Multilingual Delivery of Online Tests in Mathematics

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Introduction

Assessment and the advice given to individual students based on quiz and test results form the most expensive part of the delivery of education. Imagine a future in which all this has been automated: students take quizzes, examinations and type their solutions to homework problems in web based systems which give immediate individual feedback. This future is already here today.

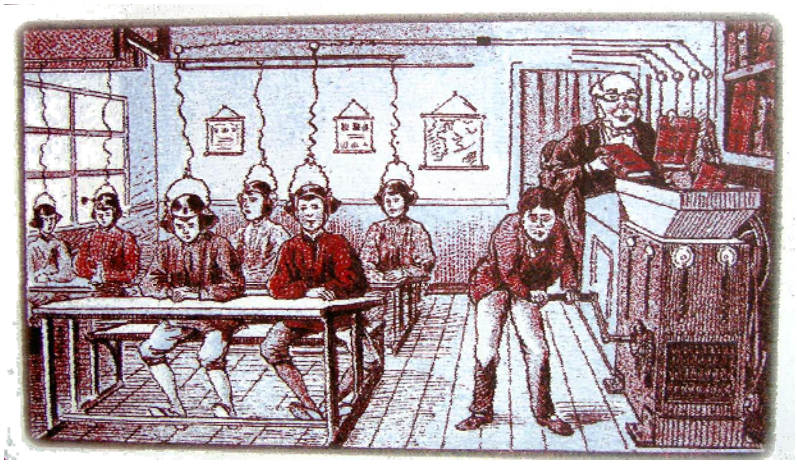

Figure 1. An early view of industrialization of instruction. The professor chooses the content, the graduate student propels the machine, and the students learn. Today this vision is being realized by different means.

The content, making this kind of industrialization of instruction possible, is very valuable, and the production of such content requires specific combination of expertise. In disciplines like mathematics, in which the required linguistic constructs are relatively simple, it is possible to encode the content in such a way that it can be automatically generated in many languages. Such an encoding multiplies, many times over, the value of the complicated content, i.e. question databases for automatic assessment. The WebALT project has developed such a language independent encoding for mathematical content together with tools to

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make it usable and editable. The WebALT multilingual software solutions target, in particular, basic mathematics areas such as calculus, linear algebra and geometry for higher education. However, the technologies used are amenable to any level of education in mathematics or in science. This project has been supported by the eContent Programme of the European Commission.

This extended abstract describes the multilingual mathematics software solutions developed by the Web Advanced Learning Technologies project and explains how to deliver effective and incisive courses in mathematics using e-Learning technologies.

Online Assessment

Online assessment systems support a variety of question types, ranging from simple multiple choice or true/false questions, to the more sophisticated kind in which the student is allowed to type the answer and the system is able to check it against the correct solution. Automatic grading of the latter type of answers is very sophisticated because the correct answer can be, almost always, written in infinitely many different ways. The system must have sophisticated computational engine to check the correctness of such answers. Such engines are available and the WebALT system offers one solution based on the use of MapleTA [6].

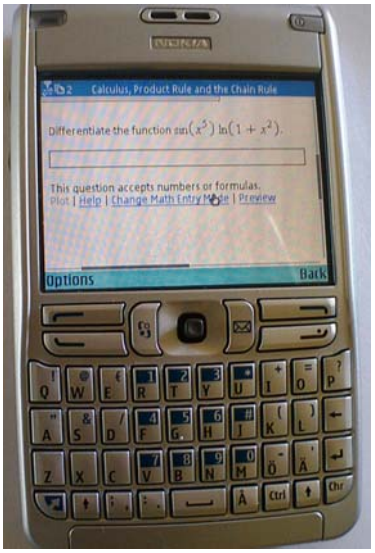

Figure 2. Online exercise on a mobile phone. Because they can be accessed using a conventional Internet browser, they are readily available with standard software.

While the conventional hand-out assignment is a static document, these systems are able, upon request, to generate a practically unlimited number of similar questions, in fact as many as the student is willing to practice. Ideally, provided that a collection of ready made high-quality exercises and problems to choose from would be available, the task of the instructor would reduce to that of choosing the right type of exercises to be assembled in an assignment.

The aim of the Web Advanced Learning Technologies project* is to provide such a collection of mathematical exercises exhibiting the best interactive features supported today by the online technology. In addition, by the combined use of web technologies for representing mathematical exercises with computer technologies for natural language generation, the same suite of mathematics assessment tests can be delivered in a variety of languages including e.g. English, Spanish, French, Italian, Swedish and Finnish.

* http://www.webalt.net

Multilingual tests in mathematics

Multilingual tests in mathematics are exercises that can be viewed by the student in a number of pre-defined natural languages. These exercises are produced by the authors using WebALT software that allows creating a language-independent representation of the kind of sentences used in the statements of typical mathematical problems. This abstract representation captures the meaning of the sentences, and can be used to automatically generate presentations in natural languages such as Spanish, English, Swedish, and French. The verbal form presentation of the question for the final reader, that is generated automatically, can be chosen to best suit the user-preferences or level of mathematical sophistication (for instance by tuning the use of symbolic expressions or of notation).

By allowing the student to view the exercises in a preferred language, multilingual tests in mathematics overcome language barriers in bilingual communities or in communities where there are large minorities speaking a language not supported at schools. Moreover, the possibility to use the same exercises in different countries represents a step forward in the process of creating international curricula based on competencies and setting standard assessment procedures for entry levels.

Authors, on the other hand, are guided during the production of interactive exercises in the choice of possible sentences by a mechanism of predictive typing that prompts them for valid multilingual constructs based on the text they have input so far. Sentences created, in English, using the WebALT TextMathEditor are multilingual in the sense explained above and the author may preview the presentation in the supported languages.

The WebALT Exercise Repository is a repository of learning objects, in particular interactive exercises in mathematics. All materials are provided with rich LOM metadata and with additional ad-hoc taxonomy for the specific subject area of Mathematics. All types of algorithmic questions are supported including in particular open questions expecting symbolic expressions as answer and tree-exercises which are problems solved in multiple steps. The same exercises can be downloaded and saved in a variety of languages and can be deployed using commercial assessment software like MapleT.A. [6] or open source solutions like STACK/AiM [4, 5] and LeActiveMath [7]. For the MapleT.A. platform, WebALT provides a plugin that can be used with the Firefox browser to allow selection of the language at play-time and to integrate the TextMathEditor with the MapleT.A. editor during authoring.

Online mathematics courses

Interactive exercises are an important ingredient of an online course in mathematics but are not the unique one. When teaching is carried out purely

online in a synchronous fashion, for instance meeting in a virtual classroom with the students, it is equally important either to have a set of lecture notes and slide presentations especially designed for this kind of medium or to be able to use new hardware like digital smartboards and tablet PCs to replicate the conventional classroom experience.

In our experience, in case of an e-lecture in mathematics, in which formulae, theorems, graphs and proofs have to be discussed; technology has to be chosen carefully [1]. A digital version of a conventional book is not an optimal solution since it does not highlight the important concepts not can it be shown in a stepwise incremental fashion. Tablet PCs and smartboards are a solution if formulae can be written as well as with paper and pencil and recent advances in recognition of handwritten mathematical expressions seem very promising [8]. This kind of hardware technology allows the lectures to use the tablet or the smartboard as if it were a conventional blackboard. All that is being written can be stored digitally, in the worst case as images, much like scanned handwritten lecture notes. In some cases however, mathematical formulas can be recognized and converted to a format that a computational engine may process and manipulate, thus providing a natural seamless integration with the computer processing power. Applets, computer animations and computational software environments are excellent insofar as the students are guided in experimenting with them and the experiments to be carried out are explained. The possibility of recording the lecture is very welcomed by the students and should certainly be taken into account when choosing the virtual conferencing system. Finally, new mobile phones, game consoles, and portable video players are relevant platforms on which to deliver instruction and eLearning material ought to be produced and designed so that it can be played on them.

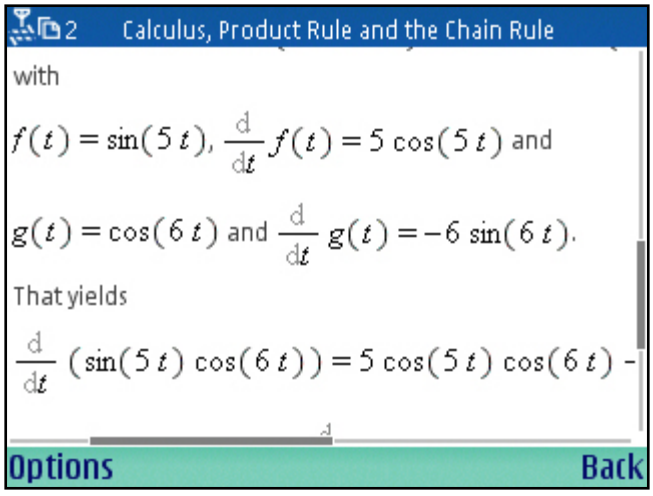

Figure 3. Complicated mathematical formulae are readable even on the display of today's mobile phones. The above picture is a screenshot of the display of Nokia E61.

It is not hard to imagine that students will need only a mobile phone, a wireless hotspot and an online testing environment to carry out their practice problems while commuting to work. Online assessment, quizzes and examinations can be delivered even using hand-held internet devices like Nokia E61 which can use either WLAN network or access the internet using services provided by an operator. Operators' internet services are still prohibitively expensive almost everywhere while accessing the internet using WLAN connections is mostly free

for the users. Hand held devices, which can use both WLAN and telephone operators' networks, form a key component of the technological infrastructure needed to industrialize instruction. Such hand held smart phones are soon very common, and they provide an inexpensive way to administer examinations in classrooms. Expensive computer laboratories are not needed anymore. The infrastructure needed to industrialize instruction is getting mature.

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