GEOGEBRAPRIM – GEOGEBRA FOR PRIMARY SCHOOL

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In this article we present the project GeoGebraPrim – GeoGebra for Primary School, a project funded by the University of Luxembourg. We will give a short overview of the project, explain the educational and technological concepts used and present first results of the study. More details will be available at the conference.

THE PROJECT

The project GeoGebraPrim started in January 2007 and will be funded until the end of this year. Its main focus is the use of the software GeoGebra(Prim) in primary school (in Luxembourg) and the integration of GeoGebra(Prim) into TAO.

GeoGebra(Prim) (see http://www.geogebra.org)

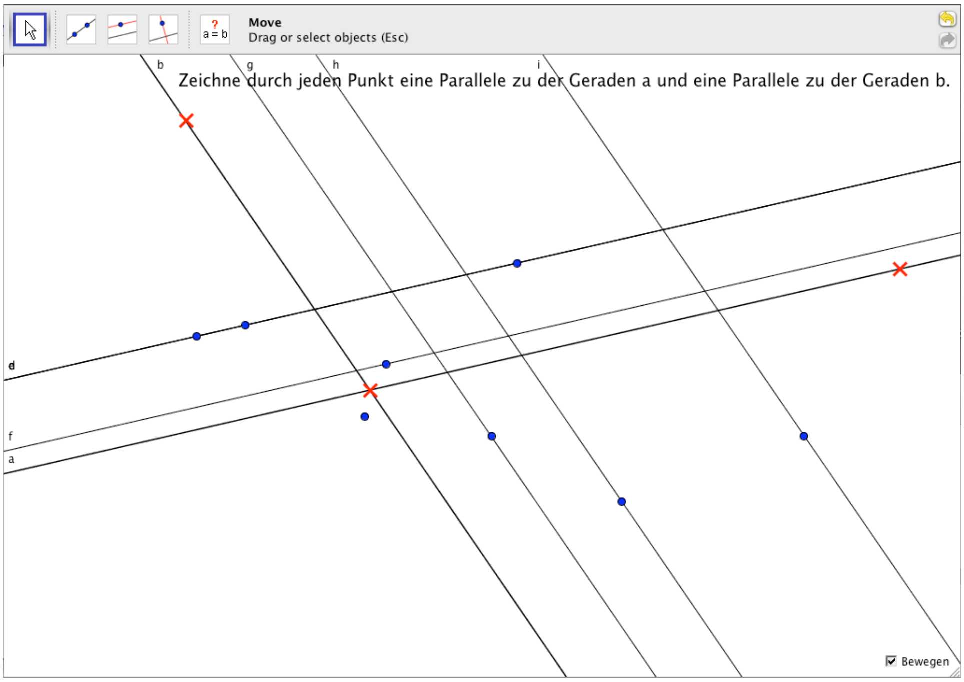

Figure 1: Exploring parallel lines in GeoGebraPrim

So far our desired changes of the existing Dynamic Mathematics Software (DMS) GeoGebra towards GeoGebraPrim – a variant of GeoGebra corresponding to the needs of the primary school – have been identified through multiple observations of children working with the software. Unfortunately the limitations of the project have only permitted us to realize few modifications. Thus the main changes have been the simplification of the user interface by disabling all unneeded features and tools (see Figure 1) and the creation of new tools to fulfil tasks not (yet) available in GeoGebra.

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TAO (see http://www.tao.lu)

TAO is the French acronym for Testing Assisté par Ordinateur (Computer Based Testing). Its framework provides a general and open architecture for computer-assisted test development and delivery and will be used to acquire an extensive protocol of the children's work (beyond the simple result).

THE STUDY

The study consists of a pre-/post-test scenario combined with observations of particularly interesting children. All in all approximately 200 children[1] of 9 years distributed in 8 classes and 4 schools in Luxembourg will participate; about half of them will follow a traditional paper-and-pencil geometry course while the others will be mixing experiences on the computer with the traditional ones.

Goals

The drag mode in GeoGebraPrim allows a dynamic exploration and interactive transformation of the represented mathematical objects far beyond the possibilities of paper-and-pencil geometry (Laborde 2001, Kreis 2004). Thus we suppose that its use in class will improve the children's understanding of the basic geometric concepts (like parallel and perpendicular lines – compare Figure 1).

The need for a combination of Dynamic Geometry Software (DGS) and Computer Algebra System (CAS) into a DMS has already been presented in 2005 by Hohenwarter & Fuchs. Sangwin has stressed the unprecedented opportunities of a DMS for mathematics education again in 2007. In our study, the bidirectional link between the graphical representation (point, segment, etc.) and the corresponding algebraic objects (i.e. coordinates, length, etc.) allows the children to discover the formulas of perimeter and area. Moreover they can use them directly in the software using the input bar. Thus we assume that the children will get a deeper insight into the bond between geometry and algebra.

This leads to the following main research question:

- Is there a significant difference between the test and the control group when comparing the pre-test to the post-test (i.e. measuring the progress)?

Test Group and Pre-Test

The schools have been selected randomly; only a sufficient number of computers have been requested. There is an experimental class and a test class in each school resulting in a comparable socio cultural context for the two groups.

All children already have basic knowledge of parallel/perpendicular lines and square/rectangle figures because these subjects have been introduced in the 3rd grade. As this study must be considered exploratory work, we choose – to get as much data

[1] We are still waiting on the agreement with one school.

as possible – to let half of the 4th grade classes pass the pre-test before and half of the 4th grade classes pass the pre-test after their recontact with the geometric concepts seen before. This allows us to draw distinctive conclusions later on when answering the following questions:

- Is there a significant difference between these two groups in the pre-test?
- Is there a significant difference between these two groups in the post-test?
- Is there a significant difference between these two groups when comparing the pre-test to the post-test (i.e. measuring the progress)?

Results

As we only have part of the pre-test results, we cannot yet make major conclusions. However one result seems to be confirmed: the knowledge of the geometric concepts (especially the one of perpendicular lines) learned in the 3rd grade is very poor!

Teaching

We promote a teaching style that makes the children active and allows them a greater autonomy in their learning process and that arouses their motivation. All our exercises and experiments have been designed to fulfil this paradigm; however we only have marginal influence on the teaching style in the different classes, as probably[1] 3 out of 4 teachers want to give the courses themselves. Nevertheless we have prepared detailed worksheets for these teachers, which are hopefully followed.

The children can work together (or not) following different scenarios. The possibilities range from working alone alternatively on a small number of computers over working alone on a sufficient number of computers to collaborating in (small) groups. All settings have different (dis-)advantages. Our experiences tend in favour of groups of two children for this age.

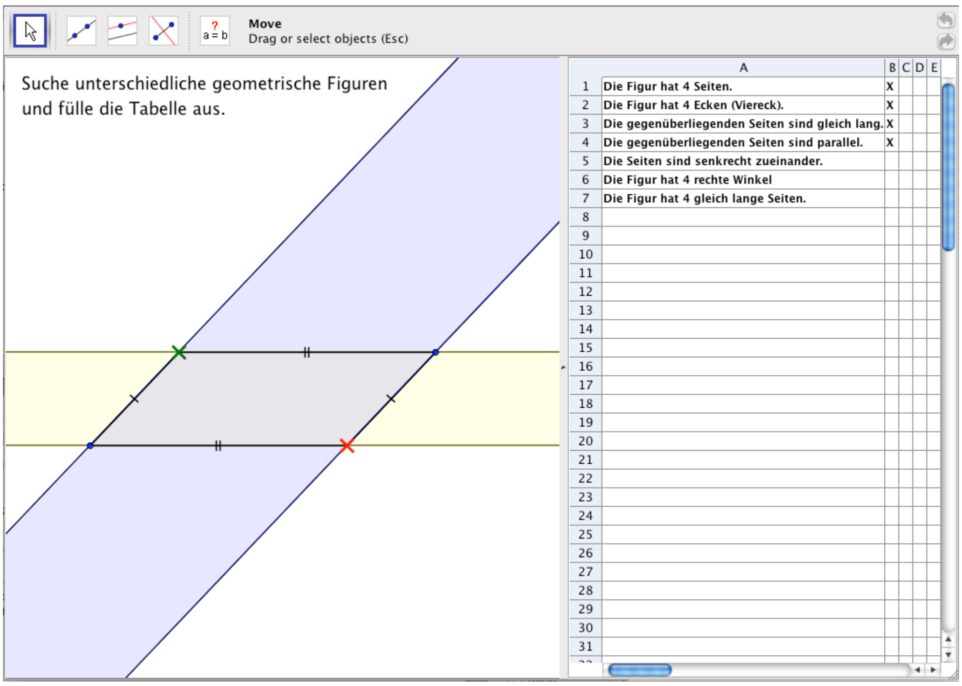

Figure 2: Exploring different geometric figures in GeoGebraPrim

In the following paragraphs we will describe a lesson (compare Figure 2) given by one of the authors. At the beginning the researcher opens the file on his computer; a beamer projects the screen. The children, who are organized in groups of two, do the same and read the instructions of the exercise. Before the different groups start with their own exploration all questions regarding the directives are answered.

The children start to investigate the construction, detect which objects can be moved in drag-mode and observe if some of the properties (here: right angle and/or segment length) change while dragging an object. Besides they can use the available tools to get further information (here: parallel/perpendicular lines) or to complete a required task (like “construct a parallel line to … through …”). Finally they should accomplish the requested task and ideally make conjectures of their own.

During the whole process the researcher and the teacher are available as resource persons to help the different groups individually without simply revealing the solution, to motivate them searching actively for (further) knowledge and to solve technical problems which might arise. In particular, they can ask advanced questions (like predicting what happens when they move a particular point of the figure) to the children who have finished their task.

Afterwards the exercises that need a completely different approach (like using a set square) are repeated using paper-and-pencil. This step is very important, as the children approaching geometry for the first time must also learn how to draw a (parallel/perpendicular) line correctly and neatly.

Post-Test

Ideally several post-tests will be conducted. First of all, all classes will pass the paper-and-pencil post-test in June. Further more, the test classes will pass another post-test online provided by the TAO platform, which will store and thus reveal details of the children. Last but not least we will try to organize another post-test for all classes after the summer holidays in October.

CONCLUSION

In this paper we discussed one way – the one where the children work using the computer – to use a DMS in primary school. Our experiments show that the children assume an active role in their learning process while being an explorer of the mathematical concepts. However the teachers must enhance and modify their teaching techniques, as a different way of geometric thinking and deeper insight in geometry concepts is required to use a DGS with a class. The children – even at the age of 9 – quickly bridge the technical challenge and rapidly start to make their own conjectures, which need to be answered. The only drawback we discovered so far is the requirement of a sufficient number of computers which unfortunately is not (yet) available everywhere (in Luxembourg).

References

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