

Discussion forum coordination support in distance courses

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Abstract

This work presents a piece of action research which investigates tools that provide coordination support to mediators and learners in discussion forums in a distance course. In an asynchronous environment such as the forums, participants must check the *Learning Management System* (LMS) regularly to follow the unfolding of the discussion and the activities of other participants. Without such information, learners and mediators do not coordinate their activities according to the group's progress and miss chances to communicate synchronously. The tools investigated aim at keeping learners and mediators informed of what happens in the forum without the need to connect to the learning environment's desktop web interface.

KEY WORDS: discussion forum coordination, notification, interaction analysis, m-learning, action research, awareness.

Resumo

Suporte à coordenação de fóruns de discussão em cursos a distância. Este artigo apresenta uma pesquisa-ação na qual são investigadas ferramentas para prover suporte à coordenação de aprendizes e mediadores em fóruns de discussão de cursos a distância. Em um ambiente assíncrono como o dos fóruns, os participantes devem verificar regularmente o ambiente de aprendizagem (*Learning Management System* - LMS) para acompanhar o andamento da discussão e as atividades dos demais participantes. Sem estas informações, os aprendizes e mediadores não coordenam suas atividades em função do andamento do grupo e perdem oportunidades de se comunicarem sincronamente. As ferramentas investigadas neste trabalho visam manter aprendizes e mediadores informados sobre o que ocorre em um fórum sem que eles tenham que se conectar à interface web para desktop do ambiente de aprendizagem.

PALAVRAS-CHAVE: coordenação de fóruns de discussão, notificação, análise da interação, *m-learning*, pesquisa-ação, percepção.

1 Introduction

In a distance course, learners must participate according to the dynamics proposed for the educational activity, fulfilling requirements in terms of number of messages sent, text quality and posting deadlines. In order to elaborate their messages and give continuity to

the discussion, learners depend on each others' messages. As messages are sent, learners decide whether there are already messages they are interested in answering to or if they prefer to wait for the arrival of new messages.

Open interviews conducted with 37 learners of four editions of the Information Technologies Applied to Education (ITAE) course at the Pontifical Catholic

University of Rio de Janeiro (PUC-Rio), carried out in 2006 and 2007, indicated that they create strategies to reply to messages, waiting and searching for those they prefer to answer. Interest in or mastery of the specific subject under discussion, the possibility to introduce a new idea or counter-argument, the message having received few replies or having already been evaluated by mediators, and the author of the message, are all reasons mentioned to choose a message (Filippo, 2008). Moreover, it is convenient for a learner to reply promptly to a message before a colleague has the chance to send a similar reply. Following the discussion is also an important task for the mediators, as they are responsible for giving feedback to learners and intervening promptly when the discussion is not unfolding as desired.

As asynchronous activities, forums can present both periods of inactivity and the arrival of gusts of messages. At any moment a message that one may be interested in replying to can be sent, or a participant with whom one wishes to communicate can get connected. To know how a discussion is unfolding or who is online, learners and mediators must access the *Learning Management System* (LMS) regularly. With such information, forum participants have the possibility to self organize and act according to the unfolding of the discussion and to interact synchronously with other participants.

This work presents the action research conducted in the real environment of the Information Technologies Applied to Education (ITAE) course at PUC-Rio University, which is offered totally at a distance through *AulaNet LMS*, an education and learning environment for the web (Filippo, 2008). The tools developed and investigated aim at keeping participants informed of what is going on in the forum without the need to connect to the learning environment's desktop web interface: accesses to the forum through wirelessly-connected PDAs, SMS notifications and popup windows notifications on computer screens were made available to the participants. This work investigates the influence on forum coordination of the availability of consultations and notifications on the unfolding of the discussion and on the presence of other *AulaNet* forum participants.

In section 2 the importance of coordination in collaboration is discussed. Section 3 presents the research context and problem, and section 4 presents the research method. Section 5 presents the cycles of this action research. Section 6 concludes this article.

2 Coordination support for collaboration

In order to have collaboration, the members of a group need to dialog (communicate), self-organize (coordinate) and

operate jointly in the shared space (cooperate) (Ellis *et al.*, 1991). Coordination is necessary so that tasks are executed timely, in the correct order, and according to the objectives and restrictions previously established (Raposo and Fuks, 2002). Should there be lack of coordination, there is a risk of misunderstandings, conflicts and task duplicity.

In order to have coordination in a group, it is necessary that the collaborative system make available awareness information (Dourish and Bellotti, 1992) through which participants get updates on the group's work progress, contextualize their own work in relation to that of their colleagues and redirect their activities. Coordinators in particular need to identify eventual problems as soon as possible. In an educational discussion forum, it is relevant to know if messages have already been sent, how the discussion is unfolding and if the other participants are online.

In collaborative learning environments, reports of activities and individual learner participation history are tools available in several LMSs such as *AulaNet* (2009), *TelEduc* (2009) and *Moodle* (2009) to follow the participants' activities. These bits of information are usually presented in an inadequate tabular form and are difficult to understand (Mazza and Dimitrova, 2004). The use of information visualization techniques allows new presentation forms such as the *Intermap/Moodle*, which makes available graphs and charts on the interactions among participants in mail and forum services (Silva, 2007), a solution also adopted by the DIAS-Discussion Interaction Analysis System discussion forum (Bratititsis and Dimitracopoulou, 2006). DIAS and GISMO-Graphical Interactive Student Monitoring System (Mazza and Botturi, 2007) make available graphic information on learner participation, informing, e.g., the performance in quizzes and the number of messages sent, of accesses to the environment and of threads initiated.

Besides graphs, charts and reports, several collaborative systems offer the possibility to notify participants of what it is taking place while they are disconnected from the environment or when the application's window is not visible on their computer screens. Collaborative systems forums such as that of *AulaNet*, *Moodle* and *BCSCW* (Appelt, 2001) use emails to inform the group when a message is posted. The widespread use of cellular phones has given rise to several applications that make use of notifications: in the educational area, there have been investigations on notifications informing about deadlines, tutorship requests and forum unfolding through SMS messages (Nonyongo *et al.*, 2005, Chiu and Choi, 2005) or cell phone wallpapers (Nakahara *et al.*, 2005). Popup windows are also used as a notification tool to inform the arrival of a message in the mailbox, as in the case of *Gmail* (2009), and the arrival of a person in the environment, as in the case of *MSN Messenger* (2009). Among these, the *iTree* is the closest to

the tools investigated in this research. This tool is a mobile application to motivate participation in discussion forums which sends information about the progress of the discussion through a cell phone wallpaper (Nakahara *et al.*, 2005). The metaphor of a growing tree is used to indicate a learner's progress in the forum without supplying quantitative data: branches, number of leaves and fruits, and color of the sky provide evidence on the progress of the forum. Unlike the *iTree*, this work uses SMS, which are more invasive, and quantitative data to enable monitoring of the discussion; furthermore, it is focused on coordination support rather than on participant motivation.

This research focuses on the investigation of coordination support tools that make available graphs, charts and notifications specifically for forums rather than on meeting the needs of a range of services in the distance education environment. This research is also focused on forums with educational objectives. It is relevant to mention that the tools investigated do not make use of the learning environment's desktop web interface: PDAs, cell phones and a client program to send notifications in popup windows are used instead. Moreover, while in Intermap, DIAS and GISMO the focus is on providing information about each learner, in this research the tools inform about the forum itself, detailing, for example, the message tree structure and number of messages posted per category. The popup notifications investigated are also different in that they enable direct participant access and action on the learning environment through links and buttons.

3 Research context and problem

The Information Technologies Applied to Education (ITAE) course, offered since 1998 by PUC-Rio, is given totally online through the *AulaNet* LMS. *AulaNet* and *ITAE* course are used by our research group respectively as a software platform and a real environment for the development and evaluation of the tools investigated.

AulaNet is a web-based teaching-learning environment that has been in continuous development since 1997 by the Laboratory of Software Engineering at PUC-Rio, and by the *EduWeb* Company, which is also responsible for its distribution. It is used in many universities and companies in Brazil and abroad, and it has versions in Portuguese, English and Spanish. *AulaNet*, based on the 3C Collaboration Model, has many different services such as *Mail to Participants*, *Conference* (forum), *Debate* (chat), *Tasks and Bibliography*, which can be chosen by the course's coordinator according to the course's structure and dynamics.

Like *AulaNet*, the *ITAE* Course has been in continuous development through the use of new services and functionalities implemented in *AulaNet*, such as the

Conference and Debate services and the availability of more advanced resources in the environment, in the modification of the dynamics of activities, and in the method adopted for learner evaluation (Groupware, 2009).

The *ITAE* course comprises 2 phases: in the first, each of the 8 topics is addressed weekly; in the second, learners elaborate interactive multimedia content about one of the topics. During each week of the first phase, learners study the contents available in the *Lessons*, *Bibliography*, *Webliography and Documentation* services, and participate in a forum through the Conference service and in a chat through the *Debate* service. In *ITAE* course, the *AulaNet Conference* service is used to carry out the "seminar" activity, in which a learner sends a text on the week's topic (the seminar) and 3 messages with questions that are discussed by learners for 50 hours. The messages must be categorized as "Seminar", "Question", "Argument" or "Counter-argument" and the discussion develops in a tree structure (Figure 1). Learners must send at least 4 messages, 2 of them by the 25th hour. Mediators do not post messages: feedback to learners is conducted through the evaluation of all messages and by means of advice provided through the *AulaNet* communication services. Eventually, it is necessary to remove a message erroneously located in the chaining of the discussion or to modify the category of a message. During the course participants communicate through the *Mail to Participant*, *Mail to Group*, *Debate and Participant Message* (instant messaging) services, receive alerts from mediators through the Mail to Group service and verify the activities programmed and their participation through the *Information and Follow-up Reports* services (Fuks *et al.*, 2002).

The problem in the *ITAE* course that originated this research is the fact that forum mediation activity is too laborious for mediators. Correcting messages is a task that consumes considerable time. Another laborious task for forum mediators is monitoring and coordinating the discussion's progress (Nakahara *et al.*, 2005). In this work, the focus was on investigating tools to support mediators in relation to the latter. Forum monitoring involves continuously reviewing the discussion to identify situations that demand action. It is appropriate that mediators monitor the progress of the discussion often to guide learners and correct problems promptly. The mediator's attention and action are higher in the first few forums, when learners are still not familiar with the dynamics of the activity, and at the beginning of each forum. The advantage of identifying a problem early on is that this prevents errors from propagating or setting in, thus affecting the course's or forum's adequate development.

The two difficulties identified regarding forum coordination – accessing the environment and getting information about the conference – can be formulated

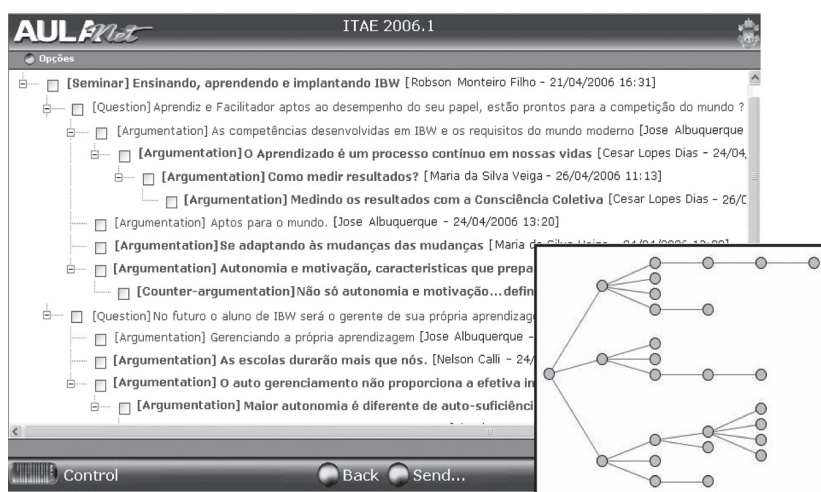


Figure 1. Snapshot of an ITAE conference and its graphical tree representation.

in a single sentence that defines the departure problem of this action research: the difficulty on the part of mediators to keep informed about the unfolding of the conference. Moreover, it must be pointed out that there are different levels of difficulty for the “accessing the environment” and “getting information on the conference” actions. An action can be “impossible” or “laborious” to perform (Table 1).

The impossibility of accessing the environment occurs when the mediator desires to check the conference in a given moment or with a predefined regularly and has no access to a desktop computer (it is impossible to access the environment). The access to the environment is laborious when a mediator, despite having access to a desktop computer, has to make the effort of remembering to check the forum and interrupting another activity to access the environment often (it is laborious to access the environment). When the environment does not supply certain information, for example a learner’s number of logins, the mediator remains unaware of it (it is impossible to get information on the conference). The situation of

being laborious to obtain information occurs when the information is available but has not been processed, and the mediator has to perform calculations to get the desired level of information (it is laborious to get information on the conference), e.g., to know message posting peak times it is necessary to check the messages’ date/time and to factor these in. The identification of these difficulties in ITAE course guided the development of the forum coordination support tools investigated in this work.

4 Research method: Action research

This investigation uses action research as research method. In an action research, the investigation is carried out by means of successive actions aiming to solve or mitigate a specific problem in a real environment (Herr and Anderson, 2005). The focus is on the investigation of research topics to understand a problem and on action to solve it within a specific context, and not on the corroboration or refutation of a hypothesis of a general nature.

Table 1. Starting point problem of this piece of action research: It is difficult for a mediator to keep updated about the forum’s progress.

	Difficulty level: Impossible	Difficulty level: Laborious
Action: accessing the environment	Mediators do not have the appropriate technology (network, computer, software) to access the environment when they consider it necessary.	Mediators need to act deliberately to access the environment.
Action: getting information on the conference	Mediators do not have in the environment the information they need (the environment does not present this information).	Mediators need to perform calculations, comparisons or estimates to extract the specific information they need (the environment does not present the desired piece of information in a summarized form).

In this work, the real environment is ITAE, the problem identified is the difficulty to coordinate participants in an educational forum activity and the action is to provide coordination support tools in *AulaNet* for course participants. By evaluating how learners and mediators use these tools, improvements or new tools are proposed, which starts a new cycle. In an action research, the researcher guides the actions, participating in the environment in which inquiries are carried out. In the case of this investigation, one of the researchers acted as a course mediator during the research. The action research is typically carried out in cycles, which successively refine the research towards a better understanding of the problem and solution appropriateness. In this action research, the four-step cycle “plan, act, observe, reflect” is adopted (Kemmis and McTaggart, 2005).

5 Cycles of action research in this work

Solutions for the aforementioned difficulties were investigated through three different types of coordination support tools: a PDA version of the Conferences service making available web pages with summarized graphical information on the unfolding of the conference (forum); SMS notifications on the unfolding of the conference and on off-pattern situations; and popup window notifications on participants’ accesses to the *AulaNet* services and on the unfolding of the conference. In all cases the objective was to investigate means to provide support to the coordination of learners and mediators beyond the “desktop/browser” paradigm, i.e., without the need to make use of a desktop computer with a browser to obtain information about the conference. Figure 2 presents a scheme of *AulaNet* LMS and the 3 different tools investigated in relation to 2 dimensions: “device mobility” (a desktop or mobile computer) and “application type” (pull mode / with browser or push mode / without browser). *AulaNetM* is the *AulaNet* Mobile version of *AulaNet* consisting in a PDA version of the *AulaNet* Conference service and in notifications sent through SMS cell phone services. *AulaNet* Companion is a popup window notification service whose client module remains resident in the desktop computer.

In this section the six cycles of this action research are described, each one conducted in each semester of the ITAE course from 2005 to 2007 (Figure 3). The unfolding of this action research is presented throughout the sections. As it investigated two different tools, cycle 2006.1 is presented in two sections. In 2007.2 cycle, the notification tool investigated included links and buttons to access directly the *AulaNet* desktop version.

Each cycle is presented according to its four phases. In the “Planning” phase, the solution proposed for that

cycle is presented. The implementation of the solution and its application are presented in the “Acting” phase. The “Observing” phase presents the types of data collected and in the “Reflecting” phase an analysis of these data is performed and the results discussed. The learners’ names used in this article are fictitious.

5.1 Cycle 2005.1: Graphical pages via web interface for PDAs

Planning: The objective in this cycle was to focus on the difficulty on the part of mediators to access the conference in the absence of a desktop computer to connect to the learning environment (difficulty: it is impossible to access the environment). As a proposed solution, *AulaNetM* (Mobile *AulaNet*), a PDA version of the *AulaNet* Conference service (Lucena *et al.*, 2006), was made available to the mediators for following the unfolding of the conference (Figure 4). This first tool was investigated in the 2005.1, 2005.2 and 2006.1a cycles.

This cycle also investigates the use of the list of conference messages in a tree structure, in its indented text form, for support to mediator coordination. This list presents a message’s meta-information - category, heading, author and date - in one line and the relationships among messages are established through indentation. From the structure of the conference tree, it is possible to evaluate if the discussion is unfolding in a sound way or if it needs intervention on the part of mediators (Gerosa *et al.*, 2004). For example, should the tree be wide and shallow, it will have many leaves, indicating a conference with many non-replied messages. Should a branch of the tree be very

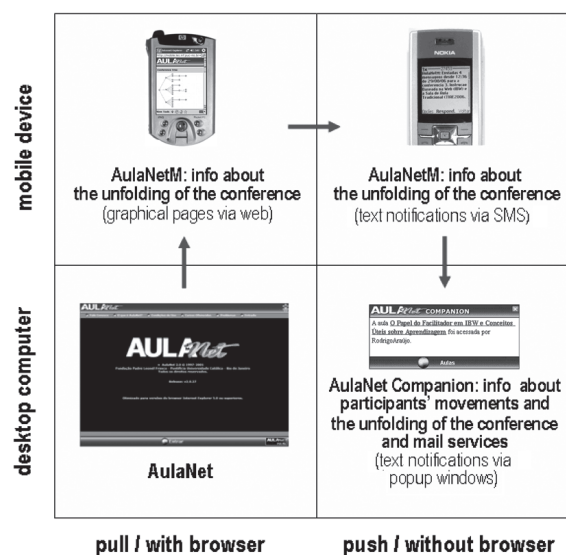


Figure 2. *AulaNet* LMS and the three coordination support tools investigated.

Cycles of this Action Research

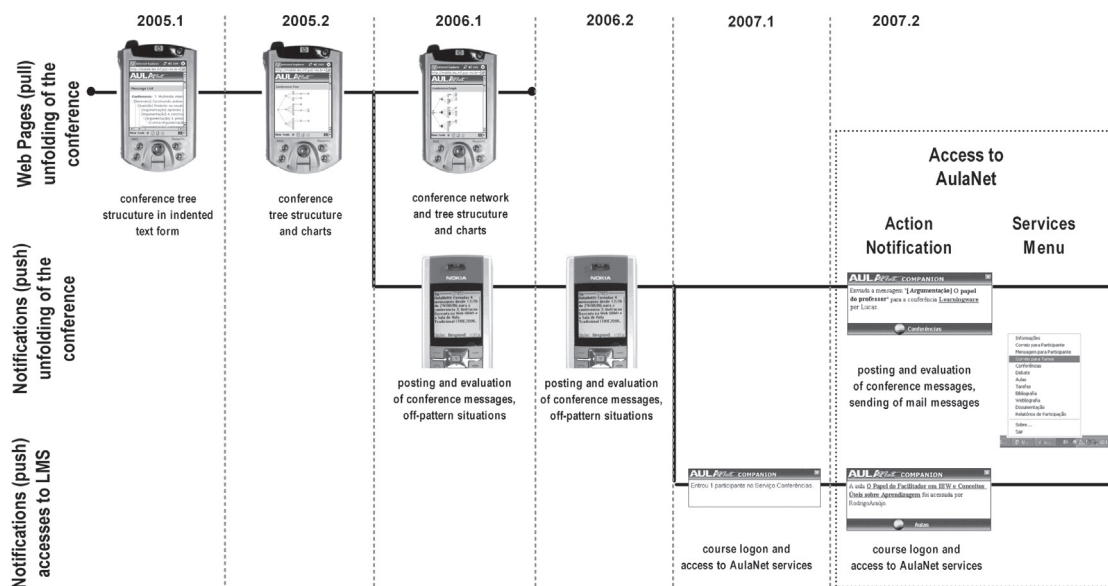


Figure 3. Cycles of this action research.

deep, the discussion can be concentrating excessively on a given topic. The meta-information “category” indicates a controversy if many messages categorized as “counter-argument” are observed; the meta-information “author” can indicate that a learner is monopolizing the discussion if it is observed that his name appears in many lines.

Acting: *AulaNetM* was implemented using JAVA/JSP technology. In order to collect data on the use of the service, all accesses to the service’s pages were recorded in a log. Additionally, a three-question questionnaire was included in *AulaNetM* login screen to identify in which situations the mediators accessed the environment: which wireless network they were connected to, if the access had been planned or opportunistic, and if a desktop computer was available at the moment they accessed the service through PDAs. The two mediators in this edition made use of two PDAs belonging to the project and three wireless networks within PUC-Rio campus. *AulaNetM* was provided in four of the course’s eight seminars so that mediators could compare their participation in the conference with and without the service.

Observing: In this cycle of the action research, three sources of data were used: navigation records, interviews using open question and the service’s login page questionnaire.

Reflecting: The results of the qualitative interviews conducted with the mediators and their activity logs showed that they identified opportunities and effectively used the PDAs in typical situations where they would be useful, such as in a restaurant queue or at a moment when all laboratory computers were busy. The use of *AulaNetM* in

opportunistic and emergency situations was also identified as advantageous for the work of mediation.

The possibility to use the information in the tree structure for coordination purposes was explicitly reported by one of the mediators, who spontaneously sent an email describing the situation that had taken place in the first week. The two mediators, physically close, needed to define urgently the share of messages to be evaluated, but did not have access to a computer at that moment. The PDA was used to access the conference and the decision was based on the information obtained directly from the conference tree structure. In the interview the same mediator summarized the relevance of the support to coordination offered by *AulaNetM* when he said “I found it very useful to see the tree through the PDA. It is a synthesis of the conference. This makes the PDA very useful, for instance, to determine if I have to rush to a computer to evaluate or if I can wait a little longer”. This statement shows a case where the difficulty “it is impossible to access the environment” was eased by the



Figure 4. Tree structure of a conference in indented text form.

availability of the Conference service in its PDA version.

The other mediator requested a report on the number of messages sent by a learner. This is an indication that the mediators' difficulty "it is laborious to obtain information on the conference" indeed takes place, as this information can be obtained in the conference's opening page but it demands from the mediator an effort to process it.

In the interviews the mediators reported an interest in using the service in certain places and situations in which this use did not occur because of poor signal quality or absence of a wireless network. The fact that the mediators were not the owners of the devices had a negative impact on the use of the service: they generally did not carry the devices with them for fear of breaking or losing them, or having them stolen. The PDA was used only to access *AulaNetM* and not as a personal assistant. Situations such as "since I have turned the PDA on to consult the calendar I will also check the ITAE seminar" did not take place. Too little experience in handling the PDA and doubts regarding, for instance, network reconfiguration also rendered the use of *AulaNetM* difficult.

5.2 Cycle 2005.2: Graphical pages via web interface for PDAs

Planning: Considering the results of the previous cycle, which indicated that accessing the conference through a PDA to analyze the conference tree structure in its indented form assists the mediators in seminar coordination, it was decided that this cycle would present the structure of the conference graphically, highlighting its tree form (Figure 5a). It was also decided that the use of web pages showing graphics summarizing message's meta-information would be investigated (Figure 5b). Graphs and charts like these enable mediators to identify off-pattern situations without having to read the messages' texts, and by presenting synthesized information they make it possible to ease the difficulty "it is laborious to obtain information on the conference". The choice of graphs and statistical data to be offered was based on previous work by our research group (Gerosa *et al.*, 2005) and on the graphics and statistical data already available in *AulaNet*, such as the number of messages posted by participant, category, tree depth level and date/time; the average number of words per message; the average tree depth level and the average leaf percentage (non replied messages). Information was made available regarding a conference, the conferences in a course edition and the same conference in different course editions.

Acting: In this cycle new pages were created to present the conference tree structure graphically and the charts. *AulaNetM* was used in four of the eight conferences.

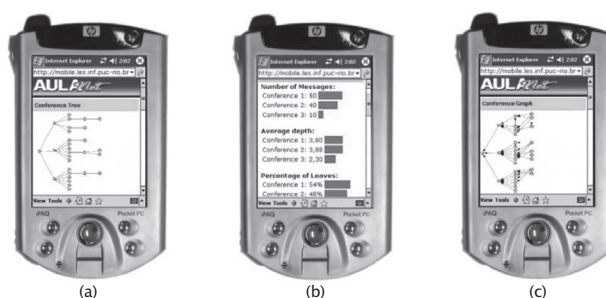


Figure 5. (a) Conference tree structure; (b) Graphics on 3 conferences in a course edition; (c) Conference network structure.

Observing: The same data sources of the previous cycle were used.

Reflecting: In this cycle of the action research the mediators approved the inclusion of the conference tree to follow seminars and did not identify situations to use the available graphs and statistical data. However, the mediation work was highly reduced in this semester as only 4 learners took the course. The difficulty on the part of mediators to handle PDAs persisted in this cycle, a fact that also contributed to a decrease in the number of accesses to the service.

5.3 Cycle 2006.1a: Graphical pages via web interface for PDAs

Planning: In this cycle the investigation with *AulaNetM* carried out in the previous cycle was repeated, once the mediation work in the ITAE 2005.2 edition was low. A page with a graph of the conference network structure was included (Figure 5c), once the desktop version of the Conference service had been modified for allowing the learner to make secondary references to other messages when replying.

Acting: In this cycle a page was included in *AulaNetM* to present the conference network structure graph. A new training session was conducted with the mediators to decrease their difficulties with the use of PDAs and wireless networks.

Observing: The same data sources of the previous cycle were used.

Reflecting: Similarly to those of the previous cycles the results of this cycle showed evidence that the structure of the conference presented in a graphical form is a relevant summarized piece of information to be offered in a coordination support tool. Observing this structure, mediators have a general "at a glance" view of what is taking place in the conference without having to read and analyze the messages to identify situations that may demand their prompt action, easing the difficulty "it is laborious

to get information on the conference”. Two pieces of research carried out with GISMO presented similar results: the instructors considered that with the information made available in a graphical form they “immediately” obtained a volume of information that would demand time and effort to obtain otherwise (Mazza and Botturi, 2007).

Regarding the use of the graphics made available in *AulaNetM*, it was identified that some conference parameters – such as tree depth level and number of characters in a message – are unusual, making it difficult for the mediator to evaluate from them if the conference is unfolding in a sound way or if it demands any action on their part. These parameters demand from the mediator longer experience with seminar mediation and with the observation of their variability. It was also identified that mediators used the statistical data and graphics only occasionally. For one of the mediators, that happened because they lacked the habit of using them in the desktop version of the service.

The mediators demonstrated in the interviews that they did not have a personal need for a PDA. On account of this, of the fact that the PDAs belonged to the university, and of the mediators’ difficulty in connecting to wireless networks, it was considered that the support to coordination of mediators through PDAs had been offered prematurely, pointing to the need to wait for a wider popularization of the technology to resume investigations on the use of this device.

5.4 Cycle 2006.1b: Notifications about the unfolding of the conference

Planning: The cycles of action research carried out in editions 2005.1 and 2005.2 demonstrated that if on one hand *AulaNetM* eased the difficulty “it is impossible to access the environment” by enabling access to the ITAE course through PDAs connected to wireless networks, on the other hand mediators had problems with the use of the device and of wireless networks and did not adopt the PDA as a personal assistant. Besides, with *AulaNetM* mediators still had to act deliberately to access the environment and keep informed about the unfolding of the conference (difficulty: ‘it is laborious to access the environment’).

In this context, the cellular phone is an adequate solution as a device to be used in coordination support tools. It is a personal device purchased by the mediators themselves whose basic operations they already master. Cell phones operate in their carriers’ coverage areas and are not restricted to the coverage areas of computer networks. These features get rid of the limitations identified when using PDAs: non-adoption of the device as a personal assistant, difficulty to operate it and connect to wireless networks, and, finally, their restricted coverage area.

Another issue considered was the possibility to use in the cell phone an affordable service in the “push” mode. With a push service, mediators receive information without having to search for it, making it possible to investigate solutions to ease the difficulty “it is laborious to access the environment”. In this case, the service chosen was the SMS (Simple Message Service) service through which mediators can receive short messages on the unfolding of the conference. Given that SMS messages may arrive “anywhere”, the SMS service also represents a solution to reduce the difficulty of mediators in keeping informed on the unfolding of the conference when they do not have a computer and network to access the *AulaNet* environment (“it is impossible to access the environment”).

Considering the ability of the SMS service to send short invasive text messages, in this cycle it was decided to offer support to coordination through a set of notifications directed to mediators. Notifications were chosen to inform them of situations that diverged from the expected pattern and potentially demanded their attention and action (Figure 6a). Among the different situations to which mediators must be attentive, six were chosen to trigger notifications: conference inactivity (learners are not posting messages), low or high participation of a learner, low or high number of replies to a message categorized as “Question”, low or high percentage of tree leaves (few or many non replied messages), uncategorized messages and incorrectly chained messages (messages posted in levels 0 and 1 of the conference, which are reserved for the seminar and for the three questions). It was established that the notifications informing on the participation of a learner and the number of answers to a question be triggered only on the second day of the conference, since in the first day situations outside the expected pattern are not always well characterized. If the situation that generated the notification persisted after a few hours, a new notification was sent to the mediators.

Seminar coordination is not accomplished by mediators exclusively; learners also need to follow what takes place in the conference and to self-organize to fulfill their tasks according to the rules established regarding quality and number of messages, as well as deadlines. Considering how difficult it is for learners to self-organize to participate in the ITAE, and how important it is for them to follow the activities of the conference in order to decide when they must read and post messages, this cycle of the action research investigated coordination support tools that could notify both mediators and learners about the unfolding of the conference. The objective was to keep them informed on the conference when they did not have access to the Internet (“it is impossible to access the environment”) or when they did not wish to go through the effort of accessing the environment to check the conference (“it is laborious to access the environment”).

Two types of notifications were investigated: “N messages sent since date/time to conference C” and “M messages evaluated since date/time in conference C”, where N and M are values that remained constant throughout the course (Figure 6b). These notifications inform about the 6 questions that identify important aspects in the supply of awareness information (Kirsh-Pinheiro *et al.*, 2001): the posting of new messages (what) by learners (who) and about the publication of new evaluations (what) by mediators (who) since the previous notification (when) in a conference (where). It was established that this information was going to be sent via SMS messages (how) with a frequency (how many) determined by the conference level of activity, that is, every time N messages were sent or every time M messages were evaluated. A silent time between 10 PM and 10 AM was adopted. At 10 AM the 2 types of notifications were sent independently of the number of messages posted or evaluations completed during the night.

The awareness information presented by these 2 types of notification is classified as aggregate and anonymous (Otjacques *et al.*, 2006), because it provides information about a group (the total number of messages posted or evaluated in a given period) and does not disclose the name of the author of the message or of the evaluation. In this work the objective was to inform the group about its activities as opposed to presenting a partial view of special interest to a learner, such as “your message has been answered” or “your message has been evaluated”.

Acting: The notification tool planned for this cycle was implemented as a client/server service of *AulaNetM*. For the server module a software agent was used that periodically checked the status of the conference and sent the SMS notifications whenever necessary. The agent framework used was Jade, which includes an execution environment and enables the use of agents in mobile devices through the Leap extension package (Caire, 2005). The sending of SMS messages was accomplished through the *Java library Comunika SMS* (Comunika, 2008), supplied by a third-party company hired for distributing SMSs to the recipients’ mobile carriers. In the 2006.1 ITAE edition, 12 students began the course under the coordination of 2 mediators. The services were available in four of the eight ITAE conferences.

The configuration of the parameters to trigger notifications that inform of off-pattern situations was chosen according to the dynamics of the seminar and to patterns verified in previous ITAE editions (Filippo, 2008). SMS notifications on the unfolding of the conference were sent every time five messages were posted in the conference and every time ten messages were evaluated ($M=5$ and $N=10$). Notifications on off-pattern situations were triggered every time five hours of inactivity were detected and when the percentage of non replied messages showed values below

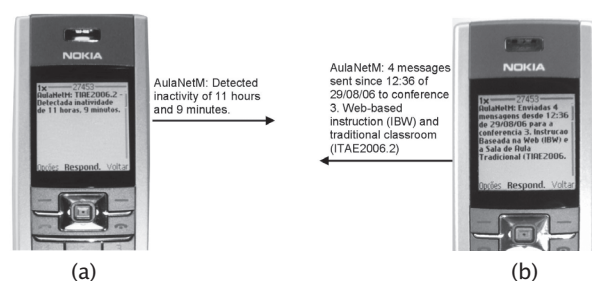


Figure 6. Notifications (a) An off-pattern situation (b) The unfolding of the conference.

20% and above 55%. The remaining notifications were only triggered starting from the second day of the seminar: when learners sent fewer than two or more than five messages and when the number of messages replying to a question had fewer than three or more than ten replies.

Observing: In this cycle of the action research the following data sources were used: survey with learners and mediators on cell phone usage profile, navigation records from *AulaNet* and *AulaNetM*, statement of SMS messages sent supplied by the Phone Company and interviews using open questions. The statement of SMS messages sent supplied by the phone company was used to determine the arrival status and the time elapsed between sending the notification from *AulaNetM* server and its arrival in learners’ and mediators’ cell phones. One of the cell phone carriers does not inform the status of message arrival in customers’ cell phones and another one does not inform so only in some cases.

To evaluate the influence of SMS notifications on the seminars, learner participation was investigated regarding the actions of accessing the conference’s opening page, posting messages and opening messages for reading. It was investigated whether in the four of the eight seminars in which notifications were used these actions occurred more or less times and earlier or later throughout the 50 hours of the conference. Statistical tests Student’s *t*, Mann-Whitney and randomization (Siegel, 1981) were used to indicate significant differences in these parameters.

The interviews were conducted after the eight conferences with the two mediators and the nine learners who had not dropped the course.

Reflecting: In the survey carried out at the beginning of the course, it was verified that 58% of the learners sent and received up to three SMS per month. In a scale of 1 to 5, where 1 was “never” and 5 was “always”, 66% of the learners marked option 5 indicating that the SMS was always welcome.

After the eight seminars the nine learners who did not drop the course received a total of 41 SMS alerts, 27 about the posting of messages and 14 on the publication of message evaluations. On average, ten notifications were

sent per conference, and 76% of them were sent during seminar's 50-hour time period. Of the 432 SMS notifications sent, carriers did not inform the arrival status of 23%. Ten messages (2%) were not delivered, of which nine referred to a learner whose cell phone number had changed. Regarding the remaining 75%, 90% of them arrived at the learners' devices in less than five minutes, 5% arrived in 5 minutes to 1 hour and the remaining 5% arrived within 1 to 17 hours. These delays could be due to either a transmission delay or to the learner's device being turned off. Although the learners received most notifications, the question remains as to whether or not they actually read them. Not having read a notification does not mean that it did not have an effect on the learner, as two of them observed. Ernest commented that, "even without reading it, I knew what it meant 'you have to visit the conference!'".

No statistically significant variation regarding the number of accesses to the conference, the posting or reading of messages or the earlier or later accomplishment of these actions throughout the seminar's fifty-hour duration was observed in the seminars conducted with notifications.

During the interviews, most learners reported that notifications were used as a support to coordination. Based on the notifications these learners could follow the conference's activity without needing to access the environment frequently and without depending on a desktop computer, easing the difficulties "it is impossible to access the environment" and "it is laborious to access the environment". In the interviews, learners revealed that knowing about the unfolding of the seminar through SMS notifications was useful for them to become aware of the activities of other learners and to decide whether it was time for them to take action. A statement that summarized this idea was: "for me SMS alerts were useful as I said before... to signal... that there were already messages I could counterargument to...". SMS notifications also provided the notion of the passage of time and of the proximity of deadlines, as well as the possibility for learners to organize: "You become aware of deadlines", "[the use of SMS] allows you to plan, make inferences and finally conclude that you need to take action" were the comments made by two learners.

The interviews indicated that five of the nine learners changed their routines, accessing the conference after receiving SMS notifications: for one learner, seminar access increased, while five stated that it decreased. In the view of these five learners, the SMS notifications were useful to indicate when the seminar had unfolded and to decrease the situations in which they would check the conference only to find no new messages or evaluations. André commented that: "initially I accessed and it was the same... later you access when you know that somebody

has updated", indicating that the decrease in the number of accesses to the conference did not necessarily mean that information on the course of the seminar had been missed, as some of the accesses prevented would have been unnecessary.

SMS notifications were useful to decrease the work and stress associated with having to access in the environment constantly, but on the other hand they raised "concern", "sadness" or "reflection" when a learner perceived that his colleagues were working and he was not. Three out of nine learners reported some annoyance on receiving notifications with the adopted frequency. Moreover, a curiosity on the part of learners to verify their scores was also observed, and exploited in the following cycle of this action research.

The results obtained in this cycle of the action research with the use of a SMS notification service indicated that mediators were effectively assisted in their seminar coordination work, keeping informed on what was going on and having less need and lower stress to check the conference constantly. The notifications that demanded immediate action such as miscategorized or wrongly chained messages were considered by mediators as being the most useful for their activities. Notifications on messages sent and evaluated, conference inactivity, level of participation of a learner and insufficiently answered questions were useful simply to keep mediators aware of what was taking place in the conference, once these situations did not necessarily demand any action.

Notifications on the non replied message percentage were not well received by mediators: besides this type of notification having been sent too often, it provided information about a conference parameter they were not very familiar with. This type of notifications was also considered not very relevant because the actions they were supposed to trigger were not well defined and could vary according to the context. The problem with the non replied message percentage notification indicates that precise characterization by mediator is important to prevent useless notifications, sub-notifications or over-notifications. When that happens, the notification is ignored. It should be noticed that the configuration of an off-pattern situation becomes difficult to figure out when one is not familiar with associating a certain parameter value with an unusual situation, such as that one regarding non-replied message percentage notifications.

5.5 Cycle 2006.2: SMS notifications on the unfolding of the conference

Planning: Considering the statements of the previous cycle's learners regarding their curiosity in having

information on the evaluations of their messages, it was decided for this cycle of the action research to increase the number of notifications on the evaluations published during the seminar's fifty-hour length. In the four seminars of the previous cycle, only 2 of the 14 notifications sent within these 50 hours provided information on the publication of new evaluations.

The investigation about the availability to mediators of graphs, charts and notifications through PDAs was discontinued, as in the previous cycle it was observed that the use of PDAs as a means of support to coordination was premature for the needs of the 2 ITAE mediators.

Acting: To perform the investigation planned for this cycle of the action research the notification triggering parameters were reconfigured: notifications about the unfolding of the conference were triggered every four messages posted and every four evaluations published. The notifications on the non replied message percentage were triggered when it was lower than 20% and higher than 70%, potentially decreasing the number of times this notification was sent. Another alteration was that notifications regarding situations outside the usual pattern were sent to the mediators during the 4 first conferences, when, according to a mediator, learners were still learning about the dynamics of the seminar and provoked more situations that demanded the mediators' attention.

Observing: In this cycle the same data sources of the previous cycle were used. From this cycle onwards, one of the authors of this research started acting as 1 of the 2 course mediators, making her own notes and receiving spontaneous comments from participants throughout the course via AulaNet communication services. The 7 learners who reached the end of the 8 conferences were interviewed.

Reflecting: In the survey conducted at the beginning of the course, it was verified that from the course's seven learners, 71% received 1 SMS message a day and 57% sent more than 1 SMS message a day. In a scale of 1 to 5 where 1 corresponded to "never" and 5 to "always", 71% of learners gave it a score of 5 indicating that SMSs were always welcome.

The seven learners who completed the eight seminars of the 2006.2 ITAE edition received a total of 33 notifications, 21 (81%) regarding message postings and 12 (19%) regarding the publication of message evaluations. The number of notifications on the publication of evaluations sent during the 50 seminar hours increased as planned, from 9% to 40% of the total number of notifications received. The number of notifications sent during the seminar increased from 56% to 76%. Five out of seven learners were curious about the evaluation of their messages, and three of them reported having check conferences to see their grades.

In this cycle, situations similar to those investigated in the previous cycle were observed. For the learners of the two editions who approved the service, the notifications offered them support to follow and participate in the seminar according to the information received. The use of notifications kept the learners informed even when away from the Internet, easing the difficulty "it is impossible to access the environment", and prevented the need to access to the conference too frequently; easing the difficulty "it is laborious to access the environment". It was again observed that besides being laborious to check the conference frequently, in the absence of new messages or evaluations such accesses are often unnecessary and "inconvenient". Similarly to what happened in the previous cycle, three learners reported some annoyance created by the service; and in both editions two learners inferred the notification content solely from its arrival.

In cycle 2006.2 it was observed that learners in seminars with SMS accessed to the conference's opening page on average 16% earlier than in seminars without SMS, an indication that the notifications had an influence on their participation. A variation in the number of accesses to the conference and of message postings and readings was not verified, nor was it verified that message postings and readings occurred earlier or later in the conference. In the investigation conducted with *iTree*, which provides information on learner participation in forums through cell phones' wallpapers, a significant difference regarding forum consultation actions was also observed (Nakahara *et al.*, 2005). Regarding the number of messages posted the two pieces of research showed no significant variation. It was not mentioned that the *iTree* forum's messages had been evaluated, a fact that confers to the activity a different dynamics from that at the ITAE seminars.

In relation to the mediation work, both mediators confirmed the results of the previous cycle: the notifications that enabled immediate action were the most relevant for mediators whereas the others were useful mainly to follow the development of the discussion.

5.6 Cycle 2007.1: Popup window notifications on participants' movement

Planing: For the success of a collaborative system, besides awareness information directed towards activities carried out in a shared real or virtual object ("task-oriented" awareness), awareness information regarding people who are in the environment ("social" awareness) must also be present (Prinz, 1999). In this cycle, the objective was to expose the movement that takes place in the environment when participants access *AulaNet's* different services. Knowing in which services participants are working enables

inferences regarding what is happening (Erickson *et al.*, 2002); for example, if somebody accesses the Conference service, this person can be about to post a message; if the person accesses the Debate service, he can be trying to establish contact with someone.

The development of *AulaNet* Companion (ANC), a notification service that can be used even when participants are not connected to *AulaNet*, was planned. Using ANC, participants are aware of what is going on without making the effort to check the ITAE course on the web (difficulty: “it is laborious to access the environment”). The notifications are presented in popup windows on the screen’s corner and inform how many participants have connected to the course or accessed a certain service in the previous minute. Every notification is presented in the form “N participant(s) have accessed the *ServiceName* service”. To preserve privacy, the participant’s name does not appear in the notification, but it is possible to check who is connected to the environment through a feature in *AulaNet*. This awareness information is classified as aggregate and anonymous, as it refers to a group (the number of participants that have accessed the service and not each individual) and does not disclose the participants’ names (Otjacques *et al.*, 2006). The investigation on the use of SMS notifications was suspended to prevent conflict with the ANC investigation, which took place within this and in the next cycle.

Acting: The ANC was implemented as a client/server service. The client, which is initiated at Windows logon, presents a 10-second notification in a popup window informing the movement of participants in the previous minute (Figure 7). ANC was made available to two mediators and eight learners of ITAE’s 2007.1 edition. The notifications were available in four of the eight seminar weeks.

Observing: The navigation records of *AulaNet* participants, the records of notifications they received, interviews using open questions and spontaneous remarks made through the *AulaNet* communication services were used as data sources. The interviews of two of the eight learners were disregarded, since for operational reasons they did not use ANC.

Reflecting: The six learners who used the service received an average of 460.2 notifications in four weeks (standard deviation = 329.6). A statistically significant variation in the actions of learners was not observed regarding the number of accesses to the forum’s opening page, the posting and the opening of messages for reading, nor in the earlier or later accomplishment of these actions throughout the seminar’s duration.

The interviews indicated that the main use of ANC for four of the six learners was to be reminded of the course and of the activities to be performed. As the notification texts did not mention the activities learners must perform, these results indicate that the notifications themselves had greater influence than their content. ANC enabled three of the six learners to infer when new messages would be posted in the seminar and to act accessing the conferences to fetch those messages. There was no evidence that the communication among learners was influenced by the notifications. The mediator who acted directly attending to learners’ requests used the service to follow the actions and habits of learners and to infer when new messages would arrive; the other mediator, who acted on the background, did not consider the notifications useful and turned off the service as he felt annoyed by ANC’s interruptions. The suggestions presented included the detailing of notifications, especially regarding participant identification, the sending of notifications about message postings and the possibility for participants to communicate through ANC as a messenger. The availability of a mechanism that enables direct participant action in the course after receiving a notification was also a functionality identified as desirable by both mediators and two learners.

5.7 Cycle 2007.2: Action notifications on participant movement and on message postings and evaluations

Planning: The suggestions proposed in the previous cycle were considered worthy of investigation and served as a starting point for the planning of this cycle. Thus, it was



Figure 7. Snapshot of an ANC notification.

investigated the use of notifications of the individual (not aggregate) and identified types (Otjacques *et al.*, 2006) as per participants' request that notifications be more detailed: the names of participants were identified and, in the case of the Conferences, Lessons and Documentation services, the notification informed which conference, lesson or specific document was being accessed. Notifications were also included informing when a message was posted by learners, evaluated by mediators or sent through the Mail to Participant or Mail to Group services. Additionally, the original ANC concept was reformulated to transform it into a service that offered notification sending and access to the environment simultaneously. Thus two new functionalities were introduced: the "action notification" and the "services menu" (Figure 8).

Through the action notification a participant can perform an action in the environment. An action is the access to the course's opening page, or to an *AulaNet* service or content page. The action is initiated by clicking a link or button in the notification window. Upon receiving the notification the participant self organizes by deciding either to ignore the information, not to act, to wait before acting, or to act. The action to be performed can be a communication, coordination or cooperation action. For instance, if a learner joins the Debate service (chat) because he received a notification that somebody has joined that service, this is a communication action; if he joins the Follow-up Report service to check his average score after being notified that his message has been evaluated, this is a coordination action; and if he joins the Tasks service to work in a task after being notified that a colleague had accessed the same task, this is a cooperation action.

The services menu, called up by clicking the ANC icon in the toolbar, also enables the participant to open an *AulaNet* service directly without having to open a browser. The service menu was introduced so that direct access to the environment is not restricted to the few seconds when the popup notification window is open.

Acting: For this cycle the services menu was implemented and links and buttons were added to ANC's popup window. ANC was available in an alternate frequency: two weeks on, two weeks off, and so on. In the two first weeks with the ANC service sixteen different types of notifications were sent. In the two other conferences carried out with ANC the eight types of notifications that received most votes from learners were sent. Two mediators and twelve learners took part in 2007.2 ITAE edition.

Observing: In this cycle three other sources of data were added: the record of each click on notification links and on services menu items, a questionnaire for voting on preferred notifications and a chat debate on the use of notifications.

Reflecting: Learners approved the possibility of accessing the *AulaNet* environment through the action notification and the services menu to reach the desired page directly. Access to the environment was generally not accomplished through the action notification, as learners either did not have enough time to click the links or opted for not interrupting what they were doing. On the other hand the services menu proved to be a functionality that contributed to the adoption of ANC, being the predominant form of access for 4 out of 9 learners who used ANC. By enabling actions in *AulaNet*, the introduction of the action notifications and of the services menu conferred a new dynamics to the use of ANC. Gil reported that during the period without ANC "the process of interacting with the course was much more bothersome" and 2 learners reported that there were occasions in which they forgot the *AulaNet* URL address because they often accessed the environment through the service menu. The number of notifications received and accesses to *AulaNet* is presented in Figure 9.

Of the twelve learners, one did not use the service because of its inconvenience (Lauro). Two others (Flávio and Emilio) reported during the interview having used ANC very little, both on account of not being able to install ANC at work and of sporadic home computer usage (Emilio, who received 1091 notifications, left his computer

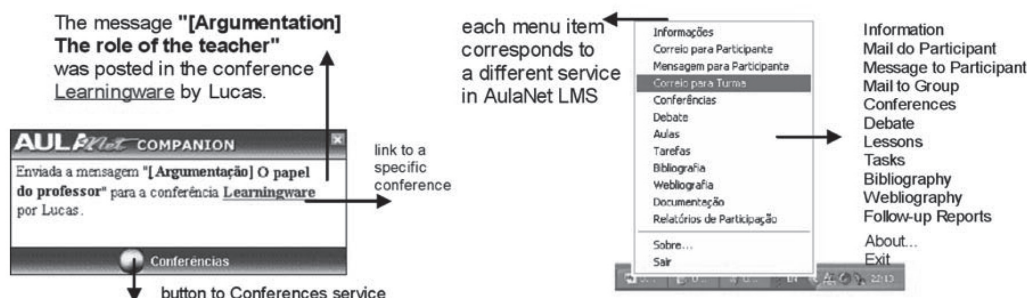


Figure 8. Snapshot of an ANC notification and the ANC services menu.

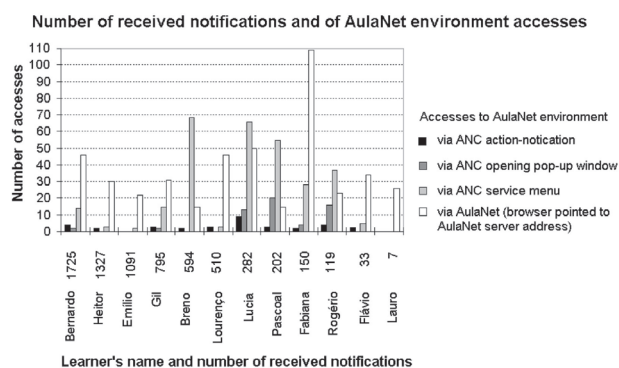


Figure 9. Chart showing the number of notifications received and accesses to the course through both AulaNet and AulaNet Companion.

on permanently, but worked out of town during the week and did not see these notifications). The data on these 3 learners were not considered.

Of the nine learners who used ANC, six had it always on and received an average of 550 notifications in the 4 weeks (standard deviation = 273). The other three (Rogério, Pascoal and Lucia) received an average of 201 notifications (standard deviation = 82) using ANC in a similar fashion. They turned ANC on and off according to their interest in using it and accessed ANC through the services menu more often than through AulaNet. Moreover, these were the learners who made the most accesses to the environment through the popup window presented when

Table 2. Vote result of learners' preferences regarding notifications.

Learners' Vote Result notifications ordered by preference (8 - highest preference; 0 - lowest preference)		
Average of votes among the 8 types of the most voted notifications	5,8	1. Message M evaluated in conference C
	5,2	2. Message M sent to conference C by participant P
	4,4	3. Message M sent to Mail to Group service by participant P
	3,5	4. Conference C was accessed by participant P
	3,2	5. Message M sent to Mail to Participant by participant P
	3,2	6. Debate service was accessed by participant P
	1,9	7. ITAE course was accessed by participant P
	1,7	8. Mail to Group service was accessed by participant P
M, C, D, L – respectively message title, conference, documentation, lesson P – participant name Mail to Participant – one recipient only e-mail service Message to Participant – instant message service		

ANC opened (87% of the 56 accesses): this window featured a button taking the user to the opening page of the ITAE course. As per Pascoal's comment, when ANC initiated he clicked the link to access the ITAE course and then always kept the browser open in one of the course's services. Access to *AulaNet* services through the services menu was carried out 290 times by the nine learners, 88% of which by five learners. The action notifications were clicked 30 times by the nine learners, nine of them (30%) by a single learner.

The vote results regarding the 8 types of notifications to be kept in the last 2 weeks of the course, also reflected in the interviews and in the informal comments, indicate the learners' interest in information regarding their scores, conference-related events (message postings and conference accesses), presence of participants in the course (when participants logged on) and events in the communication services used in ITAE for both coordination and communication purposes (Table 2). These notifications indicate to learners' possible new actions such as reading and replying to a new message and making contact with a participant who has connected to the environment or demonstrated to be available to chat by accessing a communication service.

Four of the nine learners who used the service explicitly stated that ANC enabled them to keep informed on the unfolding of the seminar and on people accessing the environment without the need to connect to *AulaNet*, thus demonstrating that their effort to access the environment was made easier (difficulty: "it is laborious to access the environment"). Eight of the nine learners mentioned having planned, accessed the environment and interacted with their colleagues because of these notifications. In the seminars conducted with notifications a statistically significant variation in the actions of learners was not observed regarding the number of accesses to the forum's opening page, the posting of messages and the opening of messages for reading, nor in the earlier or later accomplishment of these actions throughout the seminar's 50-hour duration.

An interest on the part of learners in knowing when mediators were present in the environment was also identified; 3 learners explicitly reported that used ANC to wait for the mediator logon. ANC was useful for the support to the coordination of the 3 mediators, especially for the mediator who acted directly attending to learners' requests. For this mediator, access to the environment took place according to the notifications received, enabling him to act promptly without having the work of checking *AulaNet* frequently. Two learners commented on the swiftness of the mediator's services. One of these affirmed that "someone seemed to be there exclusively to reply to me..."

In this cycle of the action research there was no demand for more detailing of the messages, indicating

that participants were satisfied with notifications presented in an identified, not aggregate form. Participants did not report problems regarding privacy and the annoyance reported by three participants decreased in the two weeks when only the eight best voted notifications were sent.

6 Conclusion

This work presents an action research that investigates the availability of tools in collaborative systems for providing support to learners and mediators in the coordination of discussion forums. This investigation focused on the development of coordination support tools that enable learners and mediators of ITAE to follow the forum's unfolding without being restricted to the use of a browser in a desktop computer. In the case of mediators, summarized information was also made available to assist them in evaluating the unfolding of the discussion. In this context, 3 types of tools were investigated which make available forum information in the form of graphs, charts and text notifications through PDAs, cell phones and desktop-resident client programs. After six cycles of action research conducted with four mediators and four cycles conducted with 37 learners, indications were found that the different tools investigated in this research enabled course participants to keep informed on the conference regardless of being connected to the AulaNet's desktop version and get coordinated based on the information received.

A possible line of investigation based on this work would refer to the improvement of forum coordination support tools already developed such as the use of graphics in PDAs. The availability of different types of notifications, such as reminders about deadlines, must also be investigated. New cycles of action research can also investigate the use of links in action notifications to trigger communication through instant messaging or through the use of notifications in which participants configure individually those they wish to receive. Another line of inquiry is the reproduction of these cycles in discussion forums whose dynamics is different from that of the ITAE course seminar; for example, in discussion forums where learners do not have their messages graded.

This work has contributed with reflections on the introduction and use of the tools proposed by studying the results obtained in a real environment. Since it is an investigation made on a particular problem in a specific context, the concept of "transferability" is appropriate in the action research context (Herr and Anderson, 2005); within such concept, the knowledge obtained through a piece of research is not generalized, but transferred from a "sending" to a "receiving" context. Transferability takes place when the reader of the research identifies that the problem and

the environment researched are similar to those where he researches, works, lives or is acquainted with, and that the actions and results of the research can be applied to them as well. These results may also be used as a source of data in studies that, by comparing them to similar investigations in similar contexts, identify, compile or define tools to be included in a groupware by software developers.

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