Reproducing a Geometric Working Session
Web Geometry Laboratory Project

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Abstract. The *Web Geometry Laboratory* (*WGL*) project's goal is, to build an adaptive and collaborative blended-learning Web-environment for geometry.

In its current version (1.2) the *WGL* is already a collaborative blended-learning Web-environment integrating a dynamic geometry system (DGS) and with some adaptive features. The building of the adaptive module is a two steps task, a first task, already almost completed, is the collection of data, textual, navigation and also geometric data. A second task will be, using the collected data, the construction of student profiles and/or learning paths. In this article the process of collection of the data and its visualisation will be described.

The actual testing of the *WGL* platform by high-school teachers is underway and field-tests with high-school students are being prepared. The next steps in the development of this platform will be the construction of student profiles and/or learning paths. The integration of a geometric automated theorem prover, allowing the exploration of geometric reasoning in a learning environment is also planned.

1 Introduction

The use of intelligent computational tools in a learning environment can greatly enhance its dynamic, adaptive and collaborative features. It could also extend the learning environment from the classroom to outside of the fixed walls of the school.

To build an adaptive and collaborative blended-learning environment for geometry, we claim that we should integrate DGSs, GATPs and repositories of geometric problems (RGPs) in a Web system capable of individualised access and asynchronous and synchronous interactions. 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. The *WGL*, a collaborative [5] and adaptive blended-learning Web-environment integrating a dynamic geometry system, a repository of geometric problems and

* IAESTE traineeship PT/2013/31

a geometry automated theorem prover (planned), is an strong attempt in that direction.

Such an integration it is still to be done, there are already many excellent DGSs [8], some of them have some sort of integration with GATPs, others with RGP [4]. Some attempts to integrate these tools in a learning management system (LMS) have already been done [6], but, as far as we know, all these integrations are only partial integrations. A learning environment where all these tools are integrated and can be used in a fruitful fashion does not exist yet [7].

2 Collaborative Sessions vs. Individual Work

The *WGL* is thought mostly for a blended-learning setting, that is, a classroom/laboratory where the computer-mediated activities are combined with a face-to-face classroom interaction. Nevertheless given the fact that the *WGL* is a Web application its use can extend itself to the outside of the classroom and be used to develop work at home, e.g. solving a given homework.

The *WGL* has two distinct session types. The collaborative sessions and the normal, individual work, sessions.

In a collaborative session the students are working in groups, the *WGL* provides an environment with two DGS, one where the group construction is being done and another where the students can work, following the group construction, or pursuing other ways to build the construction [5].

The construction of group profiles/learning paths and/or using the collaborative work to build student profiles/learning paths is a task to be develop in the future. For the moment we concentrate in using the individual work of the students to collect the data of his/her interaction with the system in order to be able to build student's profiles and individualised learning paths.

In the normal mode the student has access to a workbench where, using a DGS, he/she can work on problems given by the teachers and also in his/her own studies. A permissions system, similar to the "traditional Unix permissions" system allows the sharing of construction between groups of students, students and teachers. Although a given student has access to the constructions made available by other students and/or the teachers, this is an individual working mode.

It is in this individual mode that the collection of the data is being done. The navigation information: the browsing of the group list constructions; the administrative tasks and all the steps done when working in the Workbench. The geometric information: all the steps made when using the DGS applet during the construction of a geometric figure. In this mode the *WGL* doesn't provide a chat window between its users, this is only provided group-wise in the collaborative sessions, so, for the moment, this textual information is not being collected.

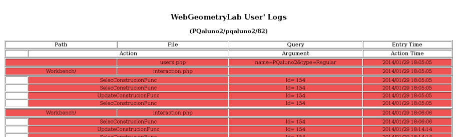
3 Adaptive Module

The construction of an adaptive module for *WGL* with the construction of student profiles and individualised learning paths, following Van Hiele levels of geometric reasoning [1], is a two steps task. The first task is the collection of data, textual, navigation and also geometric data. A second task will be, using the collected data, the construction of student profiles and learning paths. The student is informed, by his/her teacher, about the collection of the information, but all this activity is done without interfering in his/her work.

3.1 Collection of Navigation Data

In a normal session the students has access to: "Forum/Help"; "List of Constructions"; "Workbench"; "Constructions Administration". In each of this sections we collect the following data:

Forum / Help which pages where visited; which documents where downloaded;
List of Constructions which constructions where selected; which actions (save, update, remove) where done for each selected construction;
Workbench which constructions where selected and or new constructions saved; which actions, in the DGS, where done to each construction;
Constructions Administration which pages where visited.


WebGeometryLab User' Logs

(PQaluno2/pqaluno2/82)

Path	File	Query	Entry Time
	Action	Argument	Action Time
	users.php	name=PQaluno2&type=Regular	2014/01/29 18:05:05
Workbench/	interaction.php		2014/01/29 18:05:05
	SelecConstrucionFunc	Id= 154	2014/01/29 18:05:05
	SelecConstrucionFunc	Id= 154	2014/01/29 18:05:05
	UpdateConstrucionFunc	Id= 154	2014/01/29 18:05:05
	SelecConstrucionFunc	Id= 154	2014/01/29 18:05:05
Workbench/	interaction.php		2014/01/29 18:06:06
	SelecConstrucionFunc	Id= 154	2014/01/29 18:06:06
	UpdateConstrucionFunc	Id= 154	2014/01/29 18:14:14
	SelecConstrucionFunc	Id= 154	2014/01/29 18:14:14

Fig. 1. Navigation Data

No automatic processing of this information is made at this moment. All this information is made available to the student's teachers, and only to then (see Fig. 1). It is the teachers responsibility to process this information and, eventually, provide some individualised help, in a form of a list of geometric constructions, to each of his/her students.

3.2 Collection of Geometric Data

Using the *WGL* the student has access to the DGS applet in two stages: when browsing the list of constructions made available by other; when working in the workbench.

When using the DGS applet all the actions about the creation, the modification and the erasing of geometric elements are recorded in the database. Using listeners, JavaScript functions provided by the applet, all the actions are saved in the database.

Again no automatic processing of this information is currently being made. All this information is made available to the student's teachers, and only to then. This time the interface provided allow the teachers to see the "movie" (see

Fig. 2), e.g. using the DGS applet the teacher is able to recreate all the steps done by his/her students in different working sessions (buttons “next action”, “play” and “stop”).

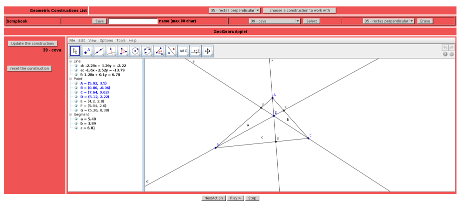


Fig. 2. Geometric Data

Using this information, adding to the navigation information and all in-class information, the teacher can infer the van Hiele levels of each of his/her students and, again, to provide some set of constructions/tasks that allow each student achieve the desired learning goals.

Learning environments supported by computer are seen as a important mean for non classroom education. The DGS are also important in classroom environments, as a much enhanced substitutes for the ruler and compass physical instruments, allowing the development of experiments, stimulating learning by experience. There are several DGS available, such as: *GeoGebra*, *Cinderella*, *Geometric Supposer*, *GeometerSketchpad*, *CaR*, *Cabri*, *GCLC* but none of then defines a Web learning environment with adaptive and collaborative features [7]. The program *Tabulæ* is a DGS with Web access and with collaborative features. This system is close to *WGL* the permissions system and the fact that the DGS is not “hardwired” to the system but it is an external tool incorporated into the system, are features that distinguish positively *WGL* from *Tabulæ*. The adaptive features and the internationalisation/localisation are also features missing in *Tabulæ* [7].

4 Conclusions and Future Work

When we consider a computer system for an educational setting in geometry, we feel that a collaborative, adaptive blended-learning environment with DGS and GATP integration is the most interesting solution. That leads to a Web system capable of being used in the classroom but also outside the classroom, with collaborative and adaptive features and with a DGS and GATPs integrated.

The *WGL* system (version 1.2) is a work-on-progress system. It is a client/server modular system incorporating a DGS, some adaptive features, i.e., the individualised scrapbook where all the users can keep their own constructions and with a collaborative module. Given the fact that it is a client/server system the incorporation of a GATP (on the server) it will not be difficult. One of the authors has already experience on that type of integration [2,3,4].

A workshop with high-school teachers on the use of the *WGL* collaborative platform is being done, November 2013 – February 2014. In this workshop teachers played the roles of student and teacher at different times, performing collaborative tasks. With this workshop it was intended to help teachers to include in their teaching practice the *WGL* platform providing a collaborative environment for geometry in their classrooms. The preliminary results of this workshop are very positive and this, and past, experiences are also being used to improve the *WGL* platform with more features suggested during these experiences.

The next task will be to finish the adaptive module providing some automatic, or semi-automatic, help to the teacher to the construction of student's profiles. A last task will be the integration of the GATP in the *WGL*. We hope that at the end the *WGL* can became a very challenging learning environment for geometry.

The *WGL* system is available at `hilbert.mat.uc.pt/WebGeometryLab/`. You can enter as "anonymous/anonymous", a student-level user. A use of the *WGL* platform in the role of a teacher is also possible but it is subject to approval by the *WGL* administrators.

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