The Web Geometry Laboratory Project

Pedro Quaresma[1] Vanda Santos[2], Seifeddine Bouallegue[3]

1: CISUC/Department of Mathematics, University of Coimbra, Portugal
2: CISUC, University of Coimbra, Portugal
3: Innov'Com / University of Carthage, Tunisia

A Learning Environment for Geometry

To build an adaptive and collaborative blended-learning environment for geometry, we claim that we should integrate:

- Dynamic Geometry Software (DGS);
- Geometry Automated Theorem Provers (GATP);
- Repositories of Geometric Problems.

in a system:

- with asynchronous and synchronous interactions (blended-learning);
- with individualised access (adaptive);
- that allows the geometric information to flow between users (collaborative);

A system with that level of integration will allow building an environment where each student can have a broad experimental, but with a strong formal support, learning platform.

A Blended-Learning Environment is a mixing of different learning environments, combining traditional face-to-face classroom (synchronous) methods with more modern computer-mediated (asynchronous) activities.

An Adaptive Environment is an environment that is able to adapt the help information given to different users and also, an important feature in a learning environment, to adapt the learning path to the different users needs.

A Collaborative Environment is an environment that allows the knowledge to emerge and appear through the interaction between its users. In the *Web Geometry Laboratory* this is allowed by the integration of a Dynamic Geometry Software and by the users/groups/constructions relationships.

The Integration of a Dynamic Geometry Software allows the constructions to be made from free objects and constructed objects using a finite set of property preserving manipulations. These property preserving manipulations allow the development of "visual proofs".

The Integration of Geometry Automated Theorem Prover allows the users to reason about a given geometric construction and/or to test the soundness of the constructions made by a Dynamic Geometry Software.

The Collaborative Module

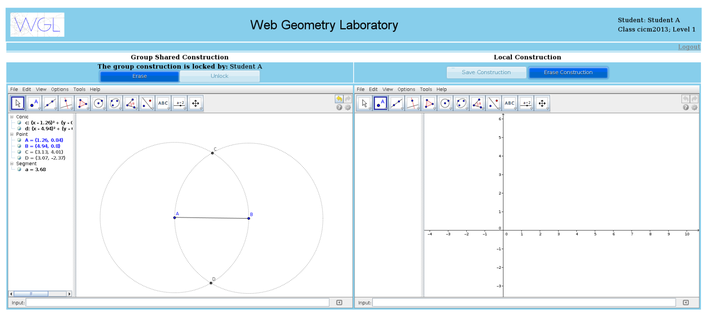

Figure 2: Student A / Group 1 (with the lock)

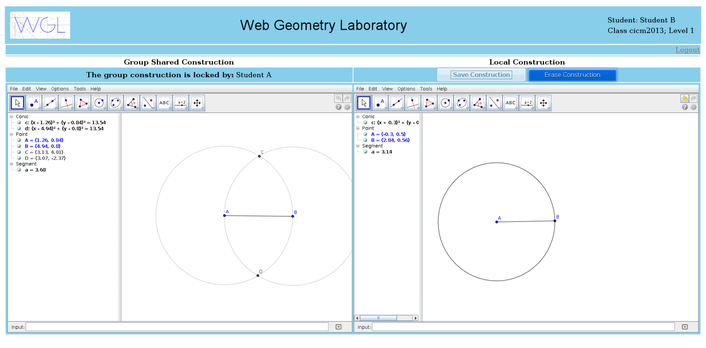

Figure 3: Student B / Group 1 (without the lock)

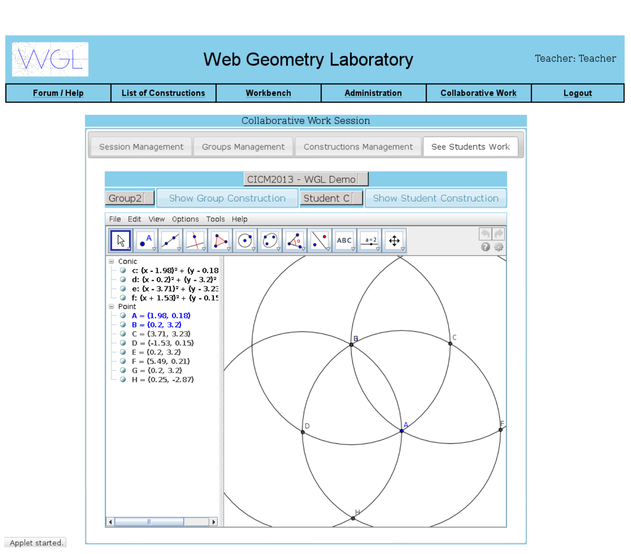

Figure 4: Teachers' Interface

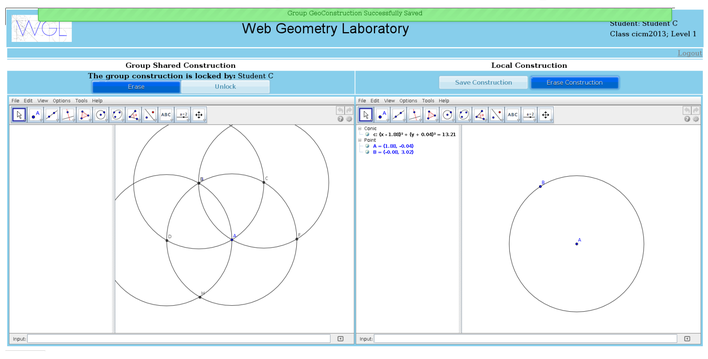

Figure 5: Student C / Group 2 (with the lock)

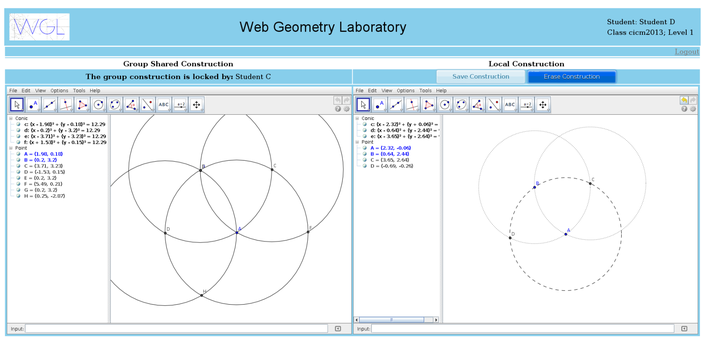

Figure 6: Student D / Group 2 (without the lock)

To allow the collaborative work a permissions system was implemented. This system is similar to the "traditional Unix permissions" system. The users will own the geometric construction defining the reading, writing and visibility permissions per geometric construction. The users to groups and the constructions to groups relationships can be established in such a way that the collaborative working, group-wise, will be possible.

In a collaborative session the students of a given group are capable of build the group-construction in a collaborative fashion. Each student has access to the group-DGS-window and to his/her personal DGS-window

The collaborative module of *Web Geometry Laboratory* distinguishes students having the lock over the group construction from those without the lock.

The students with the lock will have a full-fledged DGS applet, and they will be working with the group construction (see Figures 2 and 5).

The students without the lock will have also the two DGS applets, but the construction in the "group shared construction" one is a synchronised version of the one being developed by the student with the lock, and a full-fledged version that can be used to develop his/her own efforts (see Figures 3 and 6).

A text-chat will be available to exchange information and also to negotiate the lock exchange between group members. The teacher could always participate in this efforts (see Figure 4).

The *Web Geometry Laboratory* is a Web client/server application. The database (to keep: constructions; users information; constructions; permissions; user's logs); the DGS applet; the GATP and the synchronous and asynchronous interaction are all implemented using free cross-platform software, namely PHP, Javascript, Java, AJAX, JQuery and MySQL, and also Web-standards like XHTML, CSS style-sheets and XML. The *Web Geometry Laboratory* is a i18n/l10n tool with (for now) an English, a Portuguese and a Serbian versions.

The Web Geometry Laboratory — A Classroom Session

A classroom session using the Web Geometry Laboratory (WGL) Framework is understood as a Web laboratory where all the students (eventually in small groups) and the professor will have a computer running *Web Geometry Laboratory* clients.

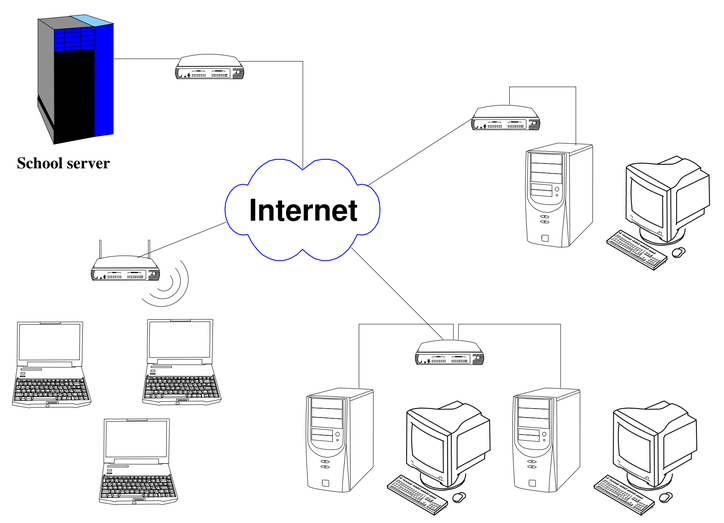

Figure 1: School Server

The *Web Geometry Laboratory* server is the place where all the information is kept:

- the users and groups information and the relationship between users and groups;
- the geometric constructions of each user;

After installing a *Web Geometry Laboratory* server the administrator of the system should:

- define all the teachers that will be using the system.

The teachers will be privileged users. They can:

- define (their) students; define groups; set the relationship between students and groups;
- set collaborative sessions;
- build constructions and decide its visibility to other users/groups;

The students can:

- build constructions and decide its visibility from other users/groups;
- participate in collaborative sessions;

Case-Studies & Future Work

The development of the *Web Geometry Laboratory* platform is supported by field-tests. From high-school teachers experimenting the platform and reporting their findings, by case-studies already done (but still in evaluation):

- a case-study in high-schools in Portugal (two schools, five classes);
- a case-study in Serbia, remote access to the platform (3 classes)

Future Work

- improvements in the collaborative module (2013);
- adaptive module (2013-2014);
- a Geometry Automated Theorem Prover integration (2014-2015);
- wider case-studies (2013-2015).

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