SUPPORTING COLLABORATIVE LEARNING INSIDE COMMUNITIES OF PRACTICE THROUGH PROACTIVE COMPUTING

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Abstract

This work focuses on a particular area of Computer-Supported Collaborative Learning (CSCL) which looks at how to create, organize and develop Communities of Practice inside a Virtual Learning Management System (VLMS), i.e. Moodle™, with the help of Proactive Computing. The goal is to increase the on-line participation of students, stimulate the learning process and address common issues in higher education institutions, like transportation, housing, health concerns and students social activities. To achieve this goal, we propose different ways of organizing students into virtual communities with a clear purpose and we provide the tools for building and sharing the knowledge, while our system informs, guides and assists students through the whole process.

The current level of involvement of the students at our university's local Moodle™ platform is quite low, despite the fact the students are obliged to use the platform for extracting, viewing and submitting assignments and other course-related materials. This is why we consider Moodle™ quite static and limited from the point of view of the interface and from the existing ways of creating learning communities. By employing Proactive Computing ([11]), the system becomes aware to the actions or lack of actions of its users, and, on the basis of predefined proactive scenarios, takes appropriate actions for steering users towards enhanced collaboration and social learning.

Using the structure of the proactive rule defined in ([13]), we have developed a new set of proactive rules which aims to automatically initiate, maintain and expand social interactions inside communities of students. Each rule is part of one of the stages of the Proactive Cycle, the whole model of proactive scenarios meant to support collaborative techniques for sharing experience, news and practices. The Proactive Cycle is divided into three main categories: "Setting-up Social Groups", "Enhancing Social Life" and "Adjusting the Social Groups". Each community starts its life-cycle in the first category and then, after developing over a certain period of time, it will either become a significant community or the system will merge it with another group, or even ending its life-cycle if there are not so many members or the group is inactive.

The set of rules will run on the Proactive Engine, developed by Zampunieris ([13]), and aside the local Moodle™ server at our university. A new Java Web Socket Server will ensure an encrypted real-time connection between the Proactive Engine and the Moodle™ blocks (parts of the user interface) developed specially for these experiments. These first series of experiments are taking into account around 1300 real students who currently use the Moodle™ platform over a full semester.

We believe our study will be significant in terms of understanding the evolution of virtual study communities, for providing a better learning experience to the users, and in terms of integrating new technologies into an existing learning management system (LMS). The results of this study, which is deployed over the summer semester, are expected to emphasize the importance of having a dynamic, proactive and intuitive learning environment. The Proactive Engine is capable to be integrated with other LMS systems, which would help the whole learning community.

Keywords: collaborative learning, proactive computing, communities of practice.

1 INTRODUCTION

The potential of proactivity can be emphasized with the help of Learning Management Systems (LMS). LMS represent an appropriate domain for handling CSCL, as they use a wide range of software tools to provide better support for interactions between the teachers and learners who are not able to be in

the same location at the same time. In general, CSCL systems use technology to provide an adequate and efficient environment for sharing, acquiring and delivering knowledge.

> "Unfortunately, in most cases, the designs of online tools and pedagogies do not support the social structures that promote community learning processes. For example, course management technologies used in most e-learning applications (e.g. WebCT and Blackboard) are designed to support highly structured, university-style learning situations and therefore may not be the most appropriate for informal, highly contextualized learning in an education community of practice." [9]

Proactivity is a solution for the majority of these systems, which, regrettably, are quite static and user-centred, depending a lot on external decisions. Instead, with the help of proactivity, they are able to take their own decisions that will help both the users and their entire community, as they become more sensitive to the user's intentions and goals. In this optic, a system acquires a semi-autonomous proactive behaviour permitting to undertake the dynamic response-actions aiming to reflect better the needs of the user. Moodle™ itself is an LMS which proves the usefulness of Online Communities of Practice (OCoPs) or Virtual Communities of Practice (VCoPs), which are particular forms of Communities of Practice (CoPs). Its primary goal is to focus on improving the learning process of students and their knowledge. But it is currently limited because it lacks the existence of social groups, where members can develop other kind of knowledge than the one related to their courses.

The goal of this work is to bring students together by deliberately forming online social communities on Moodle™. The students that will be automatically grouped together in first stage of the experiments, in the beginning of the semester, have one important thing in common - the same study program. These communities will benefits from the dynamic and continuous updates of their members. Afterwards, the composition of new groups will be based on the country of origin, the city of residence and finally, on the users' online actions or on their common interests.

Context or situation awareness is a concept used more and more by software systems all across the world. Applications that have an increased level of awareness take more intelligent decisions, can stay in control and are able to change their behaviour according to each situation. Applying context awareness to LMS requires two main phases: the understanding phase and the decision phase. Proactive computing ensures that these two phases are linked correctly and the transaction from one phase to another is performed dynamically, with the necessary amount of information.

Using Proactivity and Communities of Practice together offers great advantages both to educational institutions and to their users. Participants can build stronger relationships, share knowledge and learning materials, while CSCL software tools can easily adapt to unpredicted situations, identify new possibility for the communities, detect real-time events and provide continuous help, assistance and guidance to users, when they are not so active or when they encounter problems in their communities. Students can post fresh news, build a shared understanding of various tasks and learn to interact with students that may have other perspectives, as they are the authors of their online community.

2 BACKGROUND INFORMATION

The starting point in proactive computing is considered to be the article of Tennenhouse ([11]). Opposite to interactive computing, proactive computing was designed to be omnipresent and to enable people to concentrate on supervising tasks rather than performing simple interactions with computers. Following the same idea of proactivity, proactive systems were described as working on behalf of the user and following their own initiative ([8]).

In a new series of articles ([13], [14]) Zampunieris was describing some theoretical aspects of proactivity together with their practical implementation in an LMS. Later on, improvements were made at the level of the visual interface and the entire system architecture in ([1]). They were used to complete the LMS by continuously assisting the users in obtaining their goals and so, offering a better online educational environment to the students. After conducting experiments with these tools, results were evaluated and statistics analysed in ([2]) and ([3]).

Communities of practice existed since a long time but it was only recently that Wenger ([12]) gave them an official name, a form and divided them into particular categories according to their goal. The authors propose three main structural characteristics for identifying communities: the domain, the community and the practice. OCoPs developed in a LMS focus more on the practice as the domain and the community are normally well defined. The practice, in the context of CSCL, takes into

consideration multiple aspects like collaborative knowledge building, group and personal perspectives, mediation by artefacts and interaction analysis ([10]).

Eris S. Toner gives a very simple explanation for situation awareness in ([5]) as being the knowledge of what is happening around, both internally and externally. In the case of a LMS, the process of internal understanding is more complex as it should rely on precise information provided by the database. To modify the behaviour of a system, first we have to understand how it works, if there are some important features missing and then, what are the consequences of applying these new features. A "self-aware eternal software", according to ([6]), would support its own evolution by having accurate models for changes, by continuously tracking the history of events and logs, by analysing permanently both the static and the dynamic evolution of the system and finally, by narrowing the gap between the end-user and the domain model.

3 PROTOTYPE IMPLEMENTATION

The Proactive Prototype is developed on top of the Proactive Engine [13] and on top of the University of Luxembourg's local Moodle™ platform. The Proactive Engine represents an entire mechanism which continuously analyses data for guiding and assisting users, in order to have better online interactions in a learning environment. It is composed of multiple parts, both on the client side and on the server side: a Rules Engine (RE) written in Java, a proactive database, a database wrapper and various graphical elements at the level of user's interface. The purpose of the Proactive Engine is to transform the behaviour of the LMS by enhancing the functions of the system and/or adding new ones, while not affecting in any way the code or the execution of Moodle™. The Rules Engine is the most important part of the Proactive Engine, as it was created to store and run proactive rules. Mostly, the interaction with the LMS is done via its database, where the Proactive Engine checks for new data. This is why the database wrapper was designed – to access Moodle™'s database with a set of specific MySQL queries. The persistence of the entire engine is assured using the Hibernate™ framework ([4]).

A proactive rule is made out of five parts: *data acquisition*, *activation guards*, *conditions*, *actions* and *rules generation* ([13]). Sets of rules definitions compose scenarios or meta-scenarios, depending on their lifecycle. An instance of a rule is executed only once by the Rules Engine and then is removed from the Queue Manager, meanwhile the meta-scenarios are executed either at each iteration or after a predefined period of time, varying between once a day and once a week. The default time between two iterations of the Rules Engine is set to 5 seconds for these experiments. The distinction between scenarios and meta-scenarios is very important from the conceptual point of view as well as from the point of view of the Proactive Engine, which uses its queues to keep or to remove rules.

The first set of proactive rules that was launched on the Rules Engine was initially designed to analyse data in order to guide and assist users for better on-line interactions in educational and training environments ([14]). The representation of a more advanced network of proactive rules was introduced in ([7]).

3.1 Communities of Practice on Moodle™

The main idea of developing CoPs inside the local Moodle™ platform was to have students distributed into diversified social groups were they could exchange precious information about different courses and assignments, check for news related to student jobs, activities and events, and get in touch with other students with which they share lots of common interests.

The communities of practice were created with the help of Groups and Groupings features already integrated in the latest version of Moodle™. A category containing a course, called *Social Groups*, was created, and inside this course, a set of online activities, containing a forum, a chat and a folder were assigned to each community. There are other resources that are available from the beginning to the students at the level of the course like a user manual, with snapshots of the interface and the main tools they have to use, and a project description, containing a detailed description of the whole project. Additional resources, like quizzes or PDF files containing statistics, will be generated and then added to the groups during the experiments by particular meta-scenarios.

Moodle™ Groupings can make activities within a course available only to a set of users, which are firstly arranged into groups and groupings. Group modes will be set to "Separate Groups" for the whole course (i.e. only members of the same group can see the group activities, to all the others they are invisible) which means that the visibility of a resource will be determined by its group membership.

By default, the users inscribed in the course containing social groups will only have basic permissions for using the resources of the group, meaning that they can use them, they can add documents to the folder but they cannot change the settings of the existing forum, chat and folder.

3.2 The Proactive Cycle

The Proactive Cycle is a structure designed to create, support and develop social interaction and collaborative learning between the users. It is composed of three main phases: "*Setting-up the groups*", "*Enhancing social interaction inside the groups*" and "*Adjusting the groups*". All the rules are part of one of the 3 main stages of the proactive cycle, except the first and second scenarios which trigger the whole mechanism.

In the beginning, the Proactive Engine would have an important role in the initialisation of the Proactive Cycle because it will run scenarios responsible for creating social groups, with their corresponding resources like forums, chats, quizzes and surveys, it will inscribe all the students that are eligible to form communities and it will announce all the users about the newly created groups and resources. Creating other social groups on Moodle™ require a minimum set of initial requirements to be fulfilled, as explained in the chapter – "Joining other groups". The participants of the firstly created communities will have in common the study program which is taken from the Moodle™ database. The proactive system will enrol users directly into their corresponding communities. The main idea behind this reason was to directly engage students in mutual social interaction as they are encouraged to discover how a community looks like and how to use local resources like forums, chats and available documents. The system will take proactive measures to ensure that groups are adjusted in a way that activities inside these communities will continue to improve. Keeping participants involved and motivated for new activities represent a great advantage as well as having a core group, represented by the most active users, which would raise the level of knowledge of the entire community.

The Proactive Life Cycle of a social group is highlighted in fig. 1. All the communities start with the first stage of the Proactive Life Cycle, continuing to evolve and arrive at a mature phase during the second phase and finally, either becoming a bigger group or ending its life cycle by merging with other groups. Social groups follow the same life cycle, but they can differ from the point of view of their creation or of the initialisation of their other life cycle phases. For example, a group has only 2 potential members, which is not enough at that particular moment to form this group. Later on, if the proactive system decides that a student is appropriate for this specific group and the number of eligible users is bigger than 3, the group will start its Proactive Life Cycle by entering the first phase – "Setting-up Groups". More details about the rules from each category and their purpose are given in the next chapter – "Rules of the Proactive Cycle". A more detailed explanation of what each phase of the Proactive Life Cycle was designed for is given below.

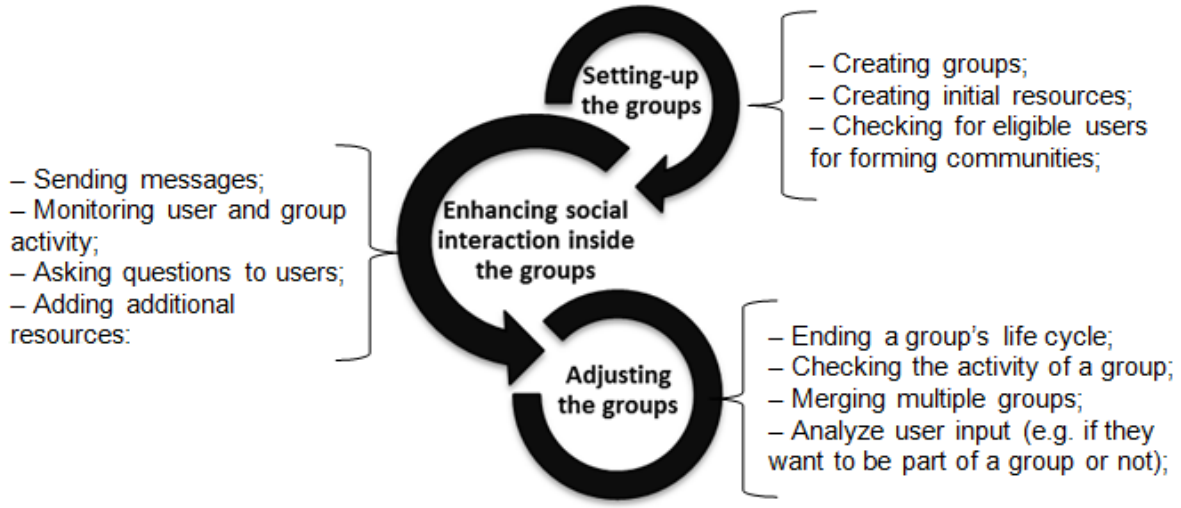

Figure 1 - Proactive Life Cycle of Groups

3.2.1 Setting-up the groups

During this phase, proactive scenarios are run by the Proactive Engine in order to initialise social groups and all their particular communication tools and materials which are created with the

appropriate levels of visibility (i.e. resources should be available only to the group's members). Then, users are inscribed into their corresponding groups, while being announced of their enrolment via a message that appears in the "Coaching Messages" block. At this time, the users get familiar with their environment and start discovering how to interact with other users and how to use the tools provided for them.

3.2.2 Enhancing social interaction inside the groups

The second phase of the Proactive Life Cycle contains dedicated proactive scenarios, developed to improve online environment of a social community and to continuously encourage its members to be active. This is the most important phase as it is supposed to last from the point where the users start building their community by sharing their knowledge and their experiences until the community reaches its end. The evolution of the communities depend mainly on the actions of their members, so the Proactive Engine is only designed to be in charge of keeping the users connected to their groups by sending them various messages through the "Coaching Messages" block, by monitoring the groups' activities and by automatically adding new resources to rise the interest of the users.

3.2.3 Adjusting the groups

This phase represents the end of the lifecycle of a social group. Specific proactive meta-scenarios, like M301 and M302, decide that a group has to pass through this phase when there are not enough members to form a community or when its members are passive and do not exchange information between them. It can happen any time, to any community which is not evolving and which stopped being active. The reason for merging two groups is to give the opportunity for active members of a group that may not have other active users to exchange information, to participate in another community with other motivated people.

One of the most important points of the Proactive Engine is that it can run in parallel multiple proactive scenarios by interleaving instances of their rules, as presented in fig. 2, so that it can simultaneously create, enhance or adjust multiple social groups. The Proactive Cycle differs a lot from the user's perspective, because there can be users who are about to be inscribed in a group and, at the same time, other members who are already part of the core group of a community by interacting regularly with other members.

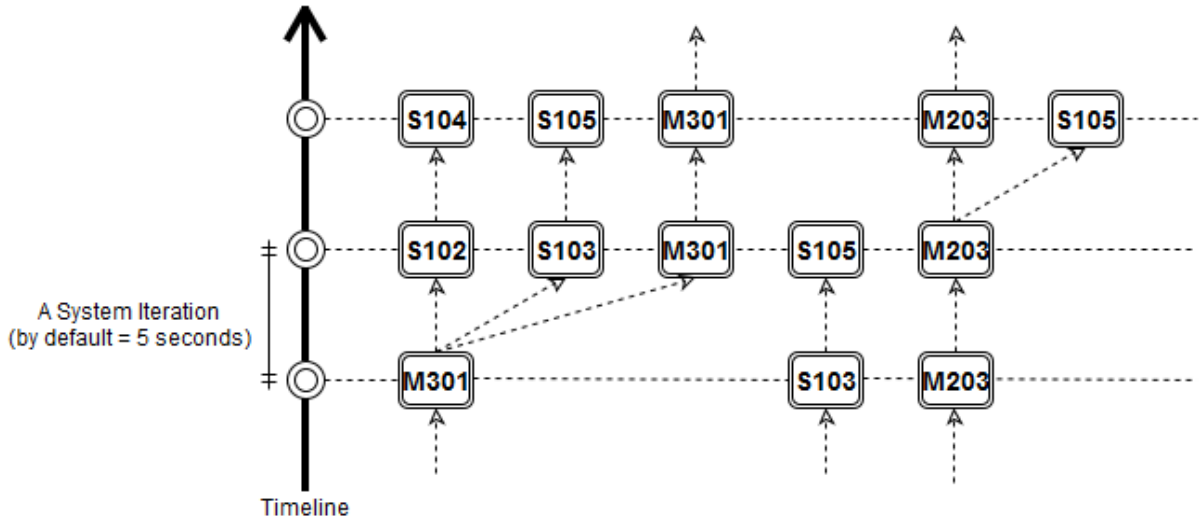

Figure 2 - Parallel execution of Proactive Rules

3.3 Rules of the Proactive Cycle

Each phase of the Proactive Life Cycle, shown in fig. 1, contains a set of scenarios and meta-scenarios. Meta-scenarios are used for detecting various events as they are executed either after a predefined period of time or continuously, because they have the ability to clone themselves. After they perform their actions, they generate scenarios which are in charge of performing well-defined actions. The scenarios execute their actions and can generate other rules but they never clone themselves.

The first two scenarios, S001 and S002, are used only once in order to trigger the Proactive Cycle. At the moment of the first execution of the Proactive Engine, the only rule that is in the queue of rules waiting to be executed is S001. Scenario S001 creates a course category called “Communities of Practice”, and inside this category, it creates a course called “Social Groups”. Then it generates scenario S002 that inscribes users, which have only the role of “student” at the level of the whole platform, inside the newly created course “Social Groups”. S002 is in charge of generating scenarios and meta-scenarios from each category of the Proactive Life Cycle, more precisely S101, S301, M201, M202, M203, M301, MTA_PushQuestion.

In fig. 3, we can notice, except the first two scenarios, three main categories in which the other scenarios and meta-scenarios are arranged. They are grouped according to the actions they perform. For example, M201, M202 and M203 belong to the second category that is designed to make sure the social groups remain as active as possible. M201 is activated each week, on Friday at 4 o’clock in the morning. It creates a PDF file with statistics from the whole course, containing the number of groups which were created and the number of students that wanted to participate in the country and city based social groups, and a PDF file with the latest statistics about each group, containing the number of new members that joined each week and the number of actions which were registered for that group including forum posts, forum replies, chat messages and uploaded files. M202 and M203 are in charge of periodically checking each group’s activity. If a group was inactive, meaning that the users did not use any of the resources of a group for more than 3 days, then M202 turns to red the icon of the specific group on the block “Social Groups”. M203 is taking care of sending messages to all the members of the inactive groups through the “Coaching Messages” block.

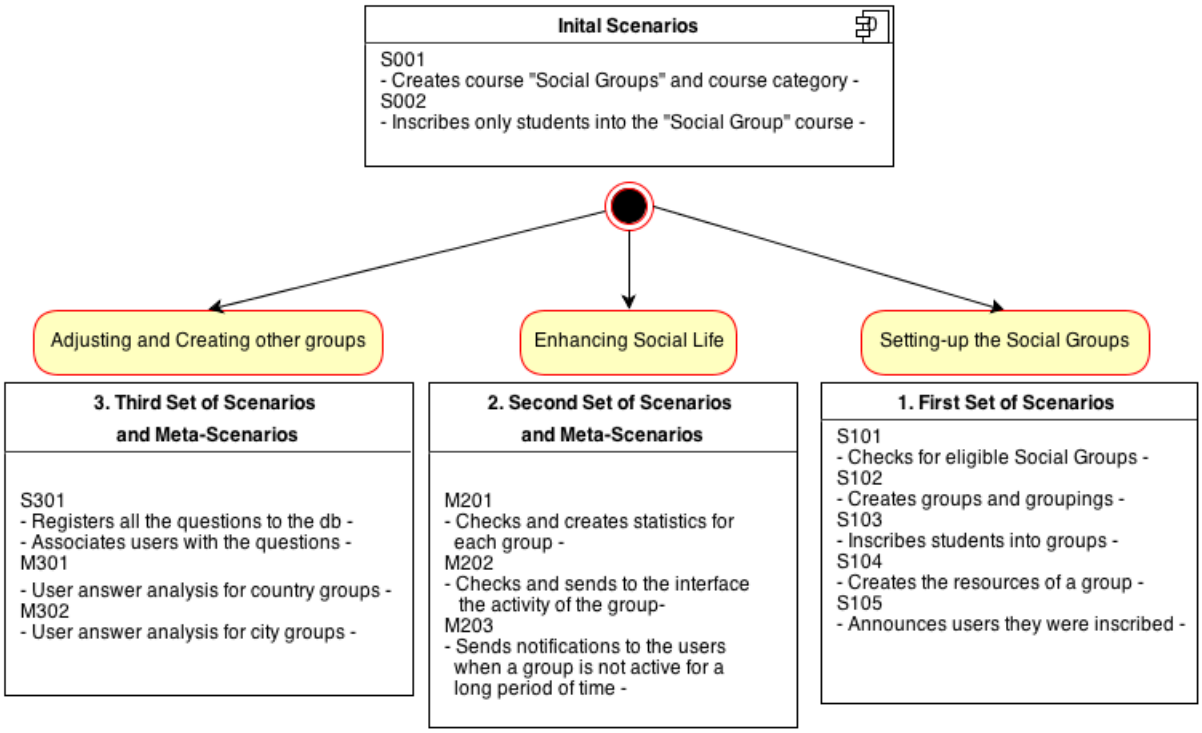

Figure 3 - Proactive Cycle rule categories

S301 registers all questions like “Do you want to join country-based social groups?” to the local database and associates each of the questions to each specific user that meets the requirements of being only a students, that is inscribed in the “Social Groups” course and that does not have any similar question associated with him/her. M301 and M302 are evaluating the answers of the users at each System Iteration, i.e. 5 seconds, and then, according to other answers already registered in the database, either create new social groups or only inscribe users in groups that were previously created. M301 and M302, in case they get activated, generate other rules like S102, S103 and S105, a generic scenario that sends users diverse messages.

3.4 Joining other groups

Initially, we considered creating social groups by extracting the city of residence and country of origin from the Moodle profile of the students but we encountered some technical problems. First of all, the Moodle fields are called “City” and “Country” and the users have problems understanding if they refer to the city and the country of residence or of origin. Then, the majority of the students left these fields empty, as they were not mandatory to fill-out when completing their profile. Finally, the data was very inconsistent for those students that still considered providing their “City” and “Country”. For example, for the city “Esch-sur-Alzette”, users wrote different names like “*Esch”*, “*Esch/Alzette”* or “*Esch-sur-Alzette”.* Because it was too difficult to treat each case in particular, for each city and each country we chose a different solution – each student would be asked in particular if they want to be part of social groups, and if they would agree, they would have to select a city or a country from a predefined list.

To establish if a user is willing to be part of other groups, the client side of Moodle™ was extended, as shown in the left side of fig. 4. A pop-up window, written in JavaScript, was created for asking each student if he/she wants to participate in other communities. The structure of pop-up window was designed to show different questions, with different content, but with the same possibility of answers for all of them (i.e. “Ok” and “Cancel”). The answer of the user is immediately sent to the server via the web sockets and then registered in a specific table of an additional database, created specially to hold extra information that cannot be stored on Moodle™’s own database.

We consider that, except the first set of groups of students, creating additional social groups should only happen if there are minimum 3 students that are determined and motivated to join these groups. This limit is considered as people are not obliged to participate, to deliver a product or to accomplish a specific task. The purpose of a community of practice is to construct collective knowledge which has to be available to all its members. Taking part in multiple communities, students can discuss and learn different things which may not be available in one community.

The meta-scenarios play a very important role in determining the proper moment to ask the students if they want to join other social groups. First of all, meta-scenarios will trigger continuously the first set of questions for those users that have not been asked and that are online. Then, after certain periods of time, the meta-scenarios are deciding if it is advantageous to create new groups and send new questions to the students. This decision is based on the activity or lack of activity of the students in their groups at the level of the whole course. If, for example, a group has only one member left, because the other members left the group, then one of the special meta-scenarios will either merge this group with another one or it will delete it. In both cases, the involved users will be notified via messages displayed in the “Coaching Messages” Moodle Block.

In fig. 4, one example of the process of accepting or rejecting to take part in other communities is presented in parallel. In case the student does not accept to join a country-based social group and selects the “Cancel” button, the pop-up window disappears and this particular question will not be shown to this student again. If a student doesn’t answer at all a timeout of 30 seconds is counted and then the server resends the question. If a student accepts to join the country-based social groups and selects “Afghanistan” as his/her country of origin, then there are multiple situations that may happen:

- There are more than 3 students that want to be part of country-based social groups with the country of origin as “Afghanistan”. In this case, the group, together with its resources, is already formed, and the new student will join immediately.
- There are exactly 3 students that answered “OK” and have the country of origin as “Afghanistan”. In this case, meta-scenario M301 starts creating the group called “Afghanistan” with all its resources. Just after this process, the students will be inscribed in their corresponding group.
- There are less than 3 students that want to create a group of students from “Afghanistan”. In this case, the students will have to wait until the minimum number of 3 students that want to create a group of students coming from the same country is reached and only then the group will be created.

A special meta-scenario is being developed to analyse the situation where there are not enough members from a country to form a group but they speak the same language as the members of other countries. This meta-scenario will be launched later on during the semester, when there are enough people that are waiting to join their social groups.

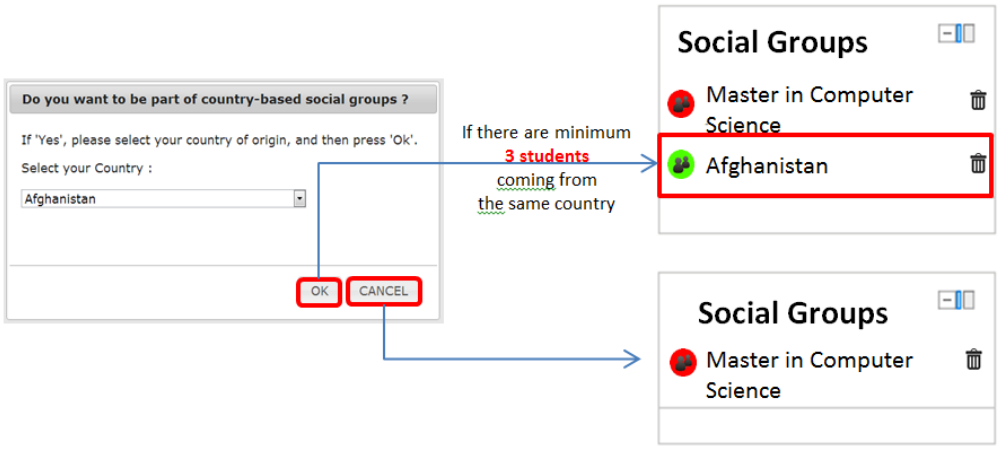

Figure 4 - Pop-up question box and "Social Groups" Moodle Block

4 SOCIAL LIFE INSIDE A COMMUNITY

Applying Proactivity, Context Awareness and OCoPs inside a LMS would not be possible without the concrete design of how would an online social community look like from the point of view of the student. We thought users will firstly be attracted by a well-developed interface of Moodle™ and more important, at what resources and means of interaction are provided by the learning platform.

At the level of the interface two Moodle™ blocks were developed to support the communication between the Proactive Engine and the users, to make users more acquainted with the events happening in their social groups and to show to everyone a list of their groups together with their level of activity. These blocks are displayed on the right side of any page inside the Moodle™ platform after a user logs in.

The block called “Coaching Messages”, shown in fig. 5, was created to increase the level of awareness of each user by providing fresh information about the groups, by alerting the users in case of an important event and by showing them that the Proactive System is dynamic and active all the time. The first version of this block was used in ([4]) for conducting experiments to obtain an automatic and enhanced management of the online assignments on Moodle™.

The block displays only the subject of the last five messages and their importance, which is calculated inside the proactive rules, on the left side of the subject. A detailed list with all the messages is opened when a user wants to read all his/her messages and clicks “Read All…”, a button situated at the bottom of the “Coaching Messages” block. Another button is provided for deleting any message both from the block and from the page with detailed messages.

Figure 5 - "Coaching Messages" block and the detailed list of messages

The block called “Social Groups”, shown previously in fig. 4, shows to each user a list of 5 groups, according to the time and date they were joined by the user. To the left of each group an icon is shown

with different colours, e.g. red for inactive groups and green for active groups, and to the right, a button used to remove the current user from that specific group.

The Moodle™ 2.2.4, which is currently used at the university, provides a multiple resources like files, folders, labels, pages and URLs, and activities like assignments, chats, feedbacks, forums, glossaries, surveys and many more. We considered that for the first set of experiments, running during the summer semester, the chat, the forum and the folder are the most relevant tools to support social life inside the social groups, as shown in fig. 6. The course "Social Groups" has a section for each category of social groups: study program, city of residence and country of origin. A fourth section will be dedicated to the social groups that will be formed by the common interests and actions of all the participants.

The forum of each group is created with a default post which welcomes its participants and introduces a new discussion. In contrast with the chat, where only online uses can participate, the forum can be used to create posts that will remain for those that will login later on. Users can use both the forum and the folder to upload files, but files can be related only to specific posts in the forum while in the folder the users can have access to the full list of documents.

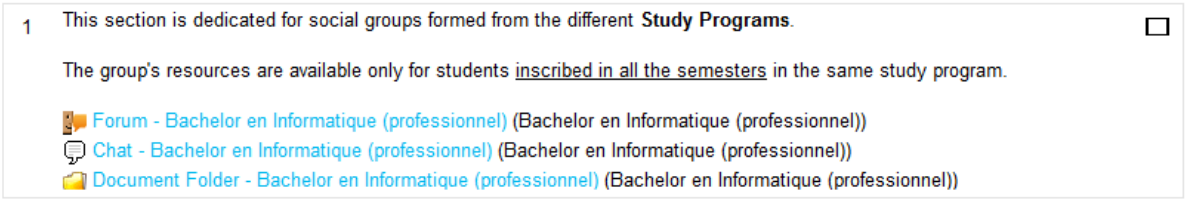

Figure 6 - Specific resources for a social group

5 CONCLUSIONS

One of the main objectives of this work was to prove that collaborative learning in a LMS can be developed with the help of communities of practice. Some of the major issues of educational institutions and student life can be addressed using CSCL systems, CoPs and Proactive Computing. Collaborative learning and interactions between students can be supported much easier if Moodle™ includes social structures not only at the level of courses but at the level of the whole learning platform. In such an environment, where experience is valuable for all the students, shared practices are a great opportunity to bring and keep members together, even for a long period of time. Using a single account, which are created at when students enrol for a study program at the University, increases the level of thrust of all the participants as well as their interest of better knowing their classmates at the Faculty level.

Even though Moodle™ is far from being an ideal system for deploying our proactive rules, it has many useful features that can be used create communities and to support social life inside them. One of them was the possibility to group all the students inscribed in the "Social Groups" course in various groups and groupings. Maybe the most helpful aspect about Moodle™ is that we could easily extend it by creating the two new blocks, i.e. "Coaching Messages" and "Social Groups".

A great challenge for us was how to make the users understand what the project is about, how to show them the benefits of actively participating in their social groups, teach them to be opened to new ideas and how to create materials to explain better what the experiments are designed to do. We hope to have increased the motivation of the users and their curiosity by automatically creating communities with various themes like the country of origin, the city of residence, the study program and later on, communities based on their common interests. Finding solid reasons for organising groups of students online was not easy because the purpose was not only to improve the students' learning skills but also to develop a high level of social interaction between people that share common things but do not know about each other. It is important for the communities to provide relevant information to its members, otherwise it is hard to keep them motivated and involved in their social groups.

We expect, at the end of the summer semester when the first experiments will come to an end, to have built well-connected communities, to have increased the level of online participation of the students in the LMS as well as in their courses and to have established a dynamic, aware, adaptive and proactive system that could be integrated with other LMS for benefiting the entire learning community.

Future research includes discovering new patterns for creating online communities of students, adding a group manager for each social group, elected randomly from the beginning and then based on his/her activity inside the group, providing to all the users inscribed in the “Social Groups” course the possibility to see the full list of groups and to join any other groups they think are interesting and finally, developing a new Moodle™ mobile application for iOS and for Android to support the new social features of the LMS. When the experiments will finish, at the end of the summer semester, a vast amount of data about student communities and the collaboration inside these circles will be available for analysis and for further conclusions. We hope our results will show that involving students in the social aspect of an LMS increases their efficiency in the learning process while addressing important issues of the student community like transportation, affordable housing, economic development, business opportunities (e.g. internships proposals) and recreation activities.

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