Communication and Collaboration Towards Problem Solving: Evaluation of PILS

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Abstract. In most e-learning scenarios the effective and efficient communication between teachers and students as well as among students is essential for the learning progress of the students. Support for mutual online presence information and spontaneous online communication has the potential to facilitate that. However, such support also entails challenges when too many disruptions occur and hinder the learning progress. This paper tackles the first step of the issue of adding collaboration to an adaptive learning environment. The EU project Adaptive Learning Spaces (ALS) has the vision of joining regular Learning Management Systems with adaptation and cooperation support. This paper introduces the ALS overall vision and the Presence in Learning Spaces (PILS) instant messaging support. Moreover, it reports on the results of the base study that is to be compared later on with the adaptive collaboration support.

Keywords: collaboration, learning, LMS, collaborative learning, PILS.

1 Introduction

The importance of instant messaging for spontaneous online communication that is facilitated through background information on the online users' availability is well-known and has been explored for some years now [13]. Despite this mutual information, users face the challenge of disruption [12]. Disruption is particularly problematic in a learning task since learning is a process where a clear focus is needed, as it is reported by Rosenberg in [14].

On the other hand, collaborative learning, in the context of Learning Management Systems (LMSs), is becoming an important factor in the e-Learning process. LMSs such as Sakai[1] allow various forms of collaboration between students; nevertheless, LMSs lack adaptation and personalization facilities for collaborative learning [6].

[1] http://sakaiproject.org/

This paper showcases some of the tools selected to work together within the ALS EU project [2], in order to research the possibility of allowing students the best of three different worlds: (1) the current e-learning world, based on LMS systems, with bountiful collaborative channels, but no or little adaptation based on the students' interaction; (2) the personalization and adaptive hypermedia world, allowing for a variety of options and reactive environments built to respond to the student's various needs, interests, goals, preference, learning styles, etc.; and (3) the online communication research world, gathering the best ways to collect data from students' activities and channel it back into the learning process.

The remainder of this paper is organized as follows. First, the ALS EU project concept and implementation is introduced in section 2, in terms of the main goals, the overall learning scenario, and the ALS system overview. Next, in section 3, the main system evaluated here is presented, PILS. PILS is an ALS component as well as an independent system, ensuring the adaptive collaboration tool supply for the ALS project and beyond. Section 4 presents in details the evaluation of the PILS system with a group of students in Computer Science in Romania, as the base study to compare with the upcoming version with more advanced features and connection to the other ALS components. PILS already offered a number of novel features specially tuned for adaptation needs and ALS, and this study focuses on determining their perceived usefulness. Next, section 5 discusses the specific lessons learned to be used from our evaluation for the benefit of the ALS project. Section 6 discusses related work, to put this work in a larger context, and finally, section 7 draws conclusions.

2 ALS Vision and Implementation

The Adaptive Learning Spaces (ALS) system is a flexible and innovative e-learning platform supporting adaptivity on the single-user and group level, built as a result of the ALS EU project with the same name.

2.1 The ALS Project Goals

The goal of the ALS project is to develop advanced concepts and technologies through which lack of (or limited amounts of) face-to-face contact between instructors and learners, as well as amongst learners in current state of the art e-learning environments can be partially compensated for. To achieve this, ALS works towards: (a) widening the range of, as well as increasing the amount of, guidance and support that open and distant learning systems can provide to learners and instructors; and (b) providing novel means to support the social cohesion of groups of learners, as well as the engagement of their members in collaborative tasks and processes.

This is, generally speaking, achieved by developing, field-testing and making openly available a software infrastructure that builds upon and goes beyond the state-of-the-art in the fields of e-learning and adaptive hypermedia systems, to support the creation of active, personalised learning spaces, that is hoped to have a clear focus on

[2] http://www.als-project.org/

learning activities, treating learners as active members of, and contributors to, their learning environments, rather than as passive recipients of their contents.

2.2 The ALS Overall Learning Scenario

In the following, an overall learning scenario is presented, highlighting the envisioned overall features of the ALS composite system.

A learner, say John, in ALS, accesses everything via a familiar environment—that is, a regular LMS. In ALS this system is the Sakai LMS, chosen after a careful comparison of available LMS (Blackboard[3], Moodle[4], Sakai[5], etc., in total 18 systems [10]). John enters Sakai and accesses a lesson, and thus transparently (for him) accesses a lesson on 'Learning XPath' in the adaptive, personalized AHA! System [4] (an adaptive engine chosen for its flexibility in enabling all kinds of adaptation). The lesson will be customized based on various data on the preferences known of John. For instance, the system knows that John prefers audio lessons and pictures, thus filtering verbose text and showing him the equivalent information in visual form. The system also knows that John is a beginner in XPath, as it is the first time he has been studying this subject. Therefore the system only shows introductory materials to John, filtering out difficult contents for later viewing. John can continue learn all by himself in this system, but, if he finds himself in difficulty, he can also request the help of his peers or an expert in the field. He can communicate with these peers in the same Sakai environment, where he has (transparent) access to the PILS communication tools (text, audio, video). PILS has been built within the ALS project to comply with the specific requirements for adaptive collaboration. Unlike other communication systems, PILS allows John to specify his exact communication status for the current course. In John's case, it is 'RequiringHelp'. He sets this in the course tab 'Learning XML'. He searches for peers or experts who are available (i.e., who have the online state 'ReadyToHelp' in the PILS system). He finds expert Mary who can help him along with his problems and questions.

Later on John also accesses the other course he is studying, 'Learning XML'. Here, he is an advanced student. He has now some time, thus he selects the course tab 'Learning XML' and sets his status for this course as being 'ReadyToHelp'. Sure enough, soon his colleague Mark contacts him asking for some help with his XML homework.

2.3 The ALS System Overview

As mentioned above, the ALS Project is focusing on delivering adaptive hypermedia [5] to groups/teams of learners by integrating adaptive tools such as: AHA! [4] for adaptive delivery; MOT [3] for adaptation authoring; and PILS (see section 3) for adaptive communication, into a popular Learning Management System (LMS) such as Sakai. **Fig. 1** shows the overall software architecture of the ALS system.

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[3] http://www.blackboard.com/
[4] http://moodle.org/
[5] http://sakaiproject.org/

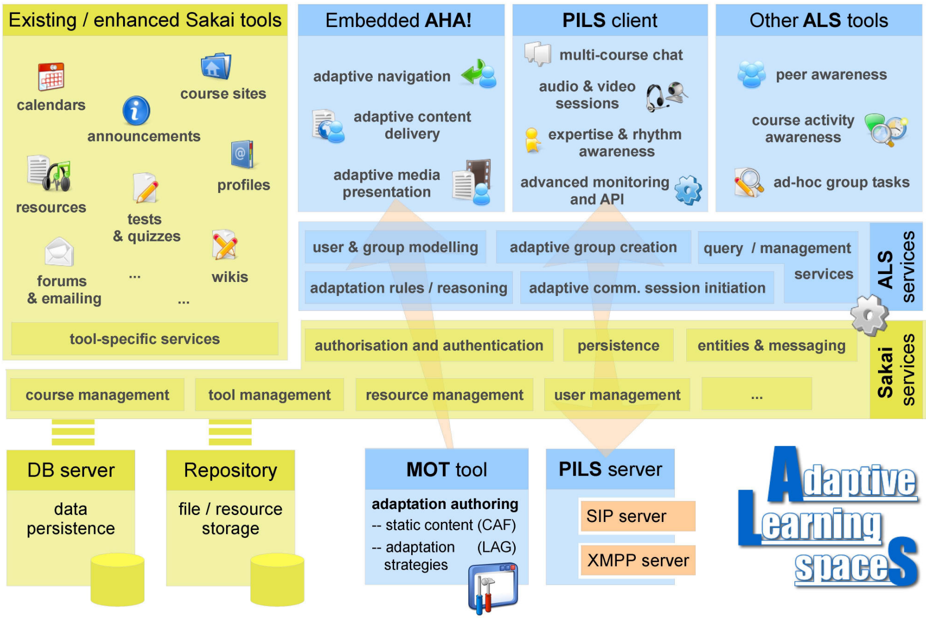

Fig. 1. ALS system architecture.

Fig. 1 illustrates the general structure of the ALS system architecture. The main component is Sakai, which consists of major tools (e.g., calendars, assessments, forums); next to it, there is an embedded instance of AHA! (enabling adaptive navigation, adaptive content delivery, and adaptive media presentation); additionally, there is a PILS client (comprising multi-course chat, audio and video sessions, expertise and rhythm awareness, and advanced monitoring and API); finally, additional ALS tools are added (e.g., for supporting peer awareness, course activity awareness, and ad-hoc group tasks). All these are communicating via and supported by ALS services (to handle all requests between ALS components). The ALS services include query services, user and group modelling, adaptation rules, session initiations. Moreover, Sakai services support the overall ALS system structure. Additionally, the authoring tool MOT is connected to the system via the use of converters [7], as well as directly communicates with the AHA! delivery platform, and it offers the authoring facilities for both static content and adaptation strategies.

3 PILS System Architecture

The *Presence In Learning Spaces* (PILS) component of the ALS System provides online teachers and learners with functionality for coordination and communication. The *coordination* is supported by mutual information of the teachers and learners about each others' presence and availability. The *mutual information* is provided by online states providing information about users' availability, and by communication states providing information about users' occupation.

Users can set their ***online states***. These online states combine well established online states from instant messaging such as *Available*, *Unavailable*, *Away*, and *Invisible* with novel online states such as *ReadyToHelp* and *RequiringHelp*. The online states have the following meaning:

1. *Available*: user is online and ready for online communication.
2. *Unavailable*: user is online and not ready for online communication.
3. *ReadyToHelp*: user is online and has knowledge and experience that she is willing to share on the current course.
4. *RequiringHelp*: user is online and has open questions where she would appreciate to get help from others about the current course.
5. *Away*: user is online and has left the computer (typically for a short time such as for a coffee break).
6. *Invisible*: user is online and does not want to be seen by others. Additionally, the conversation state indicates to users if other online users are currently in a conversation, and which communication channel (text, audio, video) they are currently using.

Furthermore, the ***communication states*** inform users about the other online users' communication activity — that is, they can see if others have one of the following communication states: *idle* (currently not in online conversation), *text* (currently in a text conversation), *audio* (currently in an audio conversation), or *video* (currently in a video conversation). These communication states are captured and displayed by the system automatically.

Both, the online states and the communication states, are course-specific—that is, online users can see the availability and communication occupation of other online users per course. So, it is easier for the contacter to decide if the contactee is available and ready for communication in the respective course.

The communication is supported via *text chat* (exchange of text messages among two or more users), *audio chat* (synchronous audio communication among pairs of users, where each user can have one or more conversations at a time), and *video chat* (synchronous audio and video communication among pairs of users, where each user can have one conversation at a time).

Fig. 2 shows a typical screen of a user of PILS, user Martin, with a text chat between Martin and Andreas on the top left; also, a video chat between Martin and Andreas (bottom left, with Martin in the left video and Andreas in the right video); and the PILS main window on the right showing in the top table tabs for the courses CSCW and PILS_Demo. Here, PILS_Demo is active, indicating that Andreas is the only online user in the conversation (via text and video chat) and the other users are idle and the bottom table, showing the two courses of Martin CSCW and PILS_Demo (here Martin can change his own online state).

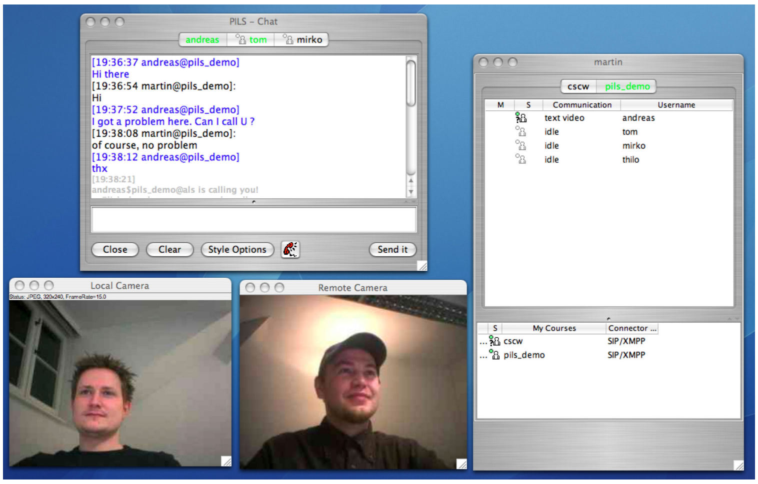

Fig. 2. PILS screenshot.

4 Evaluation of PILS

The evaluation of PILS was achieved by preparing a case study (section 4.1), defining a set of hypotheses (section 4.2), experimental setup (section 4.3), followed by a *questionnaire* (see the Annex) to evaluate the case study, and finally providing *quantitative* (section 4.4) and *qualitative* (section 4.5) analyses for the obtained results.

4.1 General description of the PILS Case Study

Case studies are the main evaluation methods of the ALS system within the ALS project. They are used to field test the system components. In particular, the overall aim of the PILS case study is to explore the quality of *sensor data* and their *suitability for adaptivity* in ALS components. This case study has the following setup elements: (1) students are participating in an online course; and (2) students communicating between each other, and with domain experts, about a course subject, by using PILS. Moreover, the measures and the criteria of this case study were determined initially to be: usability of visualization of states, accuracy of states, successful communication and collaboration of recommended vs. non-recommended partners, perception of monitoring facilities.

These overall aims for the case study were refined into a set of hypotheses, as shown in the following.

4.2 Hypotheses of PILS

The overall motivation for the PILS component is the assumption that the coordination and communication support will increase the learners' effectiveness, efficiency, and satisfaction in the learning process.

Thus, the Null-hypothesis that we are trying to refute is:

H0: *the availability of online states does not influence the learning outcome.*

The counter-hypotheses to refute H0 are:

H1a: the availability of the online state **ReadyToHelp** increases the learning **outcome** (for the learner who needs help and can easier find experts).

H1b: the availability of the online state **ReadyToHelp** decreases the learning **effort** (time for the learner who needs help and can easier find experts).

H1c: the availability of the online state **ReadyToHelp** increases the **satisfaction** (for the learner who needs help and can easier find experts).

H1d: the availability of the online state **ReadyToHelp** increases the **speed** (for the learner who needs help and can faster find experts).

H2a: the availability of the online state **RequiringHelp** increases the learning **outcome** (for the learner who needs help and is contacted by experts).

H2b: the availability of the online state **RequiringHelp** decreases the learning **effort** (time for the learner who needs help and is contacted by experts).

H2c: the availability of the online state **RequiringHelp** increases the **satisfaction** (for the learner who needs help and is contacted by experts).

H2d: the availability of the online state **RequiringHelp** increases the **speed** (for the learner who needs help and is faster contacted by experts).

H3a: the availability of the **communication states** increases the communication **efficiency** (in terms of speed of learning).

H4a: the use of online **communication** (independently of the communication channel) increases the **learning outcome** (for the learner who needs help)

H4b: the use of online **communication** (independently of the communication channel) decreases the learning **effort** (time for the learner who needs help and is contacted by experts)

H4c: the use of online **communication** (independently of the communication channel) increases the **satisfaction** (for the learner who needs help and is contacted by experts)

4.3 Experimental Setup

In order to evaluate the hypotheses as outlined above, we have extended the initial experimental setup and instantiated it as follows. In the experimental scenario, a group of 23 third year students of a 'Web Programming' course at the Politehnica University of Bucharest, Romania, evaluated PILS. The evaluation features were as follows:

1. The students were all participating in *two online lessons*: 'Learning XML', and 'Learning XPath'. These lessons were actual parts of the 'Web Programming' course that they were following, and students were expected

to learn this material by the end of the term, when they would be examined via project work.

2. For the evaluation purposes, *students were allocated three different roles* in these courses: beginner, intermediate, and advanced (or expert) users as it is shown in **Fig. 3**. As in reality the participants all were beginners in both subjects, we actually allowed those participants that were allocated the roles of intermediate and advanced to have access to extra information on that particular subject. For intermediate users this extra information was specific for the various students, with some overlaps as well as some gaps between the individual intermediate users. The experts were given access to the complete knowledge on the subject needed for the test exercise. The role of experts was given to only a small number of students. Moreover, experts were kept busy with other tasks—in particular, with the task of taking the test as a beginner student for the complementary course (cf. **Fig. 3**). Therefore, overall, we simulated a realistic situation of students with various levels of knowledge. Thus we obtained a realistic spread of knowledge and could simulate expertise, without having to actually bring students of the corresponding knowledge levels.
3. All students who were allocated roles of beginner and intermediate for a given lesson were also asked to *answer a set of questions* on that lesson. They were allowed to answer these questions based on their own knowledge, based on searching the previous lecture materials (which didn't cover all the material asked in the questions), or ask other peers or the experts (who had access to knowledge covering all questions). This was in order to encourage them to search for knowledge and allow for a realistic problem solving behaviour.
4. All students had *access to the PILS communication tool*, and were logged in for the two lessons, 'Learning XML', and 'Learning XPath'. This means that they could both set their own online state for the two lessons (to any of: *Available*, *Unavailable*, *Away*, *Invisible* as well as the novel online states *ReadyToHelp* and *RequiringHelp*) as well as view the states of all the other students in their class, with their different roles. Before starting the learning and test answering process, we asked all students to declare a current state correspondent to their role for the two lessons available (e.g., for experts that are available an appropriate state is *ReadyToHelp*; for students looking for information, an appropriate state is *RequiringHelp*).
5. After the learning process and the handing of the test papers, the students were asked to complete a *post-session questionnaire*. The questions (as shown in the ANNEX) were designed in such a way that they match one or more hypotheses. The mapping between questions and hypotheses is shown in Table 1 below.

Other characteristics of our experiment were that the learners involved knew each other. For simplification, we only used the text chat channel, as we performed this experiment in a classroom environment, and having audio would have interfered with the experiment. By using text we could simulate a remote online environment, even if students were in fact sitting in the same classroom.

Since PILS is intended to be used as a complementary tool besides the primary learning task, it is vital that in the scenario the learners have a primary task. This primary task should be a learning task. Since the other components of the ALS system were not integrated at the time of the experiment within the Sakai system, the learners were given another learning task, the problem-solving task with access to online course material, as explain in point 3 above.

Based on their own status and the online status of their peers, the students started to communicate and exchange information about the lessons.

In the following, we show the results of the quantitative and qualitative analyses of the questionnaires, respectively.

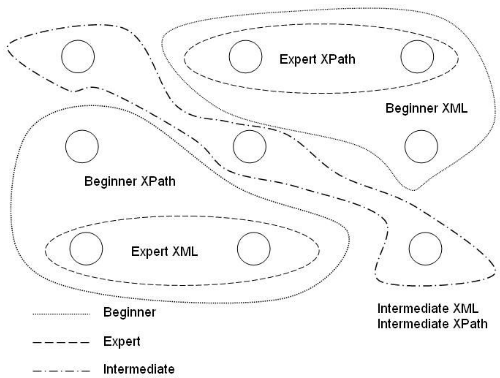

Fig. 3. Experimental setup: allocation of beginner, intermediate, advanced role for user groups.

4.4 Quantitative Analysis of the Hypotheses

We prepared an obligatory questionnaire based on our hypotheses, in which we asked five questions about PILS (see the ANNEX). We chose the One-Sample T-Test to analyze our results, because we had to compare a sample mean to a hypothesized value. The One-Sample T-test procedure allows to: 1) Test the difference between a sample mean and a known or hypothesized value; 2) Specify the level of confidence for the difference; 3) Produce a table of descriptive statistics for each test variable. This test assumes that the data are normally distributed; however, this test is fairly robust to departures from normality.

Tab. 1 illustrates the validation or refuting of the hypotheses as described in section 4.2. The first column refers to the mapping between the questionnaire questions and the hypotheses (e.g., 'Q1 H4a' means the hypothesis H4a is tested by question 1; cf. ANNEX for more information). The *t* column displays the observed t statistic for each sample (calculated as the ratio of the mean difference divided by the standard error of the sample mean). The *df* column displays the degrees of freedom for each question (here, this equals the number of students in each group minus 1). The column labelled *Sig. (2-tailed)* displays a probability from the *t* distribution with 22 degrees of freedom. The value listed is the probability of obtaining an absolute value greater than or equal to the observed *t* statistic, if the difference between the sample mean and the test value is purely random. In other words, if this probability is lower than .05, the hypothesis corresponding to the question is confirmed.

Tab. 1. Hypotheses results.

Test Value = 0; 95% Confidence				
Question versus Hypothesis	***t***	***df***	***Sig. (2-tailed)***	***Result***
Q1_H4a	5.254	22	.000	**Confirmed**
Q1_H4c	2.577	22	.017	**Confirmed**
Q1_H4b	2.336	22	.029	**Confirmed**
Q2_H4c	3.725	22	.001	**Confirmed**
Q3_H3a	3.867	22	.001	**Confirmed**
Q4_H1c	3.425	22	.002	**Confirmed**
Q4_H1b	1.553	22	.135	Not confirmed
Q4_H1d	.624	22	.539	Not confirmed
Q5_H2c	2.912	22	.008	**Confirmed**
Q5_H2b	4.114	22	.000	**Confirmed**
Q5_H2d	4.114	22	.000	**Confirmed**

Consequently, the hypotheses H1c, H2b, H2c, H2d, H3a, H4a, H4b and H4c are confirmed. Thus, we can conclude, based on the above, that '**H0**: *the availability of online states does not influence the learning outcome'* is refuted. Moreover, the use of online communication (independently of the communication channel) increases the learning outcome (for the learner who needs help) (as H4a is validated); the use of online communication (independently of the communication channel) increases the satisfaction (for the learner who needs help and is contacted by experts) (as H4c is validated); the availability of the communication state increases the communication efficiency (in terms of speed of learning) (as H3a is validated); the availability of the online states **RequiringHelp** increases the satisfaction (for the learner who needs help and is contacted by experts) (as H2c is validated); the availability of the online states **RequiringHelp** decreases the learning effort (time for the learner who needs help and is contacted by experts) (as H2b is validated); the availability of the online states **RequiringHelp** increases the speed (for the learner who needs help and is faster contacted by experts) (as H2d is validated).

Hypotheses '**H1b**: the availability of the online states **ReadyToHelp** decreases the learning **effort** (time for the learner who needs help and can easier find experts)' and '**H1d**: the availability of the online states **ReadyToHelp** increases the **speed** (for the learner who needs help and can faster find experts)' were not confirmed, as the respective probabilities were not below the .05 threshold. These are probably not confirmed because of the realistic situation we have simulated, where experts were a rare commodity, and, as the qualitative analysis that follows shows, students felt that accessing an expert was time-consuming.

4.5 Qualitative Analysis of the Hypotheses

The questionnaire asked for a rationale for each question, where the students were requested to explain their answers. Analyzing the qualitative feedback from the experiments, the result shows that the PILS system is basically understood, easy to use, and useful. The most common mentioned advantages of the PILS system are: the status **ReadyToHelp** is useful to determine who can help, and is easy to use. A few limitations of PILS were identified such as: students with the **ReadyToHelp** status were overloaded with questions from other students. Experts were extremely high on demand, and students only reluctantly communicated with other peers of intermediate knowledge, who might (or might not) have been able to help them with their tests. A sample feedback from one of the students is shown below:

"Overall, it might increase results or decrease them, it depends. It is useful to communicate once you've already accumulated knowledge, and want to clarify some points or have some questions and are looking for answers to those questions. It is useful also to obtain information from colleagues, and it might increase test results. However, it cannot substitute individual study. Without knowing some things, the knowledge obtained through online communication can only be superficial and offer the student the impression of having understood. Also, because the student knows he can ask for help, he will be more likely to do that, even in cases when — if he does his best — he could find answers to the questions or problems he doesn't know."

This shows that the students saw the value of PILS as such, although they correctly noticed that other channels are necessary as well.

5 Discussion

Overall, the students were able to use the PILS communication system in parallel with accessing course content, and solving a given problem. Various aspects of the PILS system were analysed and evaluated via the evaluation experiment that we designed. The new features that were introduced, such as the two online states 'ReadyToHelp' and 'RequestingHelp', as well as the facility of monitor and specify online states for different courses via the same tool were specifically targeted in the questions to the students. For this reason, we had two lessons represented, to show students that they can move between the two tabs and visualize their peers' status for each of the lessons, as well as set their own. Also, for this reason, students were allocated different roles, such as beginner, intermediate and expert, and thus experienced the new states introduced by PILS.

As previously explained, this experiment is the base-line experiment, to be used in comparison with the one where students use PILS within the fully integrated ALS system. By not having yet the adaptive personalization component present, we could highlight and concentrate on the specific new developments in the PILS system.

Concluding, the new states introduced were considered useful, and showed to positively influence the overall learning outcome. However, there were issues with dealing with under-pressure situations, where, for instance, experts were not available at the rate that they were requested. Moreover, our experiments highlighted some specific issues with the text chat environment, which is that when students work on another task, they might not notice the chat window requests. This is a problem that is expected to have an even higher impact in an environment with remote communication without specific scheduling conventions. A solution would be audio (e.g., beeps) or visual (e.g., flashing) signals. Here, the connection to the communication partners' attention catching research [2] should be made, as multiple sounds or visual notifications can become irritating and have an opposite effect than initially envisioned, if not properly designed.

6 Related Work

There has been considerable research on instant messaging [9] in general. Yet, in most current concepts and systems still disruption is a challenge. Some concepts and systems for reducing disruption have been presented. For instance, the Q&A system analyses the contents of instant messages and gives the users specific information on the message type [1]. In other approaches, concepts have introduced multiple social contexts with distinct online availability for its users (e.g., with an upcoming tight deadline of project X, the user U may be available for project X, but unavailable for project Y) [8]. Finally, the OpenMessenger [2] prototype supports the gradual initiation of interaction in an instant messaging system.

Moreover, e-learning in general and learning management systems in particular support collaboration; however, this collaboration is static and not adapted [6]. Here in other words, LMS systems do not collect any data for collaborative adaptation purpose. In comparison, the PILS system stores information about the teachers and learners, as well as about their presence and availability. The shared information is provided by *online states* about users' availability, and by *communication states* providing information about users' activities.

7 Conclusion

In this paper we have introduced the overall vision of the ALS project and its corresponding system, which is a composite system hosted by the Sakai LMS, and extended in the sense of featuring *adaptive personalization*, in the form of the AHA! system, *adaptive collaboration*, in the form of the PILS system, and *authoring for adaptation*, in the form of the MOT system (not detailed here). Moreover, we have introduced the PILS system, a new instant messaging system with various channels (text, audio and video) which is an independent communication tool, as well as a part of the overall ALS system. Finally, we have evaluated the PILS component of the ALS system from a quantitative and qualitative point of view. This initial evaluation of the PILS component shows that it is a valid component that can support the learning process. This evaluation also highlighted issues that still need to be resolved, such as the attention capturing issues, expert demand bottleneck, etc. This research represents another step towards bridging the gap between LMS, adaptive hypermedia and collaborative communication systems.

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ANNEX PILS questionnaire

1. I believe that, generally speaking, using online communication changes the learning process and outcome.
   - Increases learning outcome (answering TEST questions) (**H4a**) (18 Responses)
   - Decreases learning outcome (answering TEST questions) (**H4a**) (2 Responses)
   - No influence on learning outcome (**H4a**) (1 Response)
   - Better learning process (**H4c**) (10 Responses)
   - Worse learning process (**H4c**) (2 Responses)
   - Easier learning process (11 Responses) (**H4b**)
   - More difficult learning process (3 Responses) (**H4b**)
   - No influence on learning process (0 Response) (**H4b**)

2. In your opinion, did the availability of the online states (busy, available, unavailable, away, invisible, ReadyToHelp, RequiringHelp), generally speaking, influence your perceived satisfaction while answering TEST questions? (~**H0**)
   - Increases (16 Responses)
   - Decreases (3 Responses)
   - No influence (4 Responses)

3. In your opinion, did the availability of the online states (busy, available, unavailable, away, invisible, ReadyToHelp, RequiringHelp), generally speaking, influence your learning outcome? (answering the TEST questions) (**H0**), (**H3a**)
   - Better (12 Responses)
   - Worse (1 Response)
   - Neither better nor worse (4 Responses)
   - Easier (8 Responses)
   - More difficult (2 Responses)
   - Neither easier nor more difficult (4 Responses)
   - Faster (10 Responses)
   - Slower (2 Responses)
   - Neither faster nor slower (4 Responses)

4. For me, the availability of the extra online state ReadyToHelp changed the learning outcome (answering the TEST questions).
   - Better (**H1c**) (8 Responses)
   - Worse (**H1c**) (0 Response)
   - Neither better nor worse (**H1c**) (8 Responses)
   - Easier (**H1b**) (8 Responses)
   - More difficult (**H1b**) (3 Responses)
   - Neither easier nor more difficult (**H1b**) (4 Responses)
   - Faster (6 Responses) (**H1d**)
   - Slower (4 Responses) (**H1d**)
   - Neither faster nor slower (3 Responses) (**H1d**)

5. For me, the availability of the extra online state RequiringHelp changed the learning outcome.
    - Better (**H2c**) (9 Responses)
    - Worse (**H2c**) (1 Responses)
    - Neither better nor worse (**H2c**) (7 Responses)
    - Easier (**H2b**) (11 Responses)
    - More difficult (**H2b**) (0 Response)
    - Neither easier nor more difficult (**H2b**) (4 Responses)
    - Faster (10 Responses) (**H2d**)
    - Slower (0 Response) (**H2d**)
    - Neither faster nor slower (7 Responses) (**H2d**)