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Math-Bridge

D12.3.1 Annual Intermediate Public Report

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http://www.math-bridge.org/

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Author(s)	*Andrey Girenko, Sergey Sosnovsky*

e*Content*plus

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.

1 Table of content

2 Project Objectives

In an effort to succeed in global competition European economies rely on highly skilled labour force based on workers with education in knowledge-intensive disciplines, such as engineers, physicists, IT specialist, etc. At the same time, many college and university students in Europe do not have mathematics background necessary for their studies. For engineering and science education, this is particularly problematic in a number of European countries such as the Netherlands, Germany, Spain, UK and others. For instance, engineering disciplines in German universities and colleges have a drop-out rate of 25%-35%. Science disciplines at German universities and colleges have a drop-out rate of 15%-40%. Similar figures has been computed in other European countries. Moreover, many students do not expect any serious needs for mathematics in their envisioned studies and wrong expectations often reduce the motivation to study. Moreover, many teachers in schools do not have the skills and content to prepare pupils for applying mathematics in practice. Although the high drop-out rates cannot only be solved by mathematics remedy, an early opportunity to *close competency gaps* and to increase her *motivation for and insight into the requirements for a study subject*, can help students to better prepare their choice and study.

This problem has been recognized in several European countries – many European universities have individually administered entry test and remedial mathematical courses for new students. However, such model, when every university is trying to solve the same problem on its own, has several important drawbacks:

- ***Remedial courses are not accessible online.*** Still, such courses are predominantly available through face-to-face remedial sessions or on paper, and this disables many potential students to take the course before choosing a university/college. This also affects academic mobility inside Europe and creates difficulties for incoming international students.
- ***No cross-cultural and multi-lingual access for remedy.*** As the remedial content is currently and typically being created for "in-house" use, it does not enable simple access to target competences for external users, does not take into consideration the variety of European languages, diversity of ways of mathematical teaching and learning, mathematical notations, etc.
- ***No reuse and interoperability.*** The bulk of existing content is available in the form of texts, static web pages, paper documents, etc. All this does not provide any interactivity. In rare cases when the sources are encoded in a web-format and include interactivity, mostly they *cannot be reused* in another context, assembled in another way or reused for other study subjects etc. Moreover, most content is compartmentalized at publishers or universities, and cannot be exchanged or reused. Even if there are portals with a large content base such as MatheOnline, this content is not annotated properly and does not carry the semantic (mathematical) information that would be necessary to find appropriate content easily through semantic search. Finally, it is impossible to merge content from different sources. Only the application of open standards for the content encoding will allow solving the problem.
- ***No adequate information infrastructure for students, teachers, authors***. Students' motivation, self-assessment, and performance can be improved by collaborative learning in socio-web environments, by online assessments, i.e., by an *infrastructure* that facilitates self-organized assembly and annotation of content. Infrastructure for semantic search, assembly of content and feedback can also ease the work of tutors and teachers. An adequate infrastructure for the collaborative process of authoring semantic learning resources is missing. This is extremely important for future publishing in general. A new process model has to be developed and tools have to be offered which allow a content author (and metadata authors) to follow the full picture, reuse and modify content consistently.

The overall project objective is to contribute strongly towards improving the quality and effectiveness of European higher education in the field of Engineering and Technology

studies by improving, harmonizing and making accessible the European remedial eLearning content for mathematics. This objective will be attained by pursuing the following operational objectives:

1. To enable broad web-accessibility of mathematics remedial learning content
2. To make possible cross-cultural and multi-lingual web-accessibility and use of mathematics remedial learning content
3. To enable use and reuse of content and interoperability through enrichment of content and customization of technology
4. To push forward the use of open standards (LOM, IMS MathsQTI, OpenMath, OMDoc) in the content enrichment and SCORM for exercises and reporting; communication standards and open APIs for the integration of software and, where possible, integration via service-architecture.
5. To create the personalized maths remedy accessible across Europe

As the overall result and the legacy of the project, the European Math-Bridge service and Math-Bridge community will be created. The special attention will be paid to making the service self-sustainable and able to organically grow and develop. Moreover, thank to open standards the content made available by Math-Bridge will be suitable for the use and re-use outside of the Math-Bridge service (when needed) in other future eLearning initiatives.

3 Consortium

Partic. No	Participant full name	Participant short name	Country	Role in the project Several roles possible	Date enter project	Date exit project
1	German Research Centre for Artificial Intelligence	DFKI	Germany	Coordinator, technology, content provider, content enhancement	1	33
2	Tampere University of Technology	TUT	Finland	Content provider, user, evaluation, content enhancement	1	33
3	Open Universiteit Nederlands	OUNL	Netherlands	Content provider, user, technology, evaluation, content enhancement	1	33
4	Universität Wien	UV	Austria	Pedagogical expert, content provider, user, evaluation, content enhancement	1	33
5	Zinev Art Technologies Ltd.	ZAT	Bulgaria	Dissemination, content enhancement and evaluation+ user through collaborating university and high schools. Left the project	1	2
6	eurotype OHG - media asset management	ETYP	Germany	Dissemination, exploitation, content enhancement. Left the project	1	5
7	Universität des Saarlandes	USAAR	Germany	Technology, content provider, content enhacement, user	1	33
8	Eötvös Loránd University	ELTE	Hungary	Pedagogical expert, user, evaluation, content enhancement	1	33
9	Universität Kassel	Kassel	Germany	Pedagogical expert, user, content provider, evaluation, content enhancement	1	33
10	Université Montpellier II	UM2	France	User, evaluation, content enhancement	1	33
11	Universität Paderborn	UP	Germany	Pedagogical expert, user, evaluation, content enhancement	1	33
12	Universidad Carllos III de Madrid	UC3M	Spain	User, content enhancement, dissemination	2	33
13	Ergosign GmbH[2]	ERG	Germany	Dissemination, exploitation, public relations, user feedback	6	33

[2] Starting from 01.10.2009 eurotype leaves the consortium and Ergosign replaces this partner in all respective tasks

4 Project Results/Achievements

The current report covers the second project year, which delivered major technological results and laid a fundamental for a large-scale evaluation and subsequent exploitation of the principle project result – the European eLearning service for remedial mathematics (the Math-Bridge service). During the second project year the main results have been achieved around 3 strategic project directions:

4.1 Technical infrastructure for the content search, composition, delivery and use.

In this area the major achievements were:

- Design and implementation of a completely new user interface of the Math-Bridge system. The interface design was made by ERGOSIGN – a company specialized in ergonomics and usability of software interfaces. The implementation was jointly done by DFKI and UdS – the original developers of ActiveMath system, which is a technological server-side platform of the Math-Bridge service. The new user design improved significantly usability and user satisfaction, allowing easy navigation, user support and additional services (see Fig. 1).
- Technical integration with a significant number of external systems allowing for the acceptance of the software in various settings and usage scenarios. Importantly, the integration with major Learning Management Systems (Moodle, CLIX, Ilias) will make the uptake of the service easier for those potential corporate clients (e.g. Universities) already using developed learning environments. Additionally, the integration with such existing eLearning tools for mathematics as MatheOnline and STACK will provide potential users with a richer set of opportunities and enable broader variety of learning scenarios.
- Other technical improvement, which together with those mentioned above allowed launching the demo version of the Math-Bridge service (http://demo.math-bridge.org). This version is a platform for further improvements, at the same time it is already used for demonstration of the capacities of the service and attraction of potential users/uptakers.

Fundamentally, the major technical work is completed. The technical tasks left for the remaining project period are mainly concerned with polishing software and further exploitation-important functionalities development, integration of other external tools, broadening technical capacities of the system.

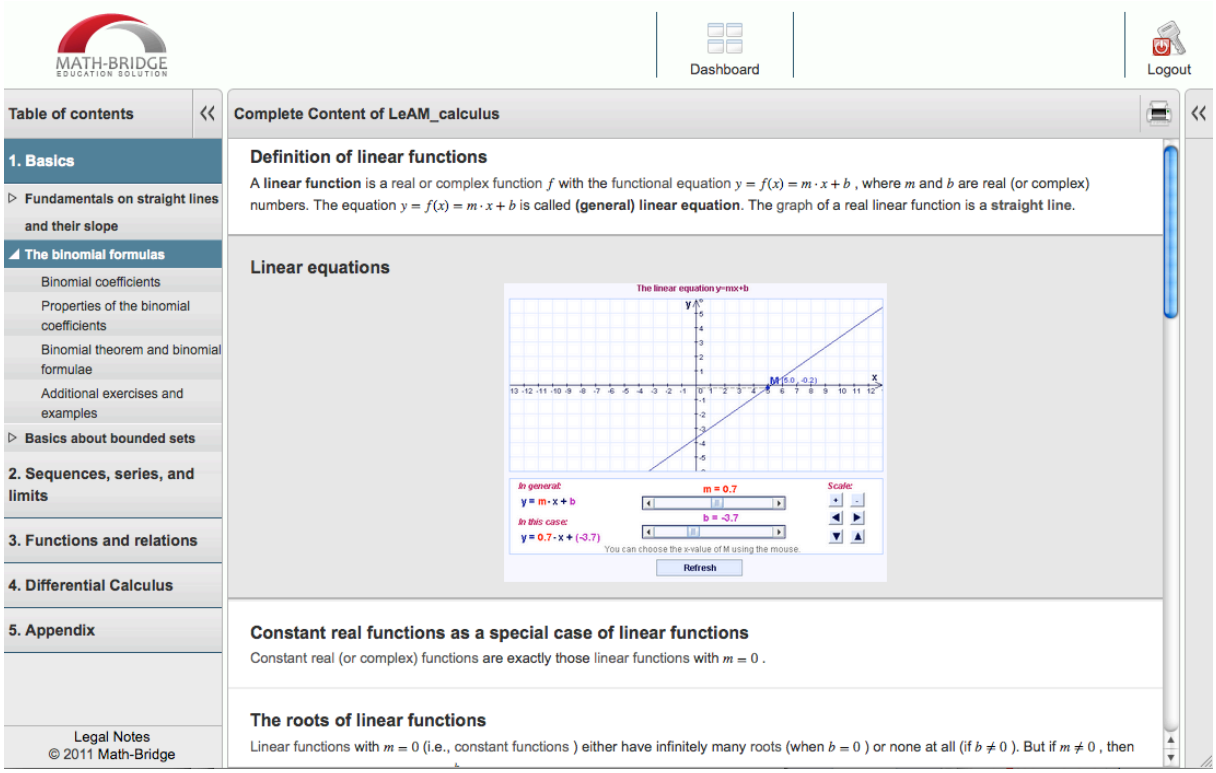

Fig. 1. New Math-Bridge interface

4.2 Content collection conversion and multilinguality.

The central objective of the second project year was to complete the content conversion, harmonization and translation, thus enabling the final evaluation and full-scale exploitation of the Math-Bridge service. This was successfully accomplished by, namely:

- Finishing the conversion of all content collections selected and provided during the first project year into a format allowing for effective use and re-use of the content within the Math-Bridge (ActiveMath) environment. The total volume of the Math-Bridge content is now exceeding 10 000 learning objects covering various topics of mathematics necessary for University studies.
- Completing the translation of the principle parts of the collection into 7 European languages, thus making possible simultaneous evaluation and uptake in many European countries (almost 2000 learning objects are already available in all 7 lnaguages).
- Developing tools and methods allowing semi-automatic content gap detection, content authoring and re-use. These tools allowed harmonization of the current content collection and will enable its organic growth and improvements.

As an important conclusion, we can state that as a result of the second year activities the project acquired the largest and most suitable math content collection in Europe (if not in the world). This content is sufficient to enable the large-scale evaluation scheduled for the end of 2011 in several Universities in 6 European countries, capable to meet the requirements of different European national curricula and pedagogical practices.

4.3 Dissemination, impact delivery and exploitation planning.

The progress in technical and content-related activities enabled the start of the activities aimed at the delivery of planned educational impacts through promoting the Math-Bridge service Europe-wide and engaging with potential users, multipliers and other partners. In more detail, the following results have been obtained:

- Significant improvement of the project and its results' visibility through wide dissemination activities including:
    - Visibility in major social environments (Facebook, Twitter, Tumblr, YouTube)

- Math-Bridge visibility at major events (like CeBIT fair, and European Conference on Technology-Enhanced Learning)
- Development and distribution of promotional materials, etc.

The number of already registered Math-Bridge users exceeds 650.

- Targeted dissemination and community building allowing establishing solid links with users, potential multipliers and institutional uptakers, including:
  - Enabling and implementing learners' and teachers' feedback gathering, the project made possible direct dialogue with the users.
  - Spreading the information material on the Math-Bridge service and its benefits to more than 500 Universities worldwide. The current number of associated Math-Bridge partners is 18 and continue to grow.
  - Communication with about 40 professional communities.
  - Initiating direct contacts with principle European publishing houses active in distributing math content (e.g. Springer, Klett Verlag, etc.)
- Business modelling and planning allowing sustainability of the Math-Bridge service after the project end. The initial analysis allowed to identify competitive strengths and market opportunities of the Math-Bridge service, delineate principles of the marketing strategy, implement economic analysis of its running costs, potential revenue sources and necessary arrangements (e.g. licensing mechanisms) allowing revenue generation. As a conclusion, the initial business model aims at making the Math-Bridge service self-sustainable within 2-3 years after the project end.

As a general conclusion, the results of the second project year have created all necessary prerequisites for the final evaluation and full-scale launch of the service.

5 Target Users & their Needs

By developing the European remedial content for Mathematics and the Math-Bridge service the project considers the following target groups of users:

1. **Students (learners).**

   Typically under this category fall
   - pupils at the last years of secondary school (high school) programme – school leavers
   - or University students at the beginning of their study (1st-2nd years of study). Also, the service can be used students at later periods of study if they identified certain competences gaps hampering the further study.

   Typical usage situations (application scenarios) include the following:
   - a school leaver preparing for University studies
   - check of math competences before entering University studies
   - a student planning study abroad in another European country or international incoming student, in both cases there is a need to harmonize the math competences with the requirements of the host University
   - remedy for competences gaps during the initial University study, which includes mathematics courses
   - remedy at later learning periods when special engineering and technology disciplines require particular math competences.

2. **Teachers (University or school)**

   Typically under this category fall
   - School teachers aiming to prepare their pupils for University studies or diversify the teaching by introducing blended learning methods
   - University teachers responsible for entrance mathematical competences check
   - University teachers teaching mathematics to engineering and technology students. Specialists responsible for remedial courses (where available)

   The usage of the service will include development of pedagogical strategies addressing particular needs of a learner, assistance to a learner in defining the target

learning outcomes, selection of assessment tools, monitoring of a learner performance, etc.

3. **Authors**
   As Math-Bridge will provide open opportunities for external authors to develop their new content, the project team considers this category of users as an important target group for the project dissemination and exploitation activities. Meeting the needs and expectations of potential authors will guarantee the sustainable operation and organic growth and self-update of the service beyond the project frameworks.
   Potential authors can be:
   - Math teachers willing to develop their own teaching materials, exercises, tests and assessments to complement the existing content
   - Specialized publishing houses developing commercial math content
   - Creative students suggesting modification of the existing LOs

   Although technologies for authoring support are out of the scope of the Math-Bridge project, the methodological and documental support for the development of LOs and their annotation will be provided.

6 Underlying Content

A unique project like MathBridge needs to have very good and specialized contents to attract teachers and students from all over Europe. The content needs to be suitable to close knowledge gaps students might have. So the idea was to use contents, which are already used in remedial courses. As there is no pan-European bridging course available we searched in many countries for such content. The outcome of these search were six content collections from Austria, Finland, Germany and the Netherlands of course available in their respective languages. For some of the contents translations in other languages like English, French and Hungarian were also available.

All in all, we collected around 1 Gigabyte of content data originally existing in forma of hundreds of files in different formats (*.doc, *.pdf, *.tex, *html). Now all these collections have been formatted into shareable form using OMDoc standard for mathematical documents (www.omdoc.org). They have been sliced into separate learning objects and annotated with pedagogical, semantic and descriptive metadata.

7 Summary of Activities

The activities within the second project year have been centred around the following thematic pillars:

1. ***Content conversion and enrichment.*** On the basis of classification of mathematical domain the pedagogical partners selected and provided to USAAR collections of their math content. Typically, the content was developed through previous projects and by Universities themselves - that is why, it was provided in various formats and languages. The content transformation activities were mainly carried out by the USAAR and ELTE teams and included slicing big learning texts, exercises, tests into re-usable Learning Objects (the granularity of slicing was agreed with the authors of the content). Each LO was then annotated (OMDoc) in order to make it semantically searchable and re-usable. This activity was finished during this year, the total number of converted LOs is now 9710 (not including more than a thousand of exercises generatable with the help of domain reasoners).
2. ***Activities for the better internationalization of Math-Bridge.*** Above all, this included the content translation into the languages, in which the necessary LOs were not present. The cross-translation was made by partners in France, Hungary, Spain, the Netherlands. The available international content is sufficient to run an evaluation trial in the second half of 2011.

3. ***Technical tasks aimed at improving the quality of Math-Bridge service.*** The tasks were focused on preparation and implementation of the deployment of the Math-Bridge service (http://service.math-bridge.org/). This included:
   - Complete re-design of the service interface and its implementation
   - Integration of several external tools improving the usability of the service
   - Separation of the project and product websites
   - Other improvements necessary for the full-scale deployment.
4. ***Preparation of the large-scale evaluation.*** Necessary planning and design work was implemented in order to start evaluation in the autumn semester of 2011.
5. ***Dissemination, community building and exploitation.*** All partners invested significant efforts into dissemination activities and laying foundations for wider uptake of the service and its exploitation. The most visible dissemination activities included:
   - Enabling user feedback gathering and interviews with teachers
   - Participation in major relevant conferences with presentations
   - Enabling dissemination through the major social environments like Twitter, YouTube, FaceBook, etc.
   - Identification and enabling communication with relevant professional communities
   - Engagement with potential associated partners
   - Dissemination to school teachers (e.g. done in Hungary by ELTE)
   - Publications, press releases, other means of traditional dissemination
   - Initial business modelling and exploitation planning aimed at guaranteeing the service's sustainability after the end of the project.
6. ***Project management and coordination.*** Despite organizational difficulties the project consortium faced during the second year (loss of the project coordinator, administrative difficulties with finalizing the GA amendment), the consortium managed to redistribute tasks and resources, strengthen communication and monitoring and continue the project implementation without significant delays. All necessary managerial and administrative tasks were performed. All reports and deliverables have been timely submitted.

8 Impact & Sustainability

During the second project year the activities aimed at delivering the impact and ensuring the sustainability of the project results were centred around the following directions:

- Broad dissemination and awareness raising. The goal was to inform the society of the project and its results, see above for the details.
- Working closely with professional community preparing and stimulating the uptake of the technology in academic process at Universities in Europe and above. The goal was to start recruiting the service users in order to have the critical mass of clients by the end of the project.
- Initial business modelling aimed at the development of the exploitation scenario guaranteeing the sustainability of the service after the end of the project funding.

The critically important aspect of the Math-Bridge business model is the selected licensing model. Fundamentally, the project is aiming to make the Math-Bridge service accessible to the European users on the basis of the licensing mechanism including 2 types of licenses:

- Freemium license for the software (environment) allowing free and unlimited use of the core features of the system and setting royalty-paying conditions for premium features (e.g. external input editor like WIRIS, etc.)
- Creative Commons License for the content, implying the regime which will enable free access to the core content, but at the same time will create stimulating environment for potential authors willing to contribute with new content and generate resources enabling sustainable maintenance of the central resources.

Apart from software and content royalties, the project considers other important sources of revenues such as provision of consulting and training services to institutional/corporate users, cooperation with publishers and other entities willing to distribute their educational

content through the Math-Bridge service. All this together ensures that the service will stay up and running, as well as organically growing and developing, in the coming years.

The final market analysis and the final business model for the service maintenance beyond the project framework will be provided in the next reports.

9 Further Information

Mainly, the covered reporting period resulted in the creation of the comprehensive conditions (both technical and content-related) for the full-scale service deployment and sustainable exploitation. The last project period will be devoted to the comprehensive evaluation of the service operation in real-life conditions (real classrooms, real academic process, significant number of learners, etc.) in several European countries. Also, the consortium will continue working on improving the qualities of the service, attracting potential users and ensuring service's sustainability.