on how successful we have been in 'exploiting the bridges and overcoming the barriers' to interdisciplinary research outlined above.

Course structure

The EUW hosts a group of thirty students from ten to fifteen different nationalities and disciplinary backgrounds that include social, natural and technical sciences. This group works together on an consultancy assignment. The main task for the students is to prepare, execute and report on a project dealing with a complex environmental problem for a non-university client on the basis of the academic knowledge and skills acquired during their MSc programme. Given the diverse backgrounds, a central learning goal is to develop the capacity to cooperate and to reflect on the value of different (disciplinary and cultural) perspectives in designing solutions for complex environmental problems. In line with the suggestions of Morse et al.[9] the students receive specific training in project management and group dynamics. This facilitates the decision making process in the group and the assignment of team member's roles in complex situations. Although team members were not selected to do the course, as recommended by Morse et al, they were confronted with assigning themselves challenging roles. This self-assignment is designed to encourage the recognition and further development of personal competencies, which includes the ability to reflect on their own functioning and contribution in executing such a project in terms of disciplinary knowledge, academic skills, team roles and cultural background.

The course is broken into six phases over eight weeks (Figure 1). The time frame of the course is designed to make explicit the temporal 'stages' the students move through, how their roles change in these stages and gain consensus over fixed deadlines. Although meeting these deadlines proves a considerable challenge, it forces students to focus their thoughts and maintain mutual accountability in the work they complete. Students are forced to communicate and act in a succinct manner during the whole project.

In the first or 'enrolment' phase students are presented with a Terms of Reference (ToR), which guides their work as consultants throughout the course. Because the ToR is developed with a real client, students are faced with a real world imperative which they are forced to internalize through the joint formulation of the project goal and objectives. The project during the last two years focused on the planning and management of public and green space in Prague, the capital of the Czech Republic, an issue set within a complex mix of environmental services and a highly politicised arena of spatial planning. The first year the students were asked to provide the Ministry of Environment with sufficient information to justify the continuation or modification of an ongoing 'greenbelt' project. The second year students were given a similar project by Arnika, a small Czech environmental NGO, who requested information to assist their advocacy work for the improvement of public and green space in the city centre of Prague, and to improve their strategies for raising public awareness. In both cases students were asked to focus on the opinions of key stakeholders and provide specific recommendations to their client for future action.

During the second or 'preparation' phase students have to develop research questions in five 'expert groups' based on pre-defined analyses: policy, stakeholder, ecosystem services and communication strategy. During this phase they are also required to make a logical framework including an action plan and to develop data collection methods. The action plans are prepared in geo-groups, which consist of one member of each expert group and which are responsible for

doing the analyses in a predefined district of Prague. The action plan makes explicit what the responsibilities are of each participant and this forms the basis of the third phase: a two week field work to collect data on site. In the second phase students are also asked to complete a Belbin team role assessments, making the participants aware of who are their team members what are their strong or weak points and providing them with insights on which they can reflect over the duration of the course.

Students undertake data analysis (phase 5) and reporting (phase 6) in both geo- and expert groups during field work and on return to the university in Wageningen. It is during this time students are challenged most to move between disciplines through meetings and collaborative writing exercises. Students are asked, again under significant time pressure, to synthesize and communicate a range of perspectives into key interdisciplinary or thematic areas.

At two points of the course students are also asked to reflect individually on their learning experience in a written assignment: first prior to going to the field, when emphasis is on enrolment and preparation, and second at the end of course where they reflect on their experiences as a whole. This sixth phase is regarded as a key learning activity as it provides students with the opportunity to reflect on crossing boundaries and competencies they acquired in the workshop, such as integrating data from different sources and knowledge from different disciplines, and responding to different perspectives to the problem at hand based on disciplinary and cultural differences.

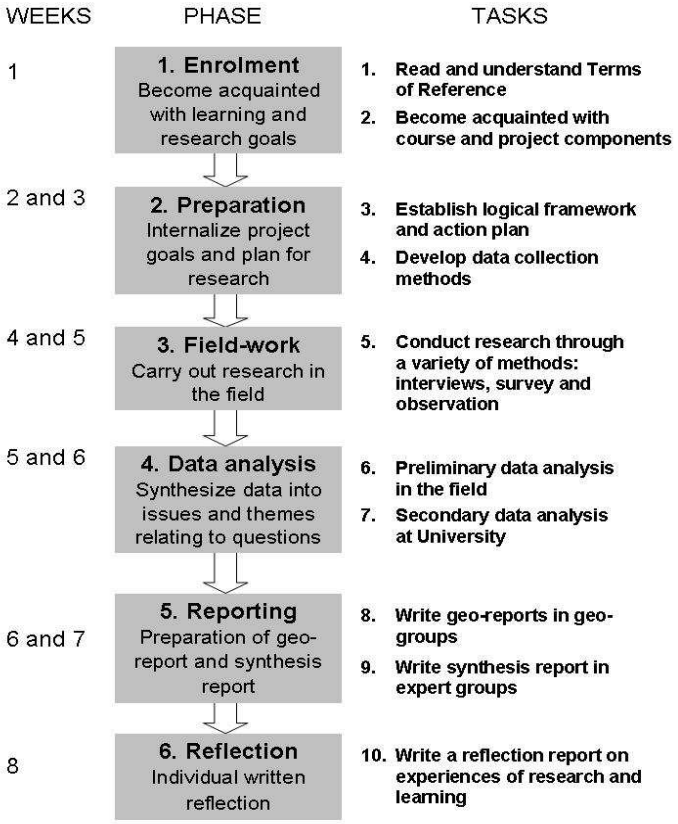

Figure 1. Timeline of phases and tasks in the European Workshop

Course components

To facilitate the students' work in the EUW a range of components are used that aim to facilitate both research and education: EUW matrix approach, field work in Prague, special website, role of the teachers towards self-regulated learning. It is these components that form the basis of the student reflections and our analysis in the following section.

EUW Matrix

A central challenge of the EUW is to work with thirty students together within a relatively short period of time and to produce one concise consultancy report. To facilitate the communication between all students and to clearly define responsibilities students are organized within a matrix structure (Table) consisting of disciplinary or expert groups and field-work teams or geo-groups. The matrix means that every field-work team consists of one 'disciplinary' expert corresponding to one of the predefined areas of analysis. Each team also has a Czech speaking person in order to contact people in Prague, to facilitate communication with, for example, stakeholders during the field work and to assist in presenting the results. A management team consisting of representatives of all groups coordinates the work.

During the whole research project students work in different groups: geo-groups and expert groups to enhance the interconnections between the work. In the preparation phase students start in geo-groups, then formulate research questions and develop data collection methods in expert groups that focus on specific disciplinary analytic tools. In the field geo-groups collect data. Analyzing the data is done in both geo-groups and expert groups. The aim of the matrix is to enable students to work in a disciplinary group and to deepen their knowledge and skills in a specific area of expertise (i.e. the columns of the matrix), but also forces them to cross the boundaries of their discipline (i.e. the rows of the matrix). In doing so the matrix is designed to enable intensive group interaction and facilitates the process of jointly formulating the goal, objectives and research questions as well as team writing. In addition it aims to makes the particular role of every individual participant within the bigger project clear.

Table 3. EUW matrix approach

		Expert group					
		1. Policy analysis	2. Stakeholder analysis	3. Analysis of cultural ecosystem services *	4. Analysis of provisioning, supporting and regulating ecosystem services*	5. Communication analysis	Management team
Geo group	1	S1.1	S1.2	S1.3	S1.4	S1.5 (CZ)	S1.1
	2	S2.1	S2.2	S2.3	S2.4 (CZ)	S2.5	S2.2
	3	S3.1	S3.2	S3.3 (CZ)	S3.4	S3.5	S3.3
	4	S4.1	S4.2(CZ)	S4.3	S4.4	S4.5	S4.4
	5	S5.1(CZ)	S5.2	S5.3	S5.4	S5.5	S5.5

Note: S – Student; CZ – Czech student acting as translator. * The concept of Ecosystem Services comes from the Millennium Ecosystem Assessment [18]

Fieldwork

The centre piece of the EUW is a two week field work period. The aim of this time away from the university is to provide a setting in which students can deal with the complexity of dealing with a range of stakeholders in a real setting. Fieldwork is widely understood as a mechanism to stress the importance of context, to develop students' ability to integrate classroom-based knowledge and to facilitate communication between participants [13-15]. During the field work of the EUW students are challenged to transcend disciplinary knowledge and to operate on a higher cognitive level by combining and connecting the findings of the different analyses. In doing so they are forced to communicate on a range of complex managerial and content related issues, but it is also a period with plenty opportunities for informal communication in an intercultural setting.

The Matrix structure is applied throughout the field work phase allowing students to interchange between geo-groups and expert groups. Geo-groups focus on the situation in a city district of Prague, whereas the members of expert groups continue to share and develop ideas on broader temporal and geographic scales. This attention to scale is seen as a particularly important factor in encouraging students to find the detail of rich issues and cases in specific areas (districts) of the city, and then to develop the capacity to position these cases in the broader context of the city as a whole. In doing so we challenge students to explicitly address temporal and spatial scale issues.

Communication

To assist formal communication between students and help them manage a range of tasks associated with the research a special website using MS SharePoint was developed for the course [19]. This website supports the organizational structure of the course and facilitates the formal exchange of information between and within the different groups. The site consist of shared document folders, a calendar and provides a notice-board for announcements. It allows students to communicate and share results and to work collaboratively on writing. Students and teachers also meet in face-to-face group discussions, where most decisions are made. Plenary and feedback sessions with teachers are also scheduled to enhance the exchange of information across and between groups.

In addition to formal modes of communication the course is also dependent on the informal communication between students throughout the course, during drinks or dinners after work. The field work period in Prague is particularly important for providing students a new setting in which they become dependent on each other for a range of course related and personal activities. During this time students have the opportunity to discuss, form opinions and informally respond to each other. This time has proven an important phase for fostering creativity and sharing alternative views on disciplines and cultures.

Role of the teachers

The role of the teachers in the EUW differs considerably to traditional lecturing. The teachers are from a range of disciplinary backgrounds and provide content related support, but are more focused on team facilitation and integration. They are constantly evaluating the progress of both geo- and expert groups, iteratively supporting students to take the next step in the research process. Key to this is assisting the students to make decisions in a group of thirty people. In doing so they try to balance the positive and negative influence of individuals, identify leaders, and encourage those who are less vocal or active.

As facilitators the teachers operate differently in the different phases of the course. In the preparation phase they provide background information on the topic, as well as on working in an interdisciplinary project. Although providing content related feedback is relevant in the next phases as well, the main focus of the teachers during the field work and data analysis is on facilitating the students' work by not telling what they should do, but asking questions to trigger them to enhance critical thinking and develop alternative views. The main task of the teachers in the reporting phase is giving feedback on written documents and encouraging students to look critically at each others documents and learn from it.

4. Students' reflection on the course

In this section we present the results of the EUW based on the reflection papers of two cohorts of thirty students. In the first year we asked the students in general to describe what they learnt from the course. In the second year we explicitly asked them to focus on the course components as described in the previous section. We asked them to reflect on how the EUW matrix approach, the field work, SharePoint and how the role of the teachers as facilitators rather than providers of information influenced their learning process. Although qualitative in nature, and therefore highly subjective, we think the results are revealing and can be used in the next round of the EUW during which we will evaluate the learning outcomes of the course in a more quantitative way.

Matrix approach

The enthusiasm about the matrix approach developed over the duration of the course as the complexity of the problem increased and the students discovered that a clear structuring component was necessary. Reflecting on the course students argue that one of the main advantages of the matrix was its role in forcing transparency and accountability between the team members. As one student put it, “the matrix was a watchdog”. The usefulness of the matrix emerged as a key problem-solving tool as conflicts arose, deadlines drew near, and team work and efficiency was needed. As one student commented, “[the matrix] is an optimal way to organize thirty students that have different cultural and disciplinary background in one project team.” In a similar vein another student noted that the matrix improved the coherence of the research, by ensuring: “… participants had a common focus and that data analysis would be done in a similar way”.

Many students also value the matrix approach because it enhanced their learning by forcing them to constantly switch between groups and argue their position on a problem in different settings and against different disciplinary knowledge and cultural backgrounds. As one student remarked, “More contacts with more people enriched me personally by forcing me to communicate with students with different personalities … I could observe and compare various points of view.” In a similar vein, another student stated “diversity is useful and helpful because I was able to learn many things from others.” We consider this diversity a key function of the matrix approach and one that fosters multiple perspectives thereby forcing students to be analytical and creative in defending or justifying their position, either in disciplinary (expert) or interdisciplinary (geo) groups.

Some students explicitly noted the benefits the matrix brings when moving between their two groups. At the start of the project critical students argued that the matrix was too limiting, having a pre-defined set of disciplines. However, faced with the organizational complexity towards the end of the project, the matrix comprehensively provided the students with a structure through which iterations to improve the reporting were communicated between expert and geo-groups. It also provided them with a starting point for developing their disciplinary knowledge before branching out to other disciplines. As one student clearly states, “… having a thorough knowledge on one specific topic is much better than just having a general knowledge about all the topics involved”. However, others recognized some barriers emerging as they moved between their two groups. One student argued that she felt personally more attached to her expert group than her geo group because her views and comments were “not welcome in some others expertise areas … according to them it was not my area”. But such conflicts are also an essential part of the interdisciplinary learning process.

The matrix was also noted as a useful tool in overcoming cultural differences and boundaries, and was reported as enhancing the learning experience of all the students. One student explicitly argued “The matrix structure allowed the intercultural exchange of ideas” – something that was an explicit goal of having multicultural geo-groups. She goes on to explain, “It showed me that an idea that I have, is not right or wrong, but that it is possible to combine different ideas and adapt them to the process. This gives me more value to the final result”. For her, and also most other students, the matrix structure forced them into open exchanges where both disciplinary and cultural exchange provided new insights that otherwise not may have emerged.

Despite the many positive points on the matrix structure, a series of criticisms also surfaced. The students, for example, criticized the rigidity of the matrix approach, defining expert and geo groups *a priori.* This limited their ability to bring forward new ideas and approaches. A few of the students reflected specifically on this issue, arguing the lack of creativity in branching out from the matrix was de-motivating. When such issues that didn’t completely fit within this structure were identified, for example using new data collection methods or statistical analysis that are relevant to all groups, a level of confusion emerged.

The complex nature of the matrix was also seen by some of the students as leading to an “excess of democracy” - referring to a degree of fatigue from managing and communicating within their simultaneous roles. One student explained how her opinion of the matrix changed over the duration of the course, “… at the beginning of this workshop I could see a big

advantage in the presence of so many diverse opinions in our team". This opinion changed towards the end of the course, "… what was advantage at the start of the beginning suddenly turned into disadvantage at the end … [because] different opinions obstructed our work [when] we were facing deadlines".

It helps when the project's management team (Table 3) reflects the cultural diversity of the students group and consists of students with relatively more experience. The second year the management team was dominated by Dutch students with little management experience. Their consensus management style was considered problematic by some of the students. One student explicitly put this down to cultural differences in management styles, stating " … in my culture, I am not used to be consulted but pointed to do things". She said that while a voluntary basis of work sharing was inherent in the management style of this management team, this led to confusing and time consuming situations, which she considered unhelpful . In the first year, such problems did not occur, probably because the management team was more diverse. Despite the rather complex nature of the matrix structure of the course it was generally well received by students and most of them saw the matrix as a positive organizational tool.

Field work

Being abroad for two weeks and together into the field is considered by the students as the most valuable component of the course. In this period they were clearly confronted with the differences between theory and practice, and experienced the importance of good planning and management, and effective communication skills. For most of the students it was their first experience in doing a real research project and that helped them to appreciate the benefits and challenges of carrying out empirical social and environmental science. As one student pointed out, this gave her the feeling that she was under pressure to find something 'new', which she had never had doing classroom based education. However, the complexity of reality and the differences and incompatibilities in the information they received from different respondents proved confusing for most of them. It is also in this phase that many students realize the importance of a proper preparation period and the value of project management tools like the logical framework, but also the flexibility needed in using these tools in order to overcome unexpected circumstances.

When reflecting on the field work many students mention that they learnt a lot from applying different data collection methods. As one of them wrote: "The different methods of data collection in the field were known by me only in theory." Another student noted: "The fact I was involved in the observations and the interviews was a good opportunity for me to apply these methods and see the difference between theory and practice". Nearly all of the students stressed how deciding on criteria for interviews or observation schedules forced them to develop communication and negotiating skills. From the plenary discussions, it also became apparent that decisions made over methods were of fundamental importance in the research process. Some of these decision proved problematic. This strongly surprised students. Indeed, the fact that consensus was rarely achieved over such decisions, even late into the field work period, emphasized for many the contested nature of interdisciplinary – and indeed intercultural – research. Overcoming this remains a challenge.

This intensive period of being a way from home in - for most of the students – a different foreign country and working and living together sometimes resulted in miscommunication and conflicts between students. In general, however, students consider it "an excellent teambuilding exercise". Many stress that the field period created opportunities for discussions, reflection and surprise on the differences and similarities between customs and people from different countries. They consider this an enriching experience. As one student emphasized: "The cultural variety of the group made part of this wonderful experience. Not only share knowledge and practice but also personal life with people from so many countries was amazing. The cultural interchange, the debate, the confronting and parallel opinions increased the quality of the results and the quality of the subject. Furthermore, sharing with them a novel experience of travelling to another country with another language is certainly among the things I will never forget from this project".

For the Czech students, who had the additional responsibility for translations and group logistics, the resulting close contact with such a variety of foreign students strongly enhanced their learning experience. One comment made by nearly all these students was their surprise at how insightful ‘outsiders’ could be, even in a topic that was new for many. For one of these students it was also the frankness of these outsider’s opinions, which are usually not voiced around such a local the topic, that struck her. Quotes include: “.. students that do not come from my country are less bounded by cultural and social patterns and stereotypes. For example, they were open in talking about corruption. This amazed me!” Indeed, this openness was seen by many as culturally determined. However, other barriers were not overcome. A Southeast-Asian student noted, for example, that negotiating the different approaches to data analysis between students of different nationalities was at times a challenge because the eagerness of Western European and African students to motivate and argue approaches and the inexperience to do this by Asian students.

The benefits of research experience and dealing with cross-cultural communication are explicit aims of the course. We designed the course in such a way to benefit students of all backgrounds. However, one unexpected benefit was the particular impact it appeared to have on the Dutch students, one of whom remarked that she was extremely surprised and happy that she was finally one of the ‘international’ students by not being a ‘local specialist’. This is interesting in the context of the programme at Wageningen University where, despite an active and successful programme of internationalisation, there sometimes remain prejudices against the skills and capacity of international students by Dutch students. Opening up the Dutch students to experience the difficulties of working in another country is a major benefit of the course.

Website SharePoint

The website developed using MS SharePoint was an essential component of the course that students generally used to share all kinds of information between them. All students agree that this possibility facilitated the communication and coordination between group members, between different groups and between students and teachers. They consider it a very useful tool to exchange announcements, to store (draft) documents and to confirm appointments. SharePoint was considered particularly important when faced with the difficulty of writing a coherent report with thirty authors. As one student stated: “It proved to be really fundamental during the last phases when we analyzed the data and wrote the reports. Many people were working on different parts of the same report, but everything was available on-line and all participants were enabled to follow the work in progress.”

Despite the positive nature of SharePoint it was also noted that it required a very different approach to communication in a course than they were used to. Students recognized that SharePoint forced them into a much more active role. This, they noted, was enhanced by the mutual activity by having access to all draft documents, which were continually updated. The students were therefore forced to continuously check and recheck the progress. This distinction between active and passive access to information underlies the philosophy of the course. As one student stated:“… while it requires only passive participation (downloading files) … EUW students must be involved actively”. This was seen positively in forcing students to engage with the information in a single location, but apparently required a different mode of collaboration and communication. An approach that has not been taught before in the academic courses where students receive information passively from lecturers.

SharePoint was also indispensable to support creativity and providing a tangible structure during the research. The ability to add, amend and design various elements of the group sites (both for geo and expert groups) was highly appreciated by the students. In line with the learning goals, students enjoyed the ability to diverge from a rigid structure of teaching and information transfer to organize, present and communicate information as they wished. As one student outlined in the reflection report, “… although SharePoint had a backbone, it offered at the same time space for every group to arrange its own site … and keep it according to their own preference”. Creativity was paralleled by comments about the clear structure that SharePoint had, anchoring students when the problems and discussions in the project became

to complex or convoluted. According to a small number of students SharePoint assisted by mirroring the matrix structure and balancing the complexity of the research problem with a tangible structure. In the words of one student, if the problem or discussion became to difficult, they could always return to SharePoint to (re)build their comprehension.

Role of the teachers

Most of the students openly recognized the facilitation role played by the teachers during the course. Many of the students appreciated the stimulation from the teachers to think critically by asking questions and providing tools rather than telling them what exactly to do. They acknowledged that this approach enhanced their learning process. As one student pointed out: "If we were 'spoon-fed' by teachers, the accomplishing the project would have been easier but we would not have learned as much". Echoing this sentiment, another student wrote: "The teachers never told us: You should do this and that! or that it must be done in this way, We had to always find our own way by ourselves".

Many of the students described that they realized after some weeks that the teachers acted more as coaches, who stimulated the research process more than the results. However, it was unnerving for most students to find that also teachers could not provide the ultimate answer to a problem. This was in fact best illustrated in the first year's course, where a student beforehand asked whether (when the course was over and the final mark submitted) they could obtain the best answer to the project. Overcoming this insecurity was difficult for both students and teachers alike. Revealing this apparent uncertainty associated with problem-solving-in-practice, was for some students a major revelation, discovering, as one student put it, that: "… justification is a very significant element in the [research] process … It can validate your choices or it can reveal the need to reconsider". The same student noted that the most valuable lesson she learnt from the course was that: "… there is no 'secret recipe' that you have to discover in order to solve any kind of problem you are appointed to. It is only a matter of choices that you make, from the very beginning". We think this emphasizes an important lesson of the course: Understanding the uncertainty associated with scientific, and especially in inter-disciplinary, research. The structure and components of the course helped to address this uncertainty explicitly.

There was also a fine line between the teachers providing feedback that challenged students and feedback that overwhelmed students. A student, who was also part of the management team, commented particularly on this point. She argued that during the evening plenary sessions in Prague the students got the feeling they had "not done enough, thought enough and tried enough to get the best out of their project". She went on to argue that the teachers should consider the impact on students' confidence of continually challenging students to think beyond their own disciplines and beyond the immediate scope of the task at hand. This continuous pressure could actually undermine a student's confidence. Although this comment was raised only once, it does indicate that teachers must continue to be aware of the limits to which students can be pushed in such a complex interdisciplinary project.

Other students were also frustrated by the teacher's continual query of "What do you think?" in response to practical and conceptual challenges. Under the actual time pressure and faced with what was perceived as an "excess of democracy" (indicating fatigue from discussion), students noted they felt making decisions rather arbitrarily and would have liked more solid advice from the teachers. For many students this facilitation rather than lecturing was a new experience from what they were used to. Some students felt confused and insecure about what the teachers expected from them and whether what they had been doing was adequate. Others commented on the endless group discussions that sometimes were very frustrating, especially when no decisions were made. Overall it appears the students would have liked the teachers to take up more leadership and provide the proper arguments to make the difficult decisions. The least they could do is to provide the management team with better guidance. For example, one student, although highly appreciating this form of teaching, argued that: "… sometimes we would welcome more concrete information because we were facing the lack of time and this method is time consuming".

The insecurities voiced over the decision making process and the time pressures were partly intentional in the hope of providing a platform in which different personalities could take a lead, which allowed for making and correcting mistakes and which facilitated the emergence of the necessary creativity in problem-solving. This also resulted in a different relationship between students and teachers: One in which expert knowledge was replaced with sharing experiences and open discussion. This was new for all students and at times difficult to accept. We believe, however, that those students who realized the different role of the teachers early in project were able to get more out of the course. As one satisfied student described it (although her relationship with the teachers remained relatively ambiguous), that she and her group was: "… free to have imaginations and practice them. Then, learn from our own mistakes".

5. Discussion and conclusions

We presented the EUW as a didactic model in which students worked on a realistic consultancy project through a well structured, collaborative research project in an intercultural setting. Based on the course description and the reflections by teachers and students, we conclude that the EUW as a didactic model to train students' cross boundaries skills was very successful. The didactic model showed students how bridges and barriers can be overcome in an interdisciplinary project and also how participating in such a well structured interdisciplinary research project contributes to enhancing boundary crossing skills. Using Morse' [9] recommendations proved to be essential in developing this interdisciplinary project in which students worked in a team effort for an intensive period of eight weeks.

In particular the EUW matrix approach combined with the field work contributed clearly to enhancing the students' awareness of disciplinary and cultural boundaries. The EUW also added to the students' appreciation of using different disciplinary and cultural perspectives in finding sustainable solutions. The students developed a positive attitude or *habitus* to recognize boundaries, a precondition for being able to cross boundaries [1]. Based on the reflection papers, however, we cannot quantify how strongly the students improved their boundary crossing skills. In the next course we'll develop the necessary measurement instrument to accomplish this. It will additionally force us to better define the characteristics of these skills and to evaluate them before and after the EUW using surveys among students.

We illustrated that working together with a diverse group of people in a relatively short period of time is a challenging and partly unpredictable exercise, which offers the opportunity to challenge and learn from each other, but requires careful planning and facilitation. In this respect there are still a few aspects of the course that require further consideration and development. One is the teachers' balance between providing a challenging environment, encouraging the students to take decisions and responsibility for their work, while on the other hand ensuring that 'democratic' fatigue does not set in. Furthermore, teachers should deal with the thin line between encouraging students to creatively explore their data while minimizing the risk of undermining their confidence. Another aspect is the rigidity of the matrix approach. We need to find innovative ways to deal with this rigidity. For instance, what to do with research skills, activities or approaches that don't fit directly in the matrix? And, how applicable is the matrix approach to other areas of interdisciplinary research? This is of particular concern as we expand the EUW approach as planned in 2009 to a coastal and marine management workshop in the Crimean region and an urban topic including the field of technology.

An important element of the course was that the students were confronted with uncertainties associated with scientific research and the often politicised nature of environmental management. Learning to deal with this uncertainty by questioning the validity of sources and realising that decisions are often made with partial knowledge, exposed the students to central challenges of crossing boundaries between theory and practice, disciplines and cultures. We expect that this realisation will be transferred into research and professional skills as they move forward with their academic and professional careers and will be exposed to the complexity of problems of society. As such, this realisation could provide one of the most important elements in the boundary crossing skills.

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