A case study of collaborative modelling: building qualitative models in ecology

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Abstract

Modelling is seen as a learning activity in itself and qualitative modelling environments start to play a role in this respect. However, building (qualitative) models is not an easy task. It is therefore necessary to develop support for teachers and students. This paper describes an experience in which Artificial Intelligence (AI) undergraduate students from the University of Amsterdam and graduate ecology students from the University of Brasilia were engaged in a collaborative model building activity. The objective was to build qualitative models about the carbon cycle and the greenhouse effect in GARP.

A questionnaire was used to obtain the students opinion about different aspects of the modelling effort. Almost all the students (94%) reported an increase in their understanding of the ecological problems after the modelling activity, (an observation that supports the idea of modelling as a learning activity in itself). In certain aspects, being an ecologist (and therefore possessing relevant domain knowledge) made some parts of the model building activity easier. For example, global identification of the processes involved. Contrary, the AI students found it easier to construct typical AI representations, such as subtype hierarchies. The most difficult task for both groups was to build a library of model fragments. Identifying quantities and their quantity spaces were also mentioned as difficult.

In order to improve the performance of the qualitative modelling environments the QR community has to put effort in developing authoring tools with explanatory facilities. The study reported here provides some insights on how to scaffold such model building tools.

1. Introduction

Model building is becoming an important educational activity. According to Forbus *et al.* (2001) it is important that students become modellers because during the modelling process they have to articulate relationships between entities and dependencies between their beliefs. This is important for both understanding the phenomenon being modelled and in developing a broader understand of complex, interrelated systems. This way, models provide means to externalise thoughts and to support questioning, discussion and justification of decisions. Finally, modelling provides students with practice in using formal representations, a skill needed for mastering mathematics and programming.

Qualitative Reasoning (QR) has a role in introducing modelling into the classroom. Historically QR systems are linked to education (e.g. SOPHIE, Brown *et al.*, 1982, and STEAMER, Hollan *et al.*, 1984). Recently, a new generation of QR related tools is being developed. During the last international workshop on QR (San Antonio, US, 2001) a number of papers illustrated that new approach: *Mobum* (Bessa & Bredeweg, 2001) and *VisiGarp* (Bowers & Bredeweg, 2001), *Vmodel* (Forbus *et al*., 2001), and *Betty's Brain* (Leelawong *et al*., 2001).

As QR-related learning environments become available, and more people start building qualitative models, it becomes important to actively develop tools to support such model building activities. To carry out an exploratory study on this topic, a collaborative modelling effort was conducted with students from the University of Amsterdam (UvA) and the University of Brasilia (UnB). These students designed qualitative models about the carbon cycle and the greenhouse effect, using the qualitative reasoning engine GARP (Bredeweg, 1992). They worked on a pencil and paper basis, and at the end of the course some of the students actually implemented their models in GARP. In order to investigate difficulties students found during the collaborative modelling effort, a questionnaire was completed by the students about different aspects of the modelling process. Their answers give us indications of how to further develop the use of qualitative modelling in the classroom.

This paper first presents the experimental context of the collaborative modelling activity. Second, it briefly discusses the domain knowledge the students had to work with. Third, the activities are described that were followed in order to have the students construct qualitative models and simulations. Fourth, the results obtained from the answers given by the students to the questionnaire are discussed. Finally, the lessons learned from of this experience are discussed.

2. The Experimental Context

The exploratory study described here involved 10 undergraduate and MSc students at the University of Amsterdam (UvA) enrolled in the discipline 'Model Based Reasoning' (MBR) and six MSc and PhD students at the University of Brasilia (UnB) enrolled in the discipline 'Models in Ecology'. Due to their different backgrounds, the approach each group took to qualitative modelling was somewhat different. UvA students took it in terms of an artificial intelligence curriculum and UnB students took the modelling effort in the context of an Ecology curriculum. UvA students had a good introduction to the QR literature in their MBR course, whereas UnB students had only basic knowledge on that. The lectures also prepared a tutorial on GARP, particularly focussing on the notion of model fragments and qualitative behaviour graphs.

Five groups were formed, each consisting of two Dutch and one Brazilian student[1]. The overall modelling problem was divided into sub-problems and each group had to tackle a specific sub-problem. In order to facilitate the interaction and communication the e-group facility offered by Yahoo! was used (mbr-ecology). All students and lecturers were subscribed to the e-group. Thus, participants could communicate with each other using regular email as well as other Computer Supported Communication (CSC) tools provided by the Yahoo! e-group facility.

In order to evaluate the modelling activity a questionnaire was used consisting of 41 questions, including personal characterisation, course evaluation, the modelling effort, and the collaboration.

[1] One group had 2 Brazilian students.

3. The Domain

An important area in ecology is nutrient cycling. Among them, the carbon cycle is particularly relevant because it includes a very broad set of phenomena and involves the interaction of biological, physical and chemical processes related to the production and use of organic matter. One of the most interesting aspects of this cycle and a big issue nowadays is the fact that compounds of carbon, specially the carbon dioxide (CO_2), retains heat and therefore affects the climate – the greenhouse effect. One of the tasks for the students was to acquire the knowledge relevant to this domain (see also next section). Figure 1 is a picture found by the students on the World Wide Web that illustrates the problem situation[2].

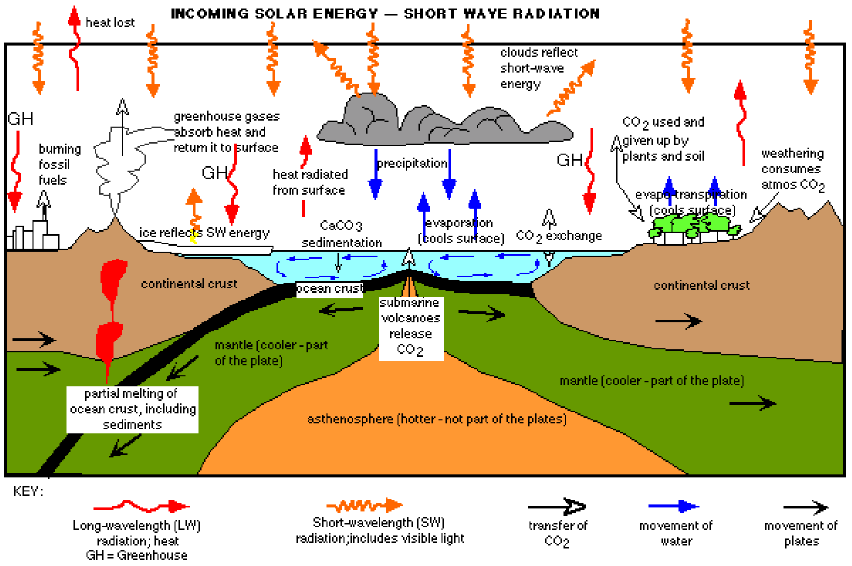

Figure 1: one of the many pictures found by the students illustrating the problem situation

4. The Model Building Method

The procedure described below was used to have the students conduct the required model building activities. Each activity was supposed to take one week, and students were expected to spend approximately 20 hours on the course during a week (including participating in seminars). For each activity, the teams had to produce written documents discussing their results and share this with the other students by placing the documents in the (mbr-ecology) e-group.

3.1 Starting the Collaboration.

Here the idea was that students should get to know each other, particularly to 'meet' the persons from the other university. Each student therefore had to perform the following three tasks:

- Register at Yahoo! and join the e-group (mbr-ecology) that was made by the lectures for this purpose.
- Send an introductory message to all the e-group members, particular stating: who you are, what you are studying, why you are interested in the modelling course and what your expectations in this respect are.
- Submit at least two bookmarks to the (mbr-ecology) e-group concerning 'global heating' (and/or the 'greenhouse effect'). The idea was that the pages referred to by these bookmarks would form the group's initial overall knowledge-based (understanding) of the problem.

In addition, and mainly to provide focus, the lectures gave the students a technical paper discussing some of the most important aspects of the 'carbon cycle' (Grace, 2001).

3.2 Form Teams and Assign Subsystems

Based on the information provided by the students, teams were formed to tackle the sub-problems that constitute the overall problem (the greenhouse effect). Notice that this step already enforced students to decompose the main problem into a set of sub-problems even though their knowledge on the domain was limited at this point. In order to prevent a potential deadlock the lecturers deliberately intervened both

[2] http://www.acad.carleton.edu/curricular/GEOL/DaveSTELLA/climate/climate_modeling_1.htm

concerning the problem decomposition and the forming of teams. After all, this step was an important one and needed to be solved in order to progress with the main model building activities.

Five themes were identified and each group started working on one of them: (a) a global model about the carbon cycle, (b) forests, (c) water and oceans, (d) human activities, like industries, transport, agriculture, and (e) the greenhouse effect.

3.3 Process Domain Related Publications

In order to learn more about their specific part of the overall problem teams had to study the domain related material (WWW pages, including some online articles) and produce a four page written document explaining and discussion their part. As all documents, this document had to be submitted to the (mbr-ecology) e-group at Yahoo! so that all teams could read about the knowledge acquired by the group as a whole[3]. Notice that each team consisted of students from both universities. During the seminars (locally at each University) group members had to present and discuss their ideas with the members from the other teams. This had two goals, first to share insights among teams and second to reduce too much diversity between the groups (part of the discussion focussed on the relations between the sub-problems).

Students were also instructed to download the qualitative simulation software (GARP and VISIGARP) and make sure that the software worked properly on their computers[4].

3.4 Structural Model and Global Behaviours

To arrive at a qualitative model of the systems under study, the model building activity should continue with a relatively strong focus on the knowledge representation underlying the qualitative simulator that we intended to use. The idea was to divide that goal into four steps (see also below). The first step consisted of three sub-activities:

- Structural model (objects and relations, e.g. part-of and is-a). Basically, a concept map including all the entities relevant to the problem organised in a subtype hierarchy. In addition definitions of structural relations, such as part-of, contains, etc, between those entities as far as needed (an example constructed by students is shown in Figure 2).
- Global description of behaviour (processes). Textual oriented descriptions of typical behaviours, in fact processes (e.g. respiration) or agents with certain behaviour (e.g. farming).
- Scenario's and related behaviour graphs. Develop two scenario's using the previously defined objects and behaviour descriptions and show how those lead to a particular behaviour graph relevant for understanding the issues concerning the problem of global heating.

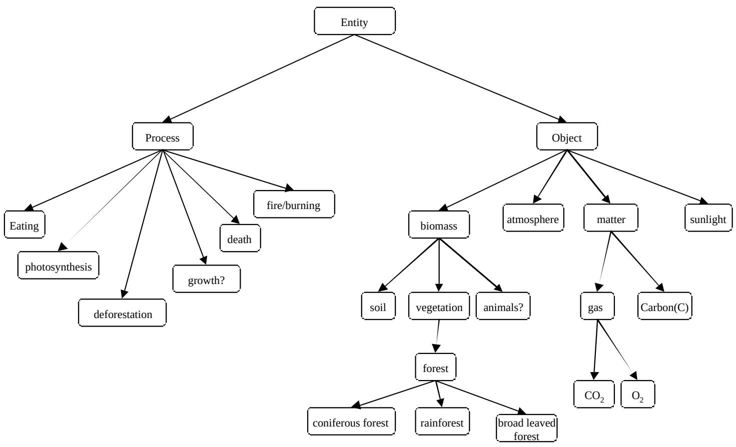

Figure 2: an example of an initial concept hierarchy constructed by students

[3] There were some technical problems with uploading and downloading MSWORD files. This caused some delay. However, soon students discovered that PDF and RTF formats could be handled properly by Yahoo!. Consequently DOC files were not used anymore.

[4] At the time of the course we did not yet have easy to use model building software, such as HOMER (Bessa Machado & Bredeweg, 2002). MOBUM (Bessa Machado & Bredeweg, 2001) was implemented as a demo, but was not stable enough to support a broad model building effort. Thus, only students with knowledge of PROLOG could be expected to actually build simulation models in GARP. Notice that currently this situation has changed. E.g. HOMER is a fully implemented workbench and can be used to build qualitative models. For details see WWW pages: http://web.swi.psy.uva.nl/projects/GARP/

3.5 Detailed behaviour model

The second step towards a specific qualitative model is to further detail the behavioural aspects. This consisted of three sub-activities:

- Define quantities.
- Define quantity spaces for each quantity and point out important landmarks.
- Construct an influence diagram (a 'causal model'). Using the previously defined quantities specify how they are causally related, mainly using the notions of influences and proportionalities (see, Forbus, 1984) (an example is shown in Figure 3).

Students also had to further detail the 'global behaviours' defined during the previous step. The idea being that this should lead to a first global description (using text) of the model fragments that will be part of the final model.

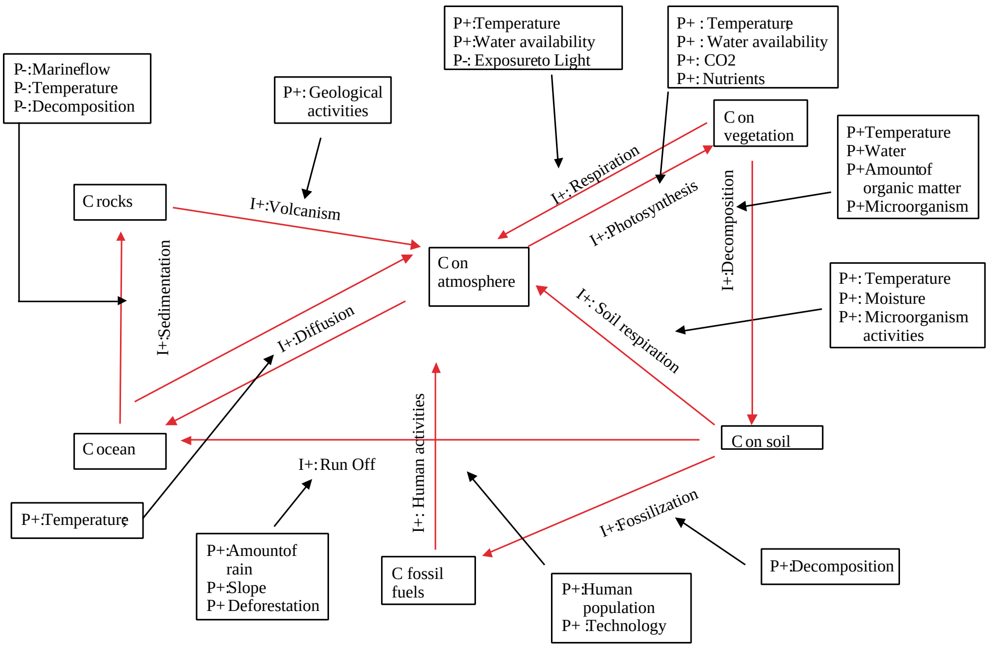

Figure 3: an example of an influence diagram constructed by students (stressing the fluxes)

3.6 Detailed specification of model fragments

The third step consisted of constructing detailed descriptions of the required model fragments. Although this step was performed using paper and pencil the students had to follow a specific syntax (provided by the lectures). Students who were more experienced with PROLOG were encouraged to formulate their model fragments directly in GARP, however, without running the simulator. The focus of this step was to conceptually clarify the set of model fragments (and not to focus on the overall effect of those model fragments on the behaviour graph potentially generated by the simulator).

3.7 Towards Detailed Implementation and Running a Simulation

During the fourth step the idea was to actually run models using the simulator. This mainly included the following sub-activities:

- Defining and implementing the possible scenarios (input systems).
- Analysing behaviour graphs generated by the simulator.
- Debugging and finalising the library of model fragments.

3.8 Writing Documentation

Finally students had to write a report discussing their model. The goal was not to simple copy and past the documents produced before, but to examine them and reformulate these documents following all the discoveries and modifications made during the model building activities. In other words, a description of the latest results had to be produced by each team.

5. The Modelling Effort

"*A change of reasoning and thinking*"

In the questionnaire there was a set of questions related to building the model. Some of these questions explored each of the main points in the models, like identifying objects, quantity spaces and so on. We asked the students to comment on how difficult they found it to develop each part of the models. The results are presented below.

Degree of difficulty – When the students were asked to define how difficult it was to build qualitative models, the answers varied. All UvA students mentioned an intermediate ('medium') level of difficulty. They made comments like qualitative modelling represented for them a "*change of reasoning and thinking*", and that once they understood the process, they found it doable. One UvA student said *"it took me a while to make the distinction between 'modelling' and 'programming'."* Among UnB students, one third found it 'more or less easy'. The tutorial prepared by the lectures made it easy for them to represent the basic processes. Also, the implementation part of the modelling effort was not their main concern.

Understanding the problem – Understanding the general problem (carbon cycle and the greenhouse effect) in the beginning of the modelling activity was 'more or less difficult' for one third of UvA students and more than two thirds of UnB students. One of the students said, "*the start was difficult. After that when you finally figured out what is needed, it was easy*". Some students referred to previous studies in biology, physics, earth sciences and chemistry at secondary school, which confirms the expectations that qualitative modelling draws on common sense and incomplete knowledge. Another one said understanding the problem was "*difficult, the theory didn't help at all, you just needed to look at what GARP needed*."

Identifying the most relevant aspects – For 40% of UvA students and 84% of UnB students, it was 'more or less difficult' and 'difficult' to identify the most relevant aspects of the problem. UvA students referred to a consult via email to their Brazilian partners "*to have a confirmation that we had chosen the right subjects*".

Identifying typical situations – Nobody found it 'easy' or 'more or less easy' to identify typical situations and to define initial scenarios. However, it was a bit more difficult for UvA students than for UnB students – maybe because of their background. One said it became "*easier as a result of identifying the most relevant aspects of the problem*".

Describing the system's behaviour – Asked about imagining the overall behaviour of the system and drawing a state-graph, the two groups gave different answers. For 84% of UnB students it was considered 'medium', 'more or less easy' and 'easy'. For 60% of UvA students it was 'more or less difficult' and 'difficult'. A UvA student said "*difficult mostly because of lack of ecological / chemical fore knowledge*" Another one mentioned the fact that the whole problem was "*fragmented over different groups*". This part of the modelling problem seems to be domain knowledge related and the difficulties are bigger in the beginning of the modelling activity.

Identifying physical objects – None of the students found it 'easy' or 'difficult' to identify the physical objects involved in the problem. For 84% of UnB students and 80% of UvA students the task was 'more or less easy' and 'medium'. One of the AI students of UvA said "*The difference between objects in GARP / Prolog and a OOP language as Java make some conceptions hard.*"

Representing objects and model fragments in isa hierarchies – In GARP, objects and model fragments are organised in isa-hierarchies. We asked the students to evaluate difficulties in building up such hierarchies. Similar distribution of answers was observed in the two groups. Half of both UvA and UnB students groups considered it 'more or less easy' and 'easy'; the other half considered this task 'medium', 'more or less difficult' and 'difficult'. Some UvA students mentioned their previous experience in doing this type of knowledge representation, whereas these were new concepts for the UnB students.

Identifying causal relations – A fundamental part of the qualitative modelling process is to identify causal relations and to draw diagrams of influences. We asked the students to include direct and indirect influences in their causal models. Opposite perceptions came up from this question: 90% of UvA students said the difficulty level was ‘medium’, ‘more or less difficult’ and ‘difficult’, whereas for all UnB students it was ‘medium’, ‘more or less easy’ and ‘easy’. We believe that the ability for explicating causal relations is very well related to domain expertise. Some interesting remarks made by UvA students refer to their difficulties: “*especially problematic was the distinction between indirect / direct influences*” indicates that they found it difficult to understand / identify processes. Another UvA student mentioned time scale problems, which are interesting and difficult aspects of ecological modelling: “*difficult, so difficult if this are going on all the time or at the same time*”. Implementation is also an issue, as pointed out by a UvA student: “*this is the point were you need the domain knowledge and a lot of modelling knowledge*”.

Identifying processes – Identifying processes is crucial for building qualitative models in GARP. Asked about how difficult it was, 80% of UvA students answered ‘medium’, ‘more or less difficult’ and ‘difficult’, whereas 100% of UnB students answered ‘medium’, ‘more or less easy’ and ‘easy’. One of the UvA students said it was “*difficult, because many processes also occur in other subsystems*”. Similarly to the previous question, domain knowledge is important for the students to identify processes.

Identifying quantities – None of the students found it easy to identify quantities and to define quantity spaces. For two thirds of UvA students and for half of UnB students, this task was ‘medium’, ‘more or less difficult’ and ‘difficult’. Their comments are helpful for understanding their difficulties: “*more or less difficult, there are too many quantities, difficult to choose the relevant ones*”. It is “*difficult to identify quantity spaces, it is hard to imagine. Would there be a maximum or not? Is zero an option?*” Another student said “*Difficult, it is hard to say when something is normal, high or maximum. Most of the times you could only say it’s positive, normal or zero.*”

Creating model fragments – Knowledge about objects, quantities, relations, conditions for things to start and to stop and causal relations is represented in model fragments. They are the fundamental unity of the library that encode knowledge in GARP models. Therefore, creating model fragments is probably the most important part of the modelling activity. It is also one of the most difficult parts: 90% of the UvA students and 83% of the UnB students said building model fragments was ‘medium’, ‘more or less difficult’ and ‘difficult’. It is “*difficult to translate the causal relations into a model fragment, because this has certain limitations on the representation you can use*” said one of the students. “*There you need to have a great understanding of GARP*”, said another one. However, “*it helps when you get an example of the subject you are modelling*” suggested a third student.

The most difficult part – Creating model fragments was considered the most difficult part by 60% of UvA students and 50% of UnB students. ‘Understanding the general problem’, in the beginning of the modelling effort, came next: 30% of UvA students and 17% of UnB students selected this option. Some comments are worth to mention. The most difficult part was “*getting a good overview of the domain, especially the perspectives one can have of the systems*”. “*Thinking about the relevance of things*” was also mentioned. A UnB student said, “*it was difficult in the beginning to understand the problems and the objectives of the modelling*”. Identifying ‘physical objects’, ‘typical situations and scenarios’, and ‘building causal models’ were not mentioned by any student as the most difficult part.

The easiest part – Among the ecologists, the activity that received more votes (34%) was identifying the processes. A student said, “*when you know what needs to be done, it works very fast. Understanding GARP makes it easy*”. For 20% of UvA students and 17% of UnB students constructing isa-hierarchies was the easiest part of the model building process.

6. Is it Worth to Build Models?

We asked the students to evaluate their knowledge about the carbon cycle and greenhouse effect and QR, having read the literature, BEFORE starting the model building and AFTER finishing the model. Building qualitative models had a positive effect on the learning process about the ecological problems for all the Dutch and for two thirds of the Brazilian students, according to their answers to the questionnaire.

The most impressive results here are: UvA = 40% beginners before, and 0% after; 0% was ‘more or less expert’ before, and 40% said so after. UnB = 50% was ‘more or less beginner’ before and 0% after; 34% was ‘more or less expert’ and 50% was ‘more or less expert’ and 17% ‘expert’ after. Some UnB students

(34%), who were not really involved in the modelling activity, said their knowledge on the domain did not improve.

We also presented the students a statement saying "building a qualitative model made me understand better the problem", and 60% of the UvA students and 83% of the UnB students said they 'agree' and 'fully agree'. One of the UvA students said "*fully agree, it gave me insight in the causality and the different perspectives from which we can look at the problem*". A different view was presented by another student, who said it "*made me able to **abstract** the problem*".

7. About the Collaboration

An UvA student said "*I think it is relevant to collaborate with people who have a different background (biology) but the fact that they are far from each other and in different countries wasn't relevant at all*" and others went on the same line. The UnB students were more excited about the international collaboration, something they are not used to. Asked about how effective was the collaboration the two groups had different opinions. The UvA students found it was not effective, whereas the UnB students found it effective.

Why is it that ecologists found the interaction 'effective' while their partners did not? An overall evaluation of the collaborative modelling effort shows that the students had an uneven experience. Five groups were formed, including students from both universities. One group had a strong interaction, and eventually they implemented part of their models in GARP; three groups had some interaction, but this was not regular; and one group had no interaction between the students. There are some elements that explain that. First, UvA students started the modelling effort earlier than their colleagues in Brazil. Therefore, they were not at the same stage of the modelling process and for some groups it was difficult to catch up. Given that e-mails exchanged in the e-group go to all the members, even for those that did not interact within their groups there was some sort of feedback. Second, there were problems with the language. Brazilian students have more difficulties with written English, and messages did not flow smoothly and quickly. Third, those groups that were not interacting could finish their work separately despite of their different background. AI students built their models using their basic knowledge of the ecological problem. Ecology students had some help (from the lecturer and from a tutorial on modelling) in order to design their models, but most of them did not try to actually implement their ideas in GARP. Finally, this was our first tentative in doing such interaction between students via internet, and we could not anticipate all the problems, prepare all the required didactic material beforehand, and adjust the timetable of the modelling activities for both courses.

Even though, 75% of all the students expressed that we should continue with the international collaboration in the future. As one UvA student said, "*yes, it was nice and it has never been done before*". The students suggested also to make a longer interaction: "*the contact should be made soon, the response should improve*" and "*increase the duration (time) of collaboration*".

8. Discussion

This exploratory study confirms the idea that modelling is a valuable learning activity, and suggests that collaborative modelling involving students with different background may add some extra value to that educational activity. We describe the collaboration between Artificial Intelligence (AI) students from UvA and Ecology students from UnB in order to build qualitative models of the carbon cycle and the greenhouse effect, using the representational schema adopted in GARP.

After the modelling effort, these students answered questions about general aspects of themselves and the course, and specific questions about the qualitative model building process. All in all, modelling is a doable activity for them, after understanding what they had to do. A student said qualitative modelling represented a "*change of reasoning and thinking*", an interesting comment for our reflection.

For the majority of the students understanding the problem they had to model and identifying the most relevant aspects were more or less difficult activities. Knowledge of the domain helps, but still this can be more or less difficult. Specific knowledge was important also for identifying typical situations the system may go through, and for describing system behaviours. Our study shows that AI and ecology students had opposite opinions about how difficult it is to describe behaviour. The same divergence of opinions we found asking them about identifying objects and organising them in isa-hierarchies. AI students are used to that and find it an easy task. Ecology students were not used and had some difficulties to create such representations.

Probably the task that requires more domain knowledge is to build the causal models that underlay qualitative models. Once again, the two groups of students presented different opinions about this task. Almost all AI students marked 'medium' to 'difficult', and almost all Ecology students marked 'medium' to 'easy'. Some problems were mentioned by them, such as the fact that the distinction between direct and indirect influences is not always clear, processes are not easy to identify, and some aspects particularly related to ecological systems. Among them, processes that happen all the time and others that happen in particular moments; processes that occur in all the parts of the system and other that occur only in some parts.

The students mentioned also difficulties for identifying quantities and their respective quantity space. One student said in order to identify quantities and quantity spaces, "*even more perception and interpretation is needed*". In fact, this is a big issue in ecological modelling. Notions like 'boiling temperature', full of meaning in domains such as physics are not easily found in ecology. The solution our students found was to assume simple quantity spaces like {zero, plus} or {minus, zero, plus} for most of the variables.

Building model fragments was considered the most difficult activity of the modelling effort. Given that these partial models encode in a specific language representations of objects, quantities, conditions, relations, situations and processes, that is, the core of the knowledge being modelled, one can understand why the students answer that way in the questionnaire.

The students recognise that it is worth to build models for their learning process. After investigating the individual progress of the students reported in each questionnaire, we noted that 100% of students from UvA reported an increase in their knowledge about the ecological problems studied. Among the UnB students, 67% reported an increase, whereas 34% said their knowledge about the problem did not increase. In the overall evaluation, these latter students were those who made less effort in the course. So we can say the majority increased their understanding of the problem.

Students engaged in collaborative modelling sometimes act as teachers and sometimes as learners. As a UvA student said, "*maybe it is a good idea if the ecologists put more emphasis on explaining the modellers their domain knowledge. Then the modellers could spend more time on making the models and hierarchies, and maybe explain things about that to the ecologists*", the essence of collaborative modelling.

This study was not intended to be prescriptive, but we can organise some suggestions we captured and learned from our students. First, it is important to provide support for collaborative modelling. In the beginning, keep the focus on the expert, imagining the overall behaviour, identifying processes and drawing causal models. Describing behaviour in (qualitatively relevant and different) states, identifying quantity and quantity spaces, that is, understanding the problem is crucial for the success of the modelling effort.

When planning the collaboration, it would be a wrong decision to separate understanding the domain knowledge from 'how to implement' that knowledge. There is a pragmatic aspect mentioned in two different occasions to be explored. One student said modelling is "*difficult, the theory didn't help at all, you just needed to look at what GARP needed*" and another one said, "*when you know what needs to be done, it works very fast. Understanding GARP makes it easy*". These results suggest that the knowledge representation should come along with thinking about the ecological system and what is relevant to model.

As expected, the strength of the interaction varied among the groups involved. One group had a strong interaction and eventually implemented running models. One group did not interact much and did not produce running models. In between, three groups existed with a reasonable amount of interaction. The perception of the Dutch and Brazilian students about the effectiveness of this experience was nearly the opposite: for the former, it was not effective, and for the latter it was effective. We explain this paradoxical as a result of different schedules, backgrounds and proposals for the two groups.

Concluding, it is worth to continue with collaboratively building qualitative models. This activity provides the students with a better understanding of the problems. Skills acquired during the modelling effort will be useful in their professional future. All students expect for one ecologist, found that qualitative models are 'very useful'. They say why: "*It is convenient as a predictive tool in management strategies and decision making*". Another ecologist said qualitative models are "*very useful for formulating the reasoning about a problem*". It is also important to get people from different countries together. In our case, we intend to give more time for the students to get know each other better and to exchange cultural experiences. We believe that cross-fertilisation of ideas may improve learning opportunities.

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