Journal of Universal Computer Science, vol. 19, no. 7 (2013), 894-911
submitted: 31/8/12, accepted: 31/1/13, appeared: 1/4/13 © J.UCS

Collaborative e-Learning through Drag&Share in Synchronous Shared Workspaces

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Abstract: e-Learning platforms allow users to collaborate with one other. Moodle, as one of the main e-Learning platforms, provides tools to perform collaborative tasks. With these tasks, students are able to share documents and information. The means provided by Moodle are not enough to perform some collaborative tasks, such as sharing documents in real-time. In this scenario users must be aware of what is happening in the system effectively. We propose the use of Drag&Share within Moodle, a collaborative tool that allows users to synchronously share resources in real-time. Through this tool, teachers are able to easily provide a shared workspace for students and be able to create groups. With such a tool, students can share all kind of resources and be aware of what is going on in the system in which they are participating and of what they are doing. All these features use standard technologies, such as HTML5.

Keywords: Collaboration, Real Time, Awareness, Shared Workspaces, eLearning, Moodle, HTML5.
Category: K.3.1, K.4.3

1 Introduction

Educational spaces have evolved to become an integrated environment with computer technologies. In blended learning [Graham 06], student's time involves physical interaction with other students, teachers and virtual environments. Resource sharing is a relevant collaborative task on e-Learning scenarios. Nowadays, mainly due to technology improvements, software and hardware equipment allow students to share all kind of resources. When doing single user tasks, students are aware of their actions. But the scenario changes when students have to interact with others. Problems arise while performing collaborative activities. Students receive all the information they need from the physical environment in face-to-face scenarios, but all this information is not available on e-Learning platforms. Users should be provided with the necessary awareness in collaborative learning. Endsley defines awareness as "knowing what is going on" [Endsley 95]. This knowledge should answer specific questions about a users' environment. To deal with these requirements, Gutwin [Gutwin 95a] has defined the awareness framework for collaborative learning. Appropriate awareness techniques are needed to answer these questions [Gutwin 04]. In real-time collaborative tasks, answering the question "what are the others doing?"

is crucial for maintaining awareness [Gutwin 95b]. In order to facilitate the design and to increase the efficiency of online collaborative tasks, such as resource sharing in real-time, there arises the need to offer solutions that allow teachers and students to successfully use new possibilities and features offered by educational environments. These solutions should provide users with the necessary mechanisms to make sure that they are aware about what is going on in the system. Our proposal is based in Moodle environments and introduces Drag&Share [Albertos 11] inside Moodle as an activity to perform collaborative activities in real-time through shared workspaces.
The rest of the paper is organized as follows. First there is a presentation of related works, followed by a description of the Drag&Share on Moodle. Then an evaluation is presented and a summary of conclusions and future prospects of this new tool.

2 Related Work

Sharing resources among students is a widespread practice in collaborative activities. Students are able to share pieces of information in physical environments, for example when they are in a classroom. They use all means available in their environment to share several kinds of resources. But in e-Learning based courses, the system must provide with the necessary tools for participants in order to help them achieve the desired results. In many cases, the role of the computer in this situation is secondary regarding the interpersonal collaboration process among students. This kind of software is designed to reinforce, not to replace, group processes carried out among humans. Also, the quality of interaction between students in collaborative scenarios determines results, as shown in [Barron 03] and [Staarman 05].

Moodle[1], as one of the main e-Learning platforms[2], is a software package for producing Internet-based courses. As a virtual learning environment it provides means allowing users to perform learning tasks. Administrators and teachers can design courses and offer tools to perform a variety of activities present in the platform. These courses can be divided into sections to organize the students' work. In each section, teachers can perform two kinds of actions: adding a resource or adding an activity. Each section may contain as many activities and resources as the teacher desires. Moodle offers a number of ways to share content by adding resources. A resource is an item teachers can use to support learning. Resource types enable almost any kind of web content to be inserted into the course. An activity is a general name for a group of features in a Moodle course. Usually an activity is something that a student will do which allows interaction with other students and/or the teacher. There are fourteen different types of activities in the standard Moodle. For example, it enables teachers to grade and add comments on uploaded files and assignments created on-line and off-line. Chat activity allows participants to have a real-time synchronous discussion. The database enables participants to create, maintain, and search a bank of record entries. Forum activity allows participants to have asynchronous discussions. In Moodle, a site may add other activities that have been developed as a contributed

[1] http://moodle.org, 3 2012
[2] https://moodle.org/stats/, 3 2012

code and found in Moodle's Modules and Plugins[3] database. Therefore, it is possible to create personalized activities in order to achieve different goals.

Sharing resources and performing collaborative tasks in Moodle can be done by using some of the features described above as well as by using external tools. There are several web applications that allow students and teachers to design, coordinate and perform collaborative activities. Google Docs allows users to create, share and manipulate documents in real time by many users. Changes are presented synchronously and users can view what others are doing in the document where they are located. Another kind of application to share documents among users is Dropbox. Through this application, users can store files and all kinds of documents, allowing them to share those documents with selected users and to synchronize them easily. Dropbox and Google Docs can be used as repositories in Moodle, but they do not provide with the necessary means to perform synchronous collaborative activities such as file sharing and file editing within Moodle. There are some previous works in this area, such as the Docs4Learning proposal [Alier 12]. This work shows a proposal for the integration of Google Docs within Moodle, but in that first step only the text editor integration is shown.

Within Moodle, to share information, teachers can use resources to link a wide range of documents. Students will be able to display and download these documents to their local devices. But students cannot use the resources available to share their documents with other students. As an alternative, they can share resources through some activities such as using a database or uploading documents in the forum. This will help students share documents and perform collaborative tasks. The database provides means to upload/download and store resources. There, students can view documents uploaded by other students. To communicate with others, students can use the chat activity. Through this activity, they are able to express their ideas and to inform the group about their activities in the collaborative task. There, students can notify when they upload documents to the database activity. Using a database and the chat within Moodle could be the perfect setup for sharing resources and perform collaborative activities with Moodle default tools.

But collaborative activities on e-Learning platforms involve many different aspects. Computer Supported Collaborative Learning is a field of study focused on the process of knowledge production in the context of joint activities on the scenario where those processes are performed through the artefact design [Koschmann 02]. These artefacts are presented in what is known as shared workspaces. A shared workspace [Ellis 91] is a set of objects and actions that can be performed, which are visible for a number of users. User interaction is limited by the boundaries imposed by the system in these shared workspaces. These boundaries are usually related to the capabilities of the platform where the application is installed: the user interface (mouse, touch screen), the size of the screen, or the need to distribute different pieces of information through several screens, devices or physical environments.

Another aspect to take into account is what is known as context. According to Dey et. Al. [Dey 01], context in applications may be defined as information that can be used to characterise the situation of an entity. To gather all the necessary information for users to be aware of what is happening in the e-Learning system, it is

[3] http://moodle.org/plugins, 3 2012

necessary to use the appropriate awareness techniques. Through these techniques the e-Learning system will provide both user and the group with the valuable information needed to keep up to date about the status of the environment. But awareness is usually a secondary goal, as the main objective is the task completion and efficiency. A framework for collaborative learning is needed in order to know what questions have to be answered in these environments. Gutwin has provided a definition of the awareness framework for collaborative learning environments [Gutwin 95a]. Four types of student awareness were identified: social awareness, task awareness, concept awareness and workspace awareness. Three of the following types of student awareness have their origin in three kinds of interaction among students as identified by Goldman [Goldman 92]: social awareness defines the social connections in the groups; task awareness shows how the task is going to be performed and concept awareness is related to how the previous knowledge of the student matches with the task. Finally, workspace awareness refers to the understanding of another person's interaction with the shared workspace at that given moment. To maintain workspace awareness, several questions need to be answered: What are the other members of the group doing to complete the task? Where are they located? What are they doing? What have they already done? What will they do next? How can I help other students complete the project? To support workspace awareness, Gutwin describes some computational techniques that may be used. Embodiments can provide people with a representation in the workspace. They provide a way to give basic sense of presence in a virtual world. Some examples are telepointers or avatars. Also, the expressive artefacts are the objects that maximize the amount of usable awareness by the group.

In addition, in collaborative tasks, there may be different groups with different needs of information management. Each group would need a piece of information and produce their own results. These groups may be related to each other, but there may be some independent groups. Interaction mechanisms should be provided by collaborative applications to manage and to coordinate these groups. One possible scenario may be collaborative learning activities. In these activities, teachers may distribute information through different workspaces and students may work in groups in these workspaces. Then, students must be able to produce information and to send it to the evaluator or to different groups.

3 Drag&Share on Moodle

In this section, we present a description of how Drag&Share has been introduced in Moodle and how it works. Then, the main features introduced in Moodle through Drag&Share will be outlined, as well as the identified workspace awareness supported by Google Docs and Drag&Share.

3.1 Introducing Drag&Share on Moodle

One solution to share resources within Moodle synchronously and in real-time is to integrate Drag&Share as an activity in Moodle. Drag&Share for Moodle is a module that allows students to share documents in real-time in Moodle. To achieve this, we have developed a Moodle module called *dragandshare*. It is based on standard technologies and does not need any special software to be installed in the client

system. The architecture of the system [Albertos 11] relies on the utilization of standard features included in the specifications of HTML5[4]. With the introduction of Drag&Share as a Moodle's module, the architecture has been simplified [see Fig. 1].

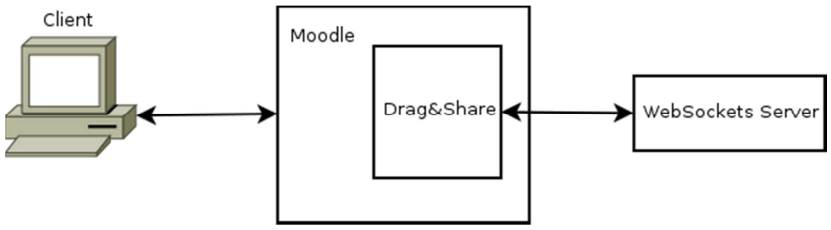

Figure 1: System Architecture

The WebSockets server implements WebSockets[5] technology. This technology has been selected because it is the best-performing of the standards-based web technology for our purpose and it is simple to work with [Gutwin 11]. It is used for a client/server communication through a bidirectional communication channel. This technology is still changing in accordance with the evolution of the HTML5 standard. As a result, several versions of the WebSockets protocol have been released.

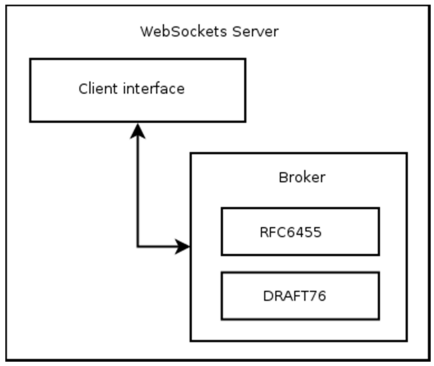

Figure 2: WebSockets Server Architecture

However, the proposal we present in this paper is protocol independent since it relies on a broker, which eases such independency. At present, the server developed with Drag&Share supports two versions of the WebSockets protocol [see Fig. 2], but it is ready to include other protocol versions when needed. The broker inside the WebSockets server uses the correct version, according to the client request. The system has been designed in this way because each platform on the client side supports a particular version of the protocol. Therefore, Drag&Share is open to continue working in the future with all the browsers that support WebSockets technologies, independently of the supported WebSockets version.

[4] http://www.w3.org/TR/html5/, 3 2012
[5] http://dev.w3.org/html5/websockets/, 3 2012

With the introduction of Drag&Share in Moodle, there are some aspects of the application that have been changed. In previous versions, the application was in charge of users´ authentication and file management. Currently, with the new proposal, Moodle is in charge of these tasks. Drag&Share uses the API[6] provided by Moodle to manage user information and to store and retrieve files and other important information related to the Drag&Share module in the Moodle database.

To install the plugin, administrators have to follow the instructions provided for installing plugins in the Moodle's official web page[7]. Then, in order to include Drag&Share in their courses, teachers only have to add the activity and give it a description.

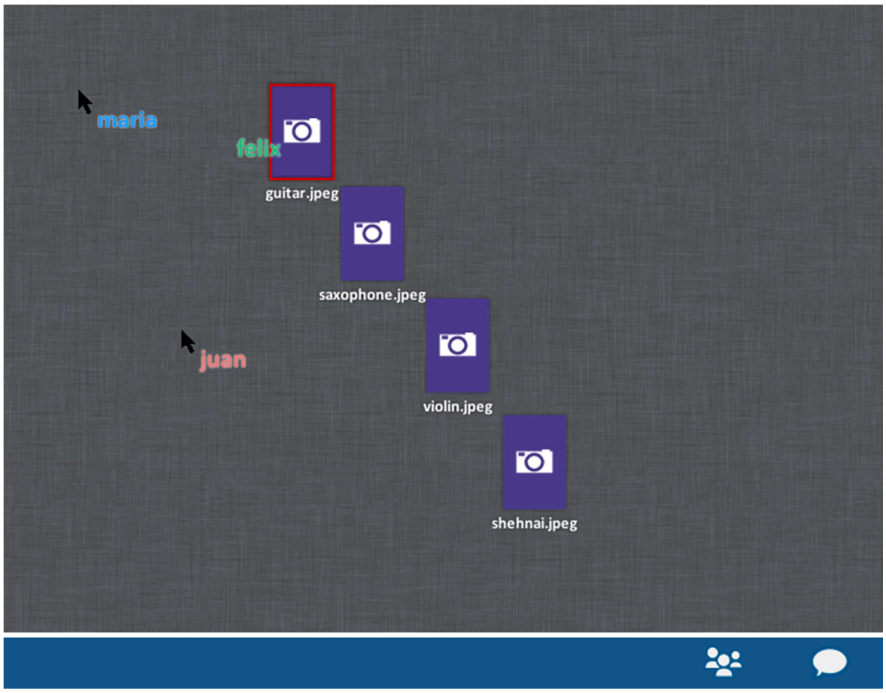

Figure 3: Shared workspace

3.2 New Features Introduced in Moodle by Drag&Share

The introduction of Drag&Share within Moodle provides a set of new features available in Moodle environments. These characteristics are the shared workspace, communication means, contextual menu, text editor, connection mechanism with other shared workspaces and workspace awareness improvements.

The shared workspace [see Fig. 3] available in Drag&Share provides an area where users are represented through the multi-pointer system. Each user is identified by one colour in the whole system. Documents are displayed by representative metaphors,

[6] http://docs.moodle.org/dev/File_API, 3 2012

[7] http://docs.moodle.org/22/en/Installing_plugins, 12 2012

according to the type of document. Drag&Share allows students to drag and drop as many documents as they want simultaneously in the shared workspace. So far, directories are not allowed to be included in the shared workspace.

The action of dragging documents into the shared workspace is described in Figure 4 [see Fig. 4]. This figure is divided into three steps, numbered with ordinal numbers. First, there are four pictures on the student's desktop. The aim of the activity is to share those pictures with other students. In the second step, the student selects all four pictures from their desktop and drags them into the shared workspace. In the third step, the student drops the pictures inside the shared workspace. Pictures are shown in the shared workspace in real-time when they are fully uploaded in the system. At this moment, all students participating in this activity can see the pictures in their shared workspace.

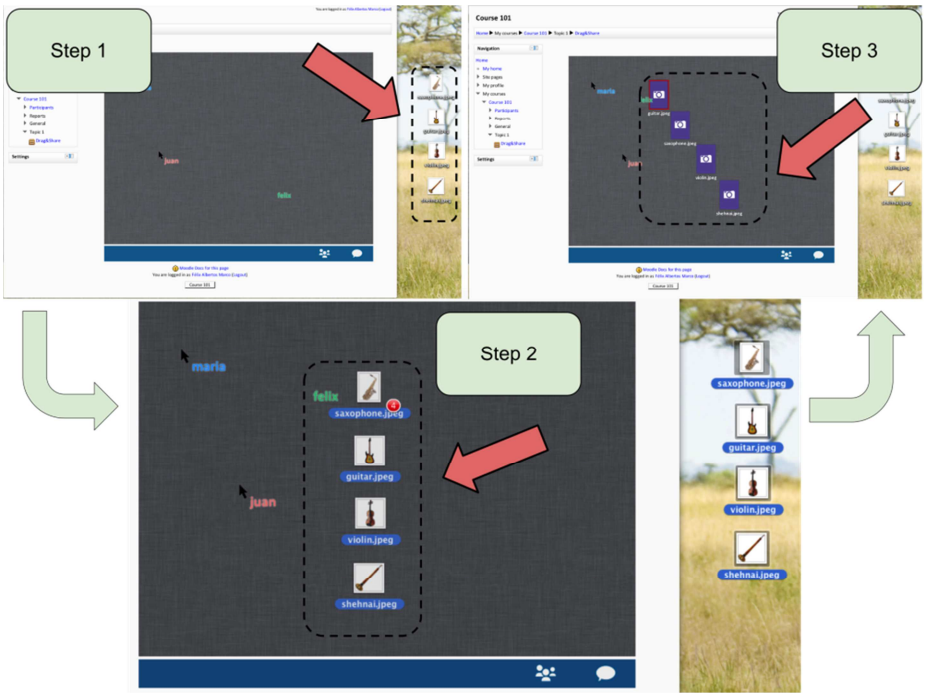

Figure 4: Dragging multiple files into the shared workspace

Users can show who is connected in the shared workspace and can also easily communicate with them through the means provided by the system. These features can be hidden or showed on demand [see Fig. 5], by simply selecting the actions available at the bottom of the shared workspace. There, users can see the number of unread messages. The chat includes not only explicit messages from the users but also messages from the system. For example, information about when documents are uploaded, downloaded, edited or deleted from the system is detailed in the chat, as well as information about the connection and disconnection of other users in the system.

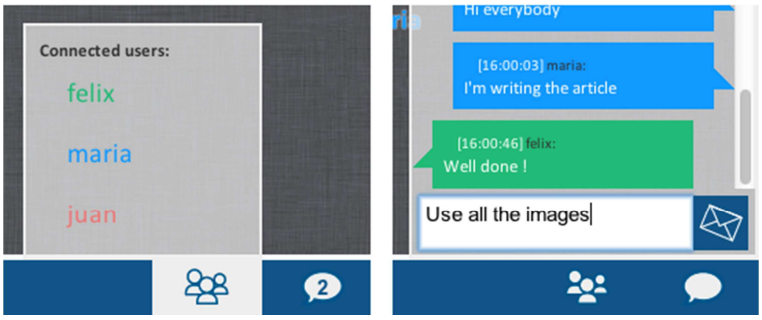

Figure 5: View of connected users and chat windows

As shown in [Albertos 11], chat information includes the date and the user performing the action, in order to keep track of who is involved in the system and what actions have been performed. Chat messages are stored in a log to facilitate the verification of the work carried out or the completion of tasks. Then, teachers can be aware of the information related with other sessions. But this information is not the only available on these logs. All the events produced within the system are included. As aforementioned, these events also include the connection and disconnection time of users in the shared workspace, as well as a timestamp for the upload/download/delete/open events related with the documents in the shared workspace. This information may be used for student's work assessment in the shared workspace as part of their evaluation process.

In addition to the information related with the events produced in the shared workspace, the system provides means to work with the shared workspace and shared resources. When the shared workspace or a document is double clicked, a contextual menu shows available actions Different actions are shown which may vary when the user clicks on a document [see Fig. 6] or on the shared workspace [see Fig. 7].

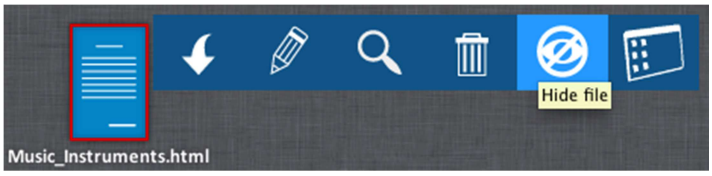

Figure 6: Document's contextual menu

The selected option shows a descriptive text. In the document's contextual menu, the first action allows users to download the document to their local device. Next, there is the *edit document* action that is only available if it is a text document (HTML, RTF, TXT). The *show document* action is represented by a magnifying glass, and the document is showed in an overlap window. Next to that it is the *delete element* action. The *hide file* action makes the document invisible for other users in the same shared workspace.

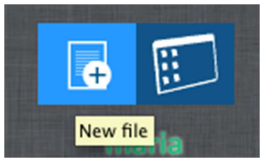

Figure 7: Shared workspace's contextual menu

As mentioned earlier, users can edit documents within the shared workspace. Drag&Share allows the editing of HTML documents, Rich Text Format documents and plain text documents. Ckeditor[8] is used as a text editor within the system. To edit documents, it has to be selected and the edit document action must be activated. Then, an overlap window will display the integrated text editor [see Fig. 9]. This text editor allows users to edit the documents formats detailed above. It presents advanced features such as text formatting. It also allows to insert images, audio and video within the document. Users cannot only edit existent documents but can also create documents inside the workspace, with the same features described before. Documents created within the system could be HTML, RFT or TXT. To do so, users have to double click in the shared workspace and select the New File action [see Fig. 7]. The text editor will appear, where they can assign a name and a document type to the document, from the description mentioned before. This characteristic allows users to create and store information without exiting the system. It is useful in all scenarios, but this feature is needed in those devices where users cannot upload documents to the system, for example in Android and iOS devices. In this way, users can create these pieces of information, store it permanently in the system, share it with the rest of users on the shared workspace and download them to their local device.

When a document is being edited, other users are informed about this action, because the document shows a lock in the upper right corner [see Fig. 8]. Therefore, other users cannot edit the document at the same time.

Figure 8: Document lock for edition

[8] http://ckeditor.com/, 12 2012

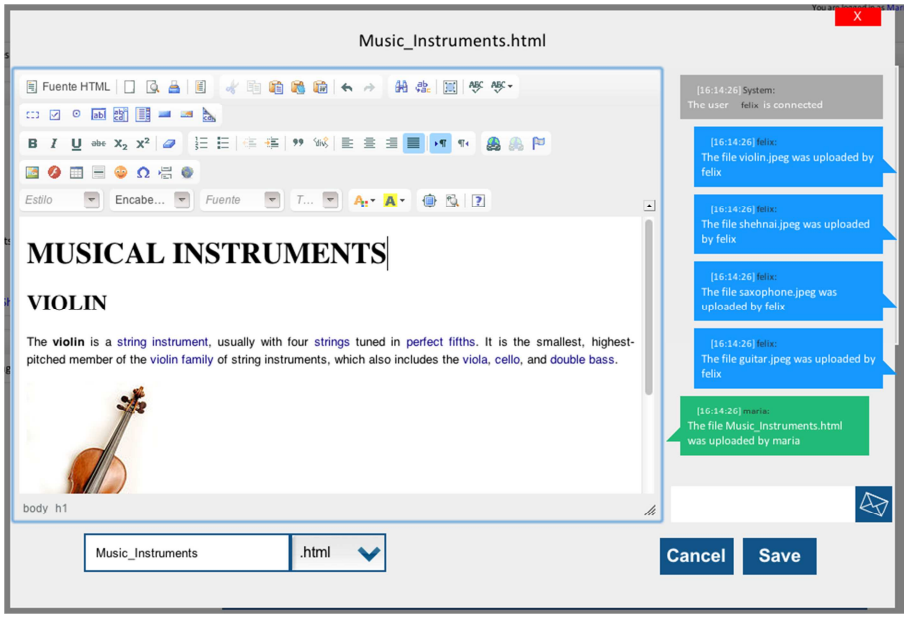

Figure 9: Integrated text editor

Drag&Share for Moodle allows course designers to manage multiple shared workspaces. These shared workspaces may be connected, when required, allowing users to send information through virtual workspaces and to "jump" there to see what is going on. As a result, all the users may have access and would be able to deliver information wherever it is required. The multiple shared workspaces concept helps solve the problems related with sharing information among individual users, groups and visualization devices. There are unlimited shared workspaces where users can organize the information and the users itself in the system. People can be grouped according to any condition, for example the role of the users, the used device or the location of the displays where the workspaces are located in. In each shared workspace, all the events, such as the telepointers movement, the information in the chat and the documents that users drop into the shared workspace, will only be available for users connected to the same shared workspace. The system provides a mechanism to form groups by simply letting users connect to a specific shared workspace. Administrators of the system will give access to users into the spaces in order to form groups. That way, resource distribution among groups of users will be much easier.

To allow users to access others workspaces there arises the necessity of connection mechanisms. These mechanisms let users establish a link between shared workspaces. A new option has been included in the contextual menu. This is the last action available in the menu [see Fig. 10], representing a workspace. It allows users to communicate with others' shared workspaces. This communication may be produced in two different ways: *jumping* or *sending* documents to other shared workspaces.

Jumping means a user is able to go to a different shared workspace. Then, users on that shared workspace will be aware of their presence. To perform this action, the user must select the *"Jump to ..."* action in the contextual menu. Then, a shared workspace name has to be specified, within the ones available for that user. At that moment, the user will be connected to the new shared workspaces, disconnecting from the old one. With this feature, users are able to move through available shared workspaces and see what is going on there.

The other operation between shared workspaces is *sending* documents to other shared workspaces. To achieve this, users have to select the "Send to …" action in the contextual menu. Then, a shared workspace name has to be specified, among the ones available for that user. At that moment, a copy of the document will be sent to the destination shared workspace. Note that at this point, there is no connection between documents, thus, the actions and modifications made in one of them will not affect the other one. Those documents are not connected anymore. This option is useful to send the result of the collaborative work to the teacher for grading, or for sharing information with other groups.

These described features allow users to interact with each other and to move between shared workspaces. They are especially useful in scenarios where an administrator has to distribute information over different virtual shared workspaces.

Figure 10: Connections with other shared workspace

Another feature the system provides is the possibility to hide documents. Through this feature, users can hide a document, making it invisible for the rest of the other users in the same shared workspace. To do this, users have to select the hide file action. The document will disappear from the other users shared workspace, but in their shared workspace an icon will appear in the upper left side of the document [see Fig. 11], indicating that the document is only visible for them.

Figure 11: Hidden document

3.3 Awareness Support on Drag&Share

The main goal of the proposal is to improve collaborative e-Learning in synchronous shared workspaces. As said before, answering the question "what are the others doing?" is crucial to maintain awareness. The system provides several means to maintain awareness. As embodiments, the system features telepointers. It also features connected user's information and chat to maintain awareness. The awareness information that telepointers show is not only related with position and movement. Telepointers also give information about the identity and activity of others in the shared workspace. The colour of each telepointer gives others the information about identity. This information together with the connected user's information [see Fig. 5] gives the name of the user. The activity information is given through the actions performed within the shared workspace. For example, when a student is moving, or arranging a document, or a set of documents, it means that he/she is paying attention to these pieces of information. Therefore other students may be aware of the intentions of that student. This is possible thanks to the feedthrough process, which the feedback users receive from the shared workspace.

All that information answers the question described in the framework proposed by Gutwin [Gutwin 95a], thus improving collaboration on this scenario [see Tab. 1].

Question for Workspace Awareness	Answers within the system
Where are the other members of the group?	Group members are shown in the shared workspace through the telepointers and the connected user's information
What are they doing?	Consequential communication is given through the telepointers, the movements of the documents within the shared workspace and the user's actions over them. Also, the chat gives information about others explicit activity
What have they already done?	Historical information is available in the chat showing what happened in the shared workspace
What will they do next?	The system gives clues about the actions that users will do through the user's actions through the shared workspace
How can I help other students to complete the project?	The interactions with other students in the shared workspace allow users to collaborate with others in order to complete the project

Table 1: Maintaining workspace awareness with Drag&Share

The awareness provided by Drag&Share may be compared with that provided to Moodle by other tools, e.g. by Google Docs [see Tab. 2]. As shown in Table 2, the awareness provided by Google Docs is related to the collaborative features within documents. Therefore, mechanisms to maintain awareness are provided if users are

working with the same document. However, if users are not working with the very same document, they will not be aware of what others are doing. Therefore, awareness for collaboration provided by Google Docs does not support workspace awareness when users are not working in the same document.

Question for Workspace Awareness	Answers within the system
Where are the other members of the group?	Cursors are shown where working in the very same document
What are they doing?	Changes in the document are shown if members are working in the very same document
What have they already done?	Historical chat information for single documents is shown
What will they do next?	Cursors position and chat information may inform users about other users intentions
How can I help other students to complete the project?	Chat information may be used to help other members located in the same document

Table 2: Maintaining workspace awareness with Google Docs

Next section will present an evaluation in order to assess the impact of the use of this system within a collaborative activity.

4 Evaluation

In the evaluation of the proposal, we want to compare Moodle‘s efficiency and satisfaction with and without Drag&Share when a group of users perform a collaborative task. We want to assess the impact in a collaborative task when using Drag&Share in Moodle. Therefore, the same pre-selected activity is both performed by using the means provided by Moodle as well as by using Drag&Share.

Analysed activity involves sharing pictures and discussing with other students about those pictures. The evaluation has taken place in two scenarios within Moodle. First, using Moodle’s standard features, the setup consists in the utilization of two activities: the database and the chat. Therefore, two windows are needed in order to be aware of the pictures and the chat. The main activity window is in the background. In the foreground, the database window and the chat window are used. In this scenario, students follow several steps to upload images into the database. In addition, they repeat all the entire process in case they want to upload more than one image. The steps to perform this action are three:

1. Select the “Add entry” option.
2. Choose a file. At this moment, another screen is shown.
3. Specify the file from its local device, or one stored within the system. If the file is stored locally, several windows are opened.

Secondly, using Drag&Share within Moodle. In this scenario users only need to drag and drop resources in the shared workspace to share pictures with other students.

The test consists in a collaborative task performed in pairs (student A and student B). Two students shared pictures and discussed which one was better. The collaborative task was divided into 5 representative activities within the process:

1. B realizes that A is in the system.
2. A uploads a picture and B realizes it.
3. B gives feedback to A about the picture.
4. B uploads a picture and A realizes it.
5. A and B share information and discuss which picture is better (measured time is only related with interface interaction).

The users recruited were students who knew how to use Moodle and were familiar with the environment. Therefore, there were no special instructions on how to use the system. They received instructions about the task that had to be performed and the tools that would be used only to assure that they understood the assignment. The group of selected students to perform the collaborative tasks had the following features:

- The group consisted of 10 students. Seven students were men and three were women.
- The participants´ age was nearly 23 years old, on average.
- The oldest and youngest users were 25 and 21 years old, respectively.

Aspects to be assessed are how the proposal affects the productivity in the task, that is, how much time users need to complete it, and how users' satisfaction is affected. Therefore, the evaluation is focused on the level of productivity and the user's satisfaction while using the system. Tasks time has been used to measure productivity and satisfaction has been measured using a questionnaire based on the SUS (System Usability Scale) test [Brooke 96], a widely used evaluation technique. Time, as a productivity measure, has been selected because it provides a good overview of the impact when performing tasks using different systems.

The productivity of the system was analysed based on the time spent to perform the collaborative task. This time was divided into the five tasks described above. The average time is shown in [see Tab. 3] for the test developed in Moodle with default activities, and in [see Tab. 4] for the test developed in Moodle using Drag&Share. On these tables, the maximum and minimum time for each task is also depicted. The average time decreased drastically in tasks 2 and 4. Time has decreased slightly in the other tasks. Globally, time decreased when Drag&Share was used.

Regarding student's satisfaction, the SUS satisfaction questionnaire was used. In this test, users express their agreement with 10 sentences [see Tab. 5] after performing the task. For each sentence, a score between 1 and 5 is given, meaning 1 strongly disagreement and 5 strongly agreement. Then, based on these values, the SUS satisfaction questionnaire final value is calculated. This value can be between 0 and 100. A final value near 100 indicates complete satisfaction.

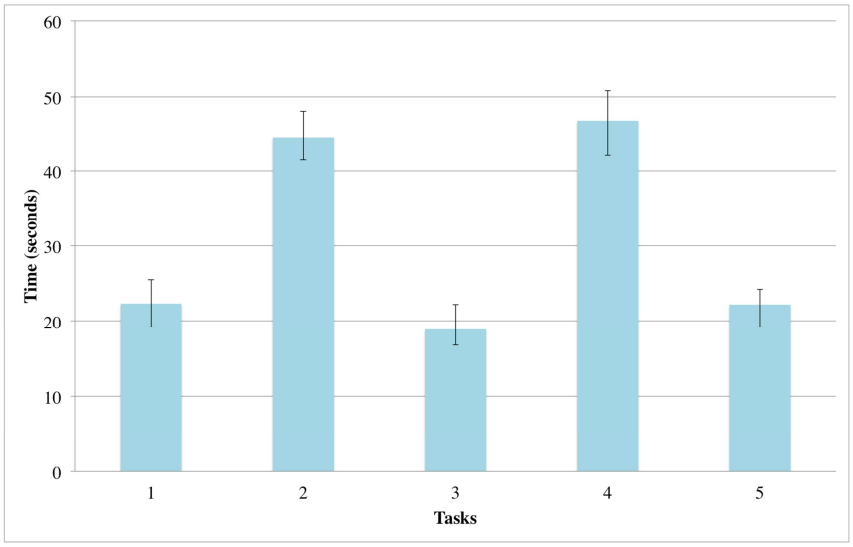

Table 3: Average time of each task on Moodle with default activities

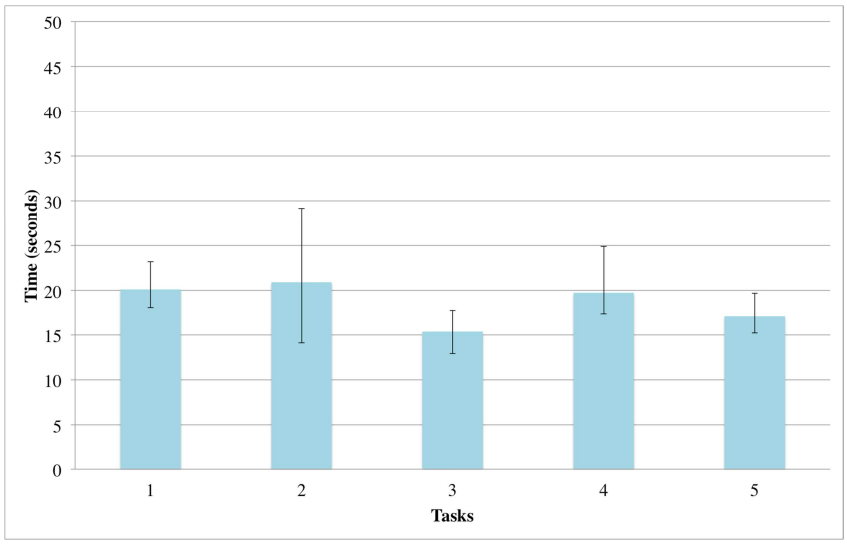

Table 4: Average time of each task on Moodle with Drag&Share

In the performed test, the final value in Moodle with default activities, based on the results depicted in [see Tab. 6], was 46.75, which indicates that students were not satisfied with the system. The final value in Moodle with Drag&Share, based on the results depicted in [see Tab. 7], was 89.5, which confirms that users were very satisfied when using Drag&Share within Moodle.

Nº	Assertions
1	I think that I would like to use this system frequently
2	I found the system unnecessarily complex
3	I thought the system was easy to use
4	I think that I would need the support of a technical person to be able to use this system
5	I found the various functions in this system were well integrated
6	I thought there was too much inconsistency in this system
7	I would imagine that most people would learn to use this system very quickly
8	I found the system very cumbersome to use
9	I felt very confident using the system
10	I needed to learn a lot of things before I could get going with this system

Table 5: SUS test sentences

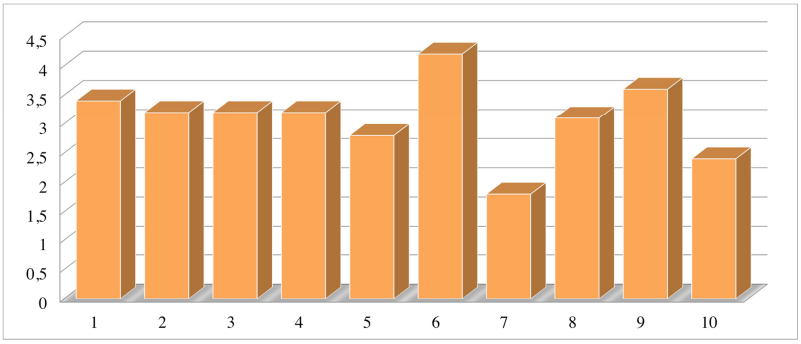

Table 6: Average SUS results for Moodle with default activities

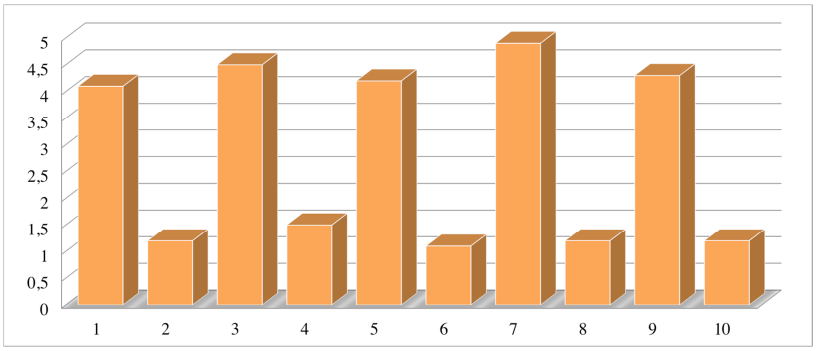

Table 7: Average SUS results for Moodle with Drag&Share

Summarizing the results, the setup with Moodle's default activities, presents some problems. In collaborative tasks students need to be aware of what is going on,

that is, what other students are doing within the objects involved in the collaborative activity. In this scenario, users must be paying constant attention to the chat window and the database window. Also, users have to follow several steps to upload images into the database and they have to repeat each step in case they want to upload more than one image. This may result in user frustration and demotivation. On the other hand, users perform the collaborative task with more efficiency and with a higher degree of satisfaction when they are working with Drag&Share.

5 Conclusions and Future Work

This paper presents Drag&Share within Moodle, a shared workspace inside Moodle that allows users to share resources synchronously in real-time.

With Drag&Share, users are aware of what is happening in the e-Learning system, since it implements the appropriate awareness techniques. Through these techniques the e-Learning system provides both individual user and the group with the valuable information needed to keep up to date about the status of the environment.

With the introduction of Drag&Share within Moodle, a set of new features is available in Moodle environments. These characteristics are: shared workspace, communication means, contextual menu, text editor, connection mechanism with other shared workspaces and workspace awareness improvements.

The evaluation of our proposal shows that the analysed tasks were dramatically improved through a time reduction in its completion. The average time performing tasks 2 and 4 has been drastically decreased, as depicted in tables 3 and 4 [see Tab. 3] [see Tab. 4].

Moreover, user satisfaction has been tested and proved to be better when Drag&Share was used.

As future work, the study of related collaborative activities within Moodle is needed to continue improving collaboration within Moodle. The utilization of new standard technologies may help improving the execution of real-time collaboration within Moodle. One key feature that will improve collaboration in the described scenario is the introduction of a collaborative text editor, instead of the text editor used in the proposal. The integration of previous work [Allier 12] might allow Drag&Share for Moodle to include the collaborative text editor provided by Google Docs. Some other aspects may be considered to improve the proposal. For instance, a huge number of users using the system at the same time could deteriorate the readability of the shared workspace with too many pointers. The inclusion of a mechanism to conceal some of the pointers in the shared workspace should be studied in order to address this problem.

Acknowledgements

This research has been partially supported by the CICYT TIN2011-27767-C02-01 project and the regional projects with reference PAI06-0093-8836 and PII2C09-0185-1030.

References

[Albertos 11] Félix Albertos, Víctor M.R. Penichet, José A. Gallud. Drag&Share: A shared workspace for synchronous collaboration, in DUI 2011, May 7, Vancouver, BC, Canada. ISBN 978-84-693-9829-6 (2011).

[Alier 12] Alier, M., M. J. Casany, et al. Docs4Learning: Getting Google Docs to work within the LMS with IMS BLTI. Journal of Universal Computer Science, vol. 18, no. 11 (2012), 1483-1500.

[Barron 03] B. Barron. (2003) When smart groups fail. The Journal of the Learning Sciences, 12-3:307–359.

[Brooke 96] Brooke, J. SUS - A quick and dirty usability scale. In Usability Evaluation in Industry (1996).

[Dei 01] Anind K. Dey. 2001. Understanding and Using Context. Personal Ubiquitous Comput. 5, 1 (January 2001), 4-7. DOI=10.1007/s007790170019.

[Ellis 91] Clarence A. Ellis, Simon J. Gibbs, and Gail Rein. 1991. Groupware: some issues and experiences. Commun. ACM 34, 1 (January 1991), 39-58. DOI=10.1145/99977.99987.

[Endsley 95] M. Endsley. Toward a theory of situation awareness in dynamic systems. Human Factors, 37, no 1:32–64 (1995).

[Goldman 92] Shelley V. Goldman. 1992. Computer resources for supporting student conversations about science concepts. SIGCUE Outlook 21, 3 (February 1992), 4-7. DOI=10.1145/130893.130895.

[Graham 06] Graham, C. R. Blended learning systems: definition, current trends, and future directions. In Handbook of Blended Learning: Global Perspectives, Local Designs, edited by C. J. Bonk and C. R. Graham, pp. 3–21. San Francisco, CA: Pfeiffer Publishing (2006).

[Gutwin 95a] Gutwin. C., G. Stark, and S. Greenberg. Support for workspace awareness in educational groupware. Proc Conference on Computer Supported Collaborative Learning, Indiana University, Bloomington, Indiana, USA October 17-20, Distributed LEA Press. pages 147–156 (1995).

[Gutwin 95b] Gutwin, C., Greenberg, S. Support for Group Awareness in Real-time Desktop Conferences., Technical Report 95-549-01, Department of Computer Science, University of Calgary. (1995).

[Gutwin 04] Gutwin, C. and Saul Greenberg. The importance of awareness for team cognition in distributed collaboration. Report 2001-696-19, Dept Computer Science, University of Calgary, Alberta, Canada. www.cpsc.ucalgary.ca/grouplab/papers/. (2004).

[Gutwin 11] Carl A. Gutwin, Michael Lippold, and T. C. Nicholas Graham. 2011. Real-time groupware in the browser: testing the performance of web-based networking. In Proceedings of the ACM 2011 conference on Computer supported cooperative work (CSCW '11). ACM, New York, NY, USA, 167-176. DOI=10.1145/1958824.1958850 http://doi.acm.org/10.1145/1958824.1958850.

[Koschmann 02] T. Koschmann. (2002) Dewey's contribution to the foundations of cscl research. In In G. Stahl (Ed.), Computer support for collaborative learning: Foundations for a CSCL community:Proceedings of CSCL 2002, pages 17–22.

[Staarman 05] J. Staarman, K. Krol, and H. van der Meijden. (2005) Peer interaction in three collaborative learning environments. Journal of Classroom Interaction, 40-1:29–39.