USING GEOGEBRA APPLETS FOR HOMEWORK ASSIGNMENTS

Šárka GERGELITSOVÁ[1], Tomáš HOLAN[2]

Charles University in Prague, Faculty of Mathematics and Physics
Malostranské nám. 25, 118 00 Praha 1, CZECH REPUBLIC
[1]email: Sarka@gbn.cz, [2]email: Tomas.Holan@mff.cuni.cz

Abstract. Elementary geometry problems referring to the plane are difficult for many students. One of the reasons for this fact is that the process of solving and evaluating such tasks is very much time consuming. Besides, evaluation of the tasks is highly complicated. In consequence, the students do not resolve as many problems as it is necessary to make them gain sufficient experience. Automatic evaluation of such tasks would speed up the evaluation process a lot. However, due to the complexity of the problems it is difficult to find a proper automated, or computer, system which might be used for this purpose. In this article we will describe a newly developed online system used by the authors and other teachers for the plane tasks evaluation. The students solve assigned tasks in GeoGebra applets embedded in web pages and submit answers to a server where they are automatically evaluated. The system has now been used at all levels of school education, starting from the high school teaching and ending up on university studies.

Keywords: construction, elementary geometry, plane geometry, task, evaluation, GeoGebra

1   Introduction

GeoGebra [1] as a tool for interpretation of geometric constructions has already found its fundamental role and place in teaching geometry.

Although it is widely used by the teachers and it benefits to the process of demonstration the use of GeoGebra to solve homework assignments is still limited. With the use of Geogebra it is possible to share and view predefined geometrical constructions, to share all the didactic materials prepared by the tutor as well as to stimulate and to motivate students for performing further research and experiments as they individually work at home.

Principal role of a teacher is to evaluate the correctness of solutions provided by students, to give the hints how a specific solution can be improved or developed, to stimulate the development of creative thinking and to evoke need to search for another solutions. The feedback given to the students is a crucial point of the educational process.

2   State of the Art

A domain of the so called Learning Management Systems (LMS) is to administer the students' accounts, to upload teaching materials, to assign the tasks to the students and to monitor the progress made by the students. Each LMS system usually allows the teachers defining and creating the (multiple-)choice tasks or tests requiring from the students to enter the proper responses which can be directly evaluated by the system. The LMS however does not allow automatic evaluating of such complex tasks as geometric constructions are.

GeoGebra pages [2] prompt how one can embed an interactive GeoGebra applet into LMS like Moodle [3] system. However, there one would not find the prompts how can the system be used for an evaluation process, especially in terms of accuracy of solutions received in the software.

There exists a GeoGebra filter [4] which can be used for the purpose of embedding GeoGebra into the Moodle platform. The filter does not explain how the system may be used for evaluation pupose.

What's more, there exists a GeoGebra Moodle filter [5] that allows embedding GeoGebra activities into Moodle course and which enables storing the scores, the date of activity, the time duration of solving process and the notification on the numbers of trials/attempts to perform the construction by each of the user. It is necessary that an individual set of data must be assigned to a specific variable.

None of the described above can be used in order to evaluate the correctness of the construction.

Furthermore, there exist some other systems like Physics Applets for Drawing (PADs) [6] which enable the evaluation just inside the applet but which do not have the capability of recording the students' make progress.

3   Evaluation of plane geometry constructions

Evaluation of plane geometry constructions can be made in various ways.

If the answer has the form of a drawing, the teacher has only little knowledge about procedure used by the student to perform the task. Moreover, the evaluation of a drawing is always encumbered by its quality: the clarity and the precision of a drawing require application of completely different skills than only the ability to find out and apply a proper algorithm.

If the answer has the form of a construction protocol or if it is accompanied by it, it is possible to consider the logic of construction, but the same task can be solved by various methods, while the question arises whether the described procedure leads to the correct solution and the evaluation process is tedious and laborious.

These two difficulties can be eliminated if the constructions are made using the GeoGebra (or another system of dynamic geometry). A drawing made with the use of GeoGebra is precise and clean, a construction protocol is usually automatically generated and the teacher can determine whether the elements forming the result of the task fulfill the assignment requirements even if the author changes the values of parameters of the construction.

However, it may happen that the solution is anyway incorrect. This may happen e.g. when the student chooses ad hoc the radii of the specified circles (Fig. 1).
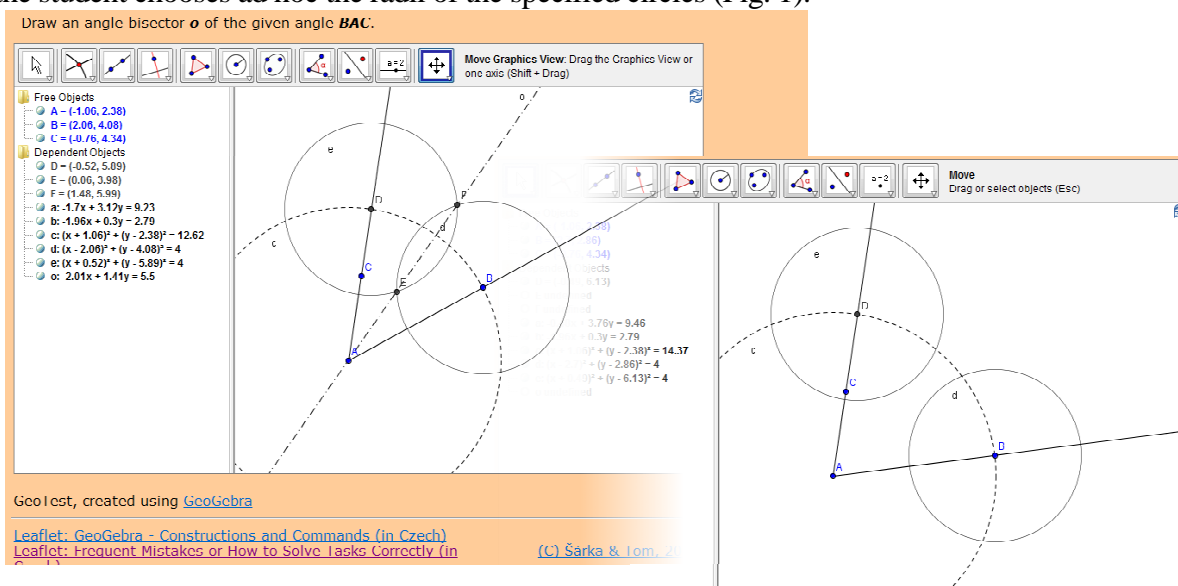

Figure 1: One example of an incorrect answer

In all the described cases the constructions are typically evaluated by the teacher which leads to an insufficient feedback given to the learner. The answers are delayed due to the laboriousness of evaluation process and also to the fact that the teacher can give a limited number of answers.

4   An automatic evaluation of construction geometry assignments – GeoTest system

In [7] is described the procedure which must be taken up to automatically evaluate the construction made within the GeoGebra system.

Once the correctness of a construction has been evaluated automatically, there is no reason why should the student postpone the submission of his/her answer and to wait for the teacher's response.

Instead, the student can let have his/her solution evaluated immediately by the system and in case the solution was evaluated as "Wrong", he/she is able to continue the solving process to find out the errors and to submit a new solution.

As it is mentioned in the Results section, immediate response by the system lets the student solve a higher number of tasks with the correct solutions.

As there is not more effort input involved in evaluation process of the student's tasks solutions and as the total process of submissions and feedback processing has become more effective and accelerated by at most to a few seconds, we can observe that a higher number of the assigned (and solved) tasks have been solved by the students in the comparable time period as it has been earlier done.

An automatic evaluation of construction geometry assignments is the basis of our system which we call the GeoTest [8].

The core of the system is a set of prepared **tasks** that the system can automatically evaluate. There are more than 600 of tasks in the set now, and they meet demands of high school curriculum of plane elementary geometry and a part of descriptive geometry course.

The **teacher** creates and manages accounts for his/her **students**, chooses the tasks from the prepared list and forms the so called **groups** for particular sets of tasks (homework, test, exercise...) designed for the chosen groups of students.

After login the **student** can see a list of his/her groups, where all outdated groups are marked with different colours. When he/she selects a group, the list of assigned tasks is shown. After he/she chooses one of the tasks, he/she can see its detailed specification and GeoGebra applet (with the specified parameters of the task), in which the task is to solve.

A solution can be submitted for evaluation at any time. Whether the solution was correct or not, the student can go on solving the problem and submit new solutions, choose another task (or go back to select another group).

Each student can see an overview of his/her results of assigned problems in the group and each teacher can see an overview of results of all his/her students (see Fig. 2).

5   Results

System GeoTest has been used by (the approximate number) 100 teachers and 4000 students in 100 classes by now. The students have been assigned over 5000 tasks (all students in the group or class were assigned the same tasks), over 160 thousands of answers have been submitted and evaluated and more than 90 % of the tasks that the students had begun to solve were finished with the correct answer.

Figure 2: Overview of results of all students in the group

6   Conclusion

An automatic evaluation system of construction geometry assignments widens the range of use of dynamic geometry system GeoGebra.

It supports students' independent work, it provides them with faster feedback than teacher could give them and as such it has a positive impact on the success of students in solving problems and it improves an effect of teaching process.

The students enjoy doing homework using the system while the teachers save their time and effort and all this extends students' experience in solving geometry problems.

References

[1]   *GeoGebra.* Retrieved May 12, 2014: http://www.geogebra.org

[2]   *Geogebra wiki: Manual: Embedding to cms, vle (moodle) and wiki.* Retrieved May 12, 2014, from GeoGebra Wiki: Manual Web site: http://wiki.geogebra.org/en/Manual:Embedding_to_CMS,_VLE_%28Moodle%29_and_Wiki

[3]   *Moodle.org.* Retrieved May 12, 2014: https://moodle.org

[4]   *Geogebra filter.* Retrieved Retrieved May 12, 2014: http://docs.moodle.org/23/en/GeoGebra_filter

[5]   Valiente, J. F., & Téllez, S. A. (2012). *Geogebra moodle filter.* Retrieved May 12, 2014: https://moodle.org/plugins/view.php?plugin=mod_geogebra

[6]   Bonham, S. (2012). *Physics applets for drawing.* Retrieved May 12, 2014: http://physics.wku.edu/~bonham/PADexamples

[7]   Gergelitsová Š., Holan, T.: *An automatic evaluation of construction geometry assignments.* Springer-Verlag, New York Berlin Heidelberg, 2012.

[8]   *Geotest.* Retrieved May 12, 2014: http://geotest.geometry.cz

WYKORZYSTANIE APLETU GEOGEBRA DO SPRAWDZANIA PRAC DOMOWYCH

Elementarne zadania geometryczne na płaszczyźnie stwarzają trudności wielu studentom. Jednym z powodów jest fakt, że proces rozwiązywania i oceny tego typu zadań jest czasochłonny, a sama ocena jest dość skomplikowana. W związku z tym uczniowie nie rozwiążą tyle problemów, by zdobyć wystarczające doświadczenie. Automatyczna ocena tego rodzaju zadań jest w stanie przyspieszyć ten proces, ale ze względu na jego złożoność dotychczas było to poza możliwościami znanych systemów.

W artykule opisujemy nowy, system internetowy. Uczniowie rozwiązują zadania w apletach GeoGebry osadzonych na stronach internetowych i składają odpowiedź na serwerze. Program znajdujący się na serwerze ocenia je natychmiast. System jest obecnie stosowany na wszystkich poziomach nauczania, od szkoły podstawowej poprzez liceum do uniwersytetu.