ECP-2008-EDU-428046

Math-Bridge

Customized and personalized access, version 1

Deliverable number	*D-7.2*
Dissemination level	*Public*
Delivery date	*31 May 2011*
Status	*Final*
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This project is funded under the *e*Content*plus* programme[1] ,
a multiannual Community programme to make digital content in Europe more accessible, usable and exploitable.

[1]OJ L 79, 24.3.2005, p. 1.

Project ref.no.	ECP-2008-EDU-428046
Project title	Math-Bridge European Remedial Content for Mathematics

Deliverable dissemination level	Public
Contractual date of delivery	October 31^{th},2010
Actual date of delivery	May 31^{th}, 2011
Deliverable number	D-7.2
Deliverable title	Customized and personalized access, version 1
Type	Demonstrator/Report
Status & version	Final, Version1
Number of pages	9
WP contributing to the deliverable	WP7
WP/Task responsible	Eric Andrès
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EC Project Officer	Marcel Watelet
Keywords	Personalization, Customization

Contents

Introduction

This document is an addition to D7.2, which is the initial server deployment of the Math-Bridge service accessible at `http://service.math-bridge.org`. It describes the state of the various components contributing to the customized and personalized part of Math-Bridge and is complementary to D7.1 [4], which describes the implementation of the pedagogical remedial scenarios.

The deliverable is to be submitted in the two versions. This version focuses on the adjustments performed in the student model, followed by a description of the ongoing graphical redesign.

1 Student Model Customization

The original student model of ActiveMath had to undergo several changes and updates in order to meet the requirements of the Math-Bridge project, especially for the new competency-system used in Math-Bridge [1],[2] and for the integration of external assessment tools.

1.1 Competency Model Adaptation

The first step of the implementation of the competency-system consisted of the implementation of the constants of the mathematical competencies and the achievement levels. An important difference of the new competency-system used by Math-Bridge, compared to the competency-systems which were already supported by ActiveMath's student model, was an additional dimension: the achievement level. The achievement level can be seen as a complexity level within each mathematical competency. Therefore, it is stored together with the mathematical competency metadata of a learning object.

Another change concerned the number of different difficulty-levels. In the original version there were five difficulty-levels (very easy, easy, medium, difficult and very difficult). This has been reduced to three (easy, medium, difficult). The student model has to interpret the new difficulty levels differently and assign each of them a wider range. Otherwise, a student would never be able to reach the same high mastery in the new student model with difficult exercises as previously with very difficult exercises. Furthermore, the new difficulty metadata is to be interpreted in relation to each achievement level of the mathematical competencies.

A weakness in the original student model was that the difficulty of an exercise was applied to all competencies trained in an exercise. Assume for example an exercise that trains

both drawing a graph and proving a theorem. However, the graph part is very simple but the theorem is complex. As a whole the exercise is very difficult, so the original student model would inaccurately assume high skills both in drawing graphs and proving theorems. However, with the achievement level we can assign different complexity levels to each mathematical competency within the same exercise. The student model has been updated for this to handle difficulties (and achievement levels) separately for each competency.

A new competency system in ActiveMath also requires translation maps to at least one of the other already implemented competency systems. These translation maps enable the student model to translate models between different competency systems and is especially useful to import old assessment models from a different competency system to the Math-Bridge competency system. Another benefit is that exercises annotated in different competency systems (e.g. PISA competency system) can be continued to be used in Math-Bridge and can be used with the new competency-system despite of its different annotation. The current mapping is a first version and requires further review and (empirical) validation.

1.2 Evidence Model Adaptation

The initial version of the Student Model was based on a dichotomous evidence model - an exercise step was considered to be either correct or wrong. However, in the context of Math-Bridge, there are two situations in which we need to handle evidences with partial correctness. The assessment tools integrated in the upcoming deliverable D 6.1 [3] report a degree of correctness for individual problems. In the Kassel-Paderborn content, there are self-assessment exercises in which the student is requested to grade herself by comparing her solution to an expert solution. These grades also represent the notion of partial correctness.

Formally, the requirement for Math-Bridge was the weighting of some specific evidences (evidence: the fact that a student has solved a specific exercise correctly or wrongly). An additional requirement was that (self-)assessment exercises should have a stronger influence for the mastery estimation than usual exercises. Additionally, it should make a difference whether the achievement (or percentage of correctness of the student's solution) is e.g. 33% or 0%.

We have solved this problem by representing each evidence from assessment or self-assessment exercises internally by several single evidences. We call this an evidence-combination and it gives the evidence a stronger weight (depending on the number of single internal-evidences). By assigning each single internal-evidence an achievement value of either zero or one, we can obtain an overall achievement value which can now also be a value between 0% and 100%. For instance, an evidence combination of a positive evidence (achievement value being 100%) and a negative evidence (achievement value being 100%) leads to an overall achievement value of 50%.

2 Graphical Design Customization

One of the tasks for the Math-Bridge service is to develop a new graphical design of the user interface, which is adapted to the users' needs. This section describes the new design and explains the reasons for several design decisions. We present three exemplary design studies for different parts of the system.

2.1 Dashboard

Figure 1 shows the new Dashboard screen concept . The idea is that after logging in, the user gets to a starting page that is built like a dashboard. She can see her last opened courses and select one of them directly or see other personal information like her own notes. These panels can be replaced by different ones depending on the needs of the individual user. The column on the left can additionally provide assistance for the user with links and secondary information. Advanced users can collapse this column if it is not needed.

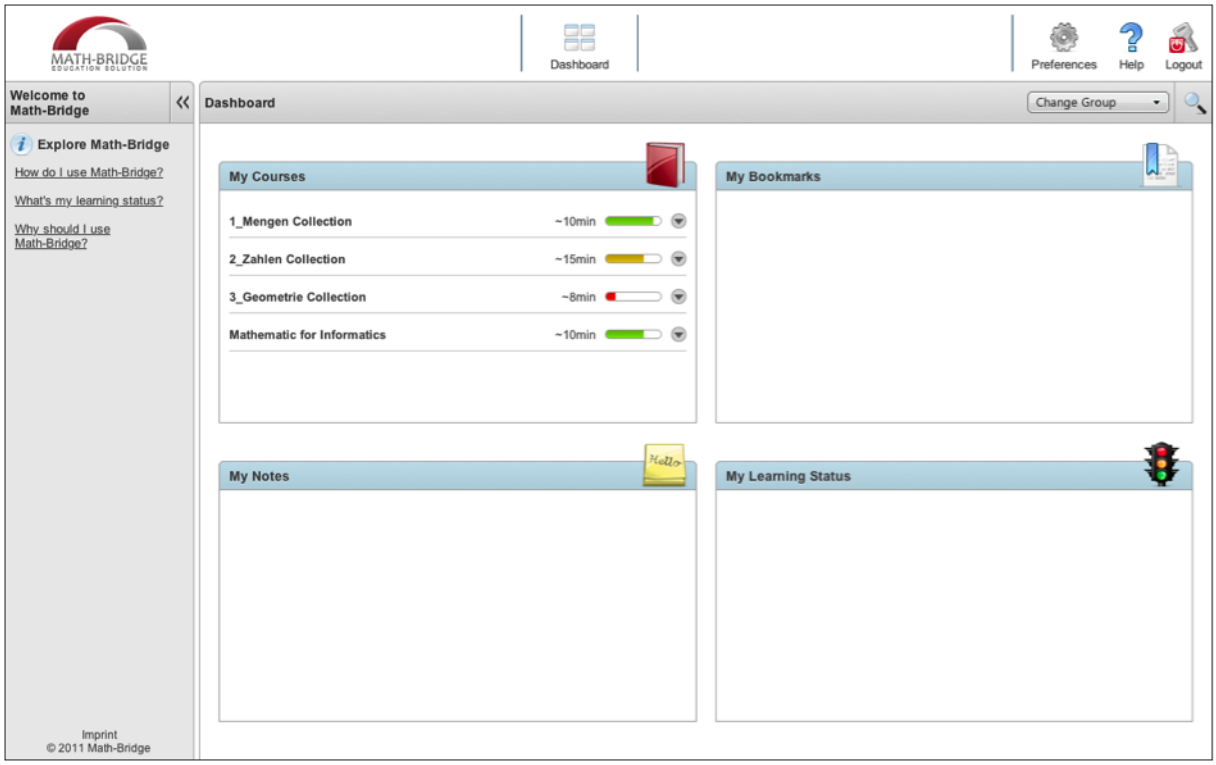

Figure 1: New dashboard concept

2.2 Book Page

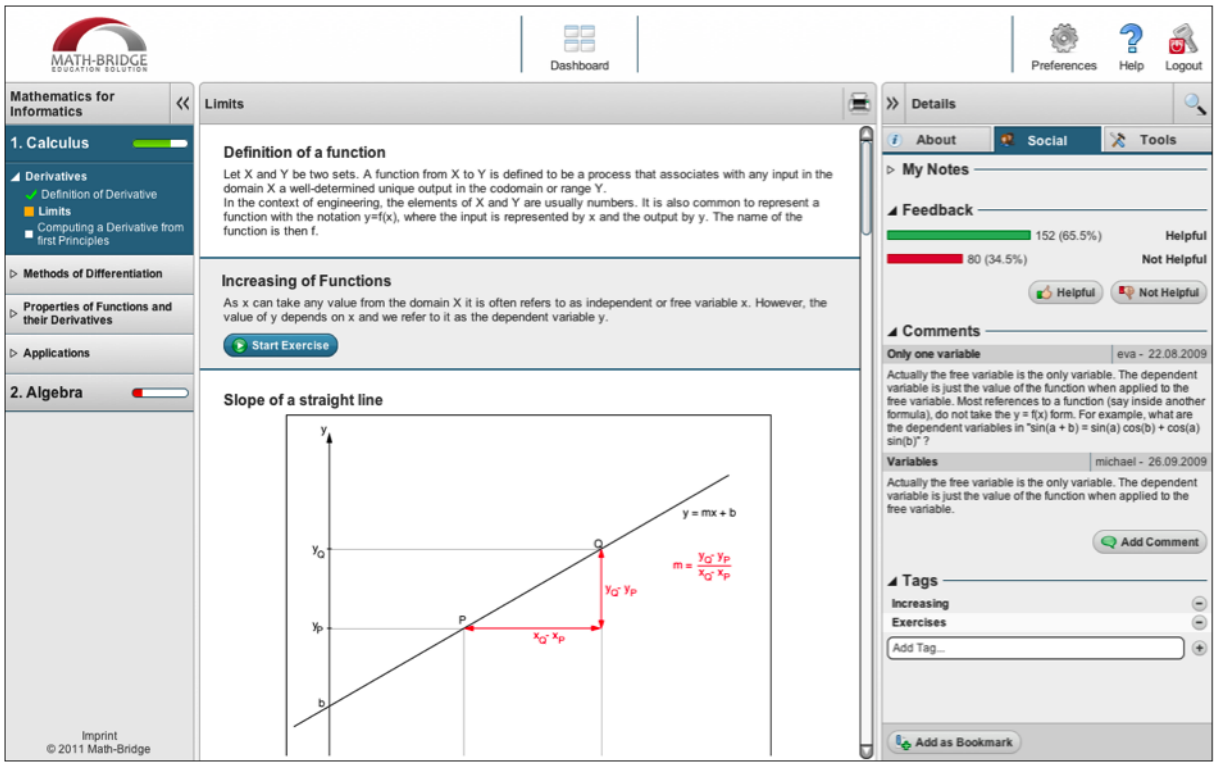

Figure 2: New page concept

Selecting a course in the Dashboard leads the user to the page view depicted in Figure 2. A three-column layout in combination with a Master-Detail-View is used to show all information needed. The three-column layout offers the opportunity to display and integrate all elements of the system and allows a certain level of flexibility.

The column on the left contains the navigation with the different chapters. The learning objects of the selected navigation point are shown in the middle main column. A single learning object can be selected to see detailed information in the right column. A selected learning object is visualized by using the same grey background and blue border like the right panel to establish a connection between the Master-Detail elements.

The right column is split into different sections using a tab control. The user has the possibility to see general or social information like comments or tags regarding the current learning object. Additionally a tab with different tools is always available. The user has the possibility to collapse the left and right panel if more space is needed.

2.3 Exercise Screen

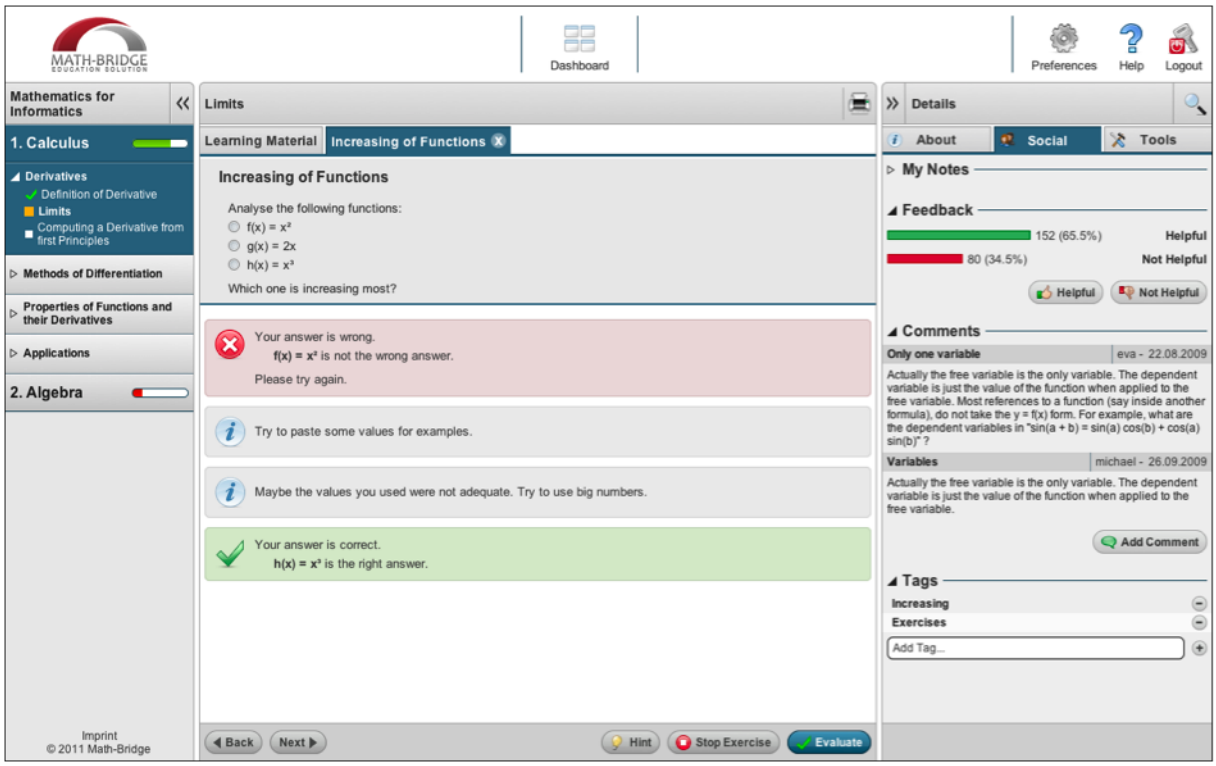

Figure 3: New exercise interface

When a user encounters an interactive exercise, she can run it and gets a page similar to Figure 3. Until now, a problem in the original ActiveMath was that each exercise triggered a pop-up window, which is bad practice as it often confuses users. This new approach solves the problem by opening a tab in the middle column of the book page, so that the user can easily switch between learning material and the exercise session.

3 Summary

We have described a first version of the customized part of the Math-Bridge service, focussing on the fundamentals required for the final version of Math-Bridge which will be made available as the second version of D7.2. We have described how the student model was adapted to the new Math-Bridge competency scheme and to the requirements set by

the integrated assessment tools. We also presented the design concept for the graphical user interface for the Math-Bridge service.

References

[1] Rolf Biehler, Reinhard Hochmuth, Pascal Fischer, Thomas Wassong, *D1.1: Competency Ontology.*

[2] Rolf Biehler, Reinhard Hochmuth, Pascal Fischer, Thomas Wassong, *Supplement to D1.1: Codebook for assigning mathematical competencies, achievement levels, domain ontology and difficulty levels.*

[3] Johan Jeuring et al. *D6.1: External tools accessible from and reporting to ActiveMath.*

[4] Eric Andrès *D7.1: Decisions for remedy implemented.*