THE PERSONALIZED AND MULTILINGUAL MATHEMATICAL LEARNING ENVIRONMENT MATHEMATIC

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The personalized and multilingual mathematical learning environment MathemaTIC is one of the flagship projects of the Digital (4) Education strategy of the Luxemburgish Ministry of National Education, Children and Youth incorporated in the concept Digital Luxembourg of the Luxemburgish government. It is based on the national curriculum, allows different pedagogical objectives (differentiation, individualization, remediation and certification) and offers 4 languages (German, French, Portuguese and English) to the user. The development is done in partnership with the teachers who can follow in real-time the learning progress of their students working in class or autonomously at home. The project is coordinated by the Agency for the Development of Quality in Schools of the Luxemburgish Ministry of National Education, Children and Youth.

INTRODUCTION

The predominant place taken by computers in all-day life and especially at work, urge a transition from paper-and-pencil towards digital learning. In fact computers are already available in most classrooms in the United States for nearly two decades (Becker, Ravitz, & Wong, 1999), and in Luxembourg nowadays all primary schools have access to at least a few of them. However the development of high quality (mathematics) learning software is expensive and time consuming (Krauthausen, 1999, 2005) and thus a lot of private companies are not willing to invest a six-digit sum for a product sold for maximum 40 Euro.

While multiple applications exist for teaching and learning mathematics (IGS, CAS, spreadsheets, …) and although their successful usage (i.e. of GeoGebra) has been shown in the Luxembourgish context (Kreis & Dording, 2010; Kreis, Dording, & Keller, 2010), these tools very often offer only isolated exercises in one language.

DESCRIPTION

MathemaTIC will however cover the whole Luxembourgish curriculum for 10-11 year old children in German, French, Portuguese and English independently of a particular textbook and graphically shows the learning progress of each student in real-time. It can be used in school or autonomously at home and serves different pedagogical objectives depending of its usage: differentiation, individualization, remediation and certification.

This learning environment is developed in partnership with teachers, researchers and curriculum specialists. The involvement of the teachers is very important – especially in the multilingual context Luxembourg is facing nowadays – to gain the required acceptance for a regular usage in schools. The development focus is that the platform can be easily integrated in the classroom and that it can actually partly replace the usage of a textbook.

Pilot Phase (April 2015 till September 2015)

The pilot phase with only part of the curriculum started in April 2015 with approximately 25 schools, 70 teachers and 900 children. A lot of valuable feedback has been received from the involved teachers on the relevance of the contents and from the participating children on the usability of the interface.

Test Phase (October 2015 till August 2016)

Starting October 2015 the environment has been made available for a selected number of Luxemburgish primary school classes. As of today 1338 children from 35 schools are using it in school and at home. The project team will visit each of the participating 88 classes 5 times during the school year to collect data about its usage while the 96 teachers agreed to follow between 7,5 and 14,25 hours of in-service teacher training related to MathemaTIC.

Finalization Phase (starting September 2016)

The entire content is expected for September 2016. Then all classes with 10 or 11 year old children in Luxembourg will have optional access to the learning platform.

INTERFACE

The interface is separated into a student view and a teacher view. The teacher has of course access to both views to be able to test the items the students will work on.
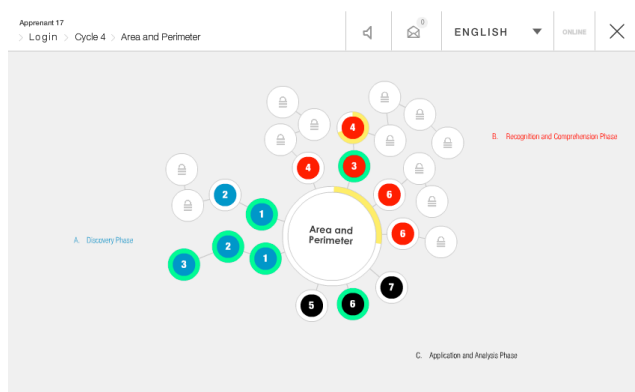
Student's View
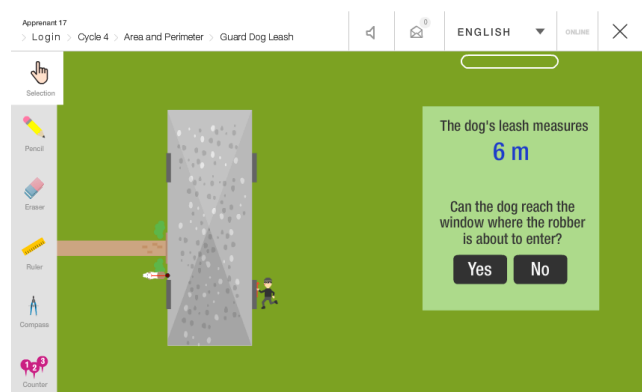

Figure 1: Student's Module View   Figure 2: Student's Item View

After login the student sees all modules, which are available on the platform. Some might be locked, others ongoing, and others completed. When the student first enters a module he must perform a diagnostic test that will determine which items will be directly available. Then the student is inside the module (fig. 1) and can choose which item he wants to work on.

The items are grouped into 3 sections using colors:

- The blue items represent the discovery phase.
- The red items represent the recognition and comprehension phase.
- The black items represent the application and analysis phase.

The first item of a branch – there can be multiple branches of the same color – is always unlocked. Further items might be unlocked right away depending on the result of the diagnostic test. When the student has finished an item with a predefined success rate then the progress bar turns to green and the next item of that branch is unlocked; otherwise the progress bar is yellow and the student must rework the same item before proceeding in that branch.

Besides the module has an overall progress bar. It serves as learning indicator and gives a quick feedback about the student's progress. At the end of the module the student takes a final test to summarize his learning achievement.
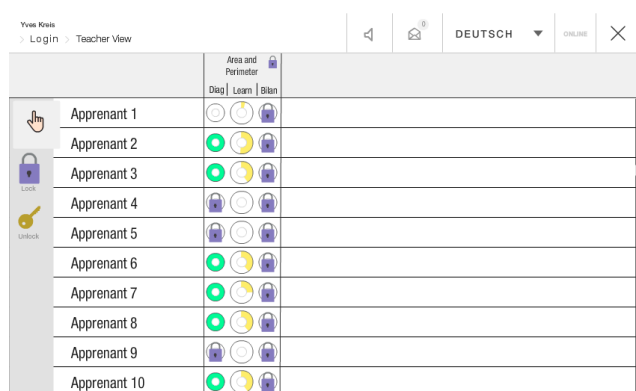
Teacher's View

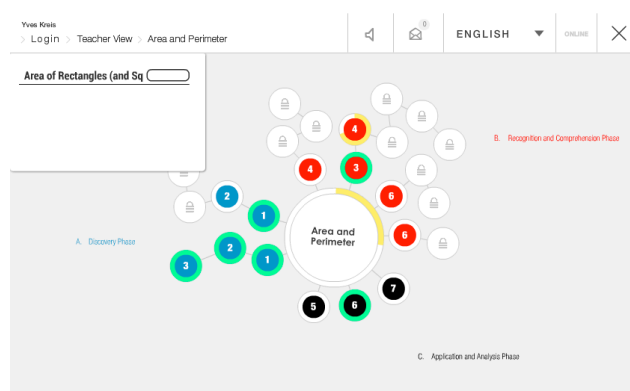
Figure 3: Teacher's Class View

Figure 4: Teacher's Module View

The teacher can (un)lock the diagnostic test and the final test. Afterwards he can follow the learning phase of his students in real-time independently if they are working in class or at home. The module's overall progress bar can be seen in the class view (fig. 3), and is clickable to access the same module view a student has but with additional information (fig. 4).

While the teacher can only see the total score of his students in the diagnostic test (to prevent an assessment), there is detailed information about their answers in the final test. These results can be printed and shared with the child and its parents or be used as a complement to another assessment.

Each module comes with a detailed didactical manual to help the teacher plan the integration of MathemaTIC in his daily activities. It describes the discovery and refreshes phase (with potential activities) and the learning phase (the alignment with the recommended text book as well as the detailed description of the items). The curriculum alignment is described in the appendix.

RESEARCH

The possibilities for research are multiple. The Luxembourg Centre for Educational Testing (LUCET) is a partner in the project. They collect annually data for the (mathematics) competencies for half of all the Luxembourgish students through standardized tests. The results of this large-scale testing can be compared to the usage and performance data retrieved through MathemaTIC. We expect a positive effect of the learning platform on the students' comprehension.

Besides this medium to long-term goal, a detailed analysis of the students solving approach (i.e. which tools are used) can reveal their strategies and their level of understanding of the topic. This is especially interesting for complex problems (fig. 2) where multiple interesting strategies exist.
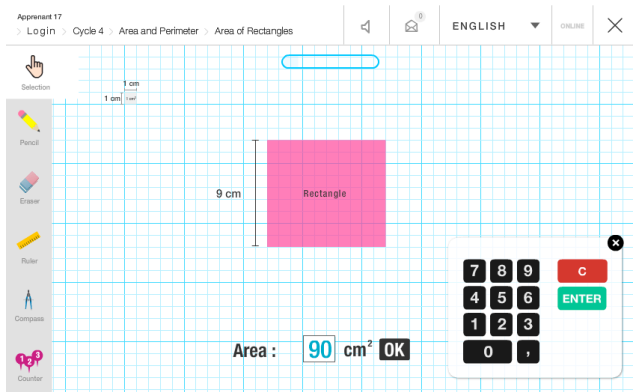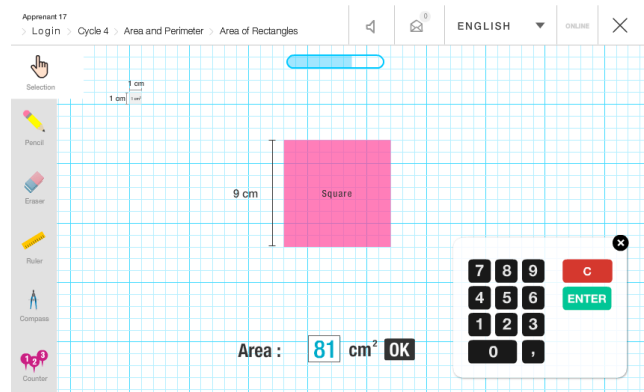
Figure 5: Area of a Rectangle

Figure 6: Area of a Square

We can also compare different items, which on first view look similar to the student: the information contained in figure 6 is however complete in the sense that no further information is required to calculate the correct result while the information in figure 5 is incomplete (the width is missing). Do the students recognize this or do they measure/count/… the width in both examples?

CONCLUSION

The personalized and multilingual mathematical learning environment MathemaTIC is currently used by approximately ¼ of the Luxembourgish children of age 10-11. It modifies the way these kids learn mathematics. At the current stage positive effects cannot yet be shown, but the way the platform has been conceived and the partners involved in the project let us hope that we will soon be able to provide this evidence.

In the meantime the software gives us a deeper insight in the solving of series of related exercises and provides us with data about the strategies used and the level of understanding acquired by the participating children. Besides we start collecting large-scale computer-based low-stakes assessment data using the final tests of the different modules, which can be compared to the standardized tests of LUCET.

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