THE DEVELOPMENT OF A BRIDGING COURSE NUMERICAL ANALYSIS INTO THE E-LEARNING ENVIRONMENT MUMIE

Daudt, J.P.R.B.
educational consultant
Delft, University of Technology
Delft, The Netherlands

Vuik, C.
professor
Delft, University of Technology
Delft, The Netherlands

Daalderop, A.G.M.
Lecturer
Delft, University of Technology
Delft, The Netherlands

Kints, R.
Teaching assistent
Delft, University of Technology
Delft, The Netherlands

Conference Topic: Math in Engineering education

INTRODUCTION

In the frame work of student mobility bridging courses for incoming master students from other engineering schools, become more and more important. More (international) students with various backgrounds enter master programmes and need bridging courses to (re)master and refresh the necessary knowledge to take advanced master courses.
Bridging courses are meant to narrow the gap between the knowledge and understanding from students and the demands in the advanced math master courses. Using an e-learning environment makes the bridging course flexible and open to adjustments and extension.

Together with three other university partners (Aalto University Finland, KTH Sweden and TU Berlin), the TU Delft has made a start, end 2012 with the development of a bridging course Numerical Analysis. Other bridging courses are developed by the other partners (Scientific Computing with Matlab, Probability and Statistics, bridge material Math for incoming bachelor students).

It has been decided to use MUMIE because it is open source ware, developed by mathematicians and there has been experience with this platform at TU Berlin and TU Delft. Another advantage to use open source ware is the fact that the work to develop content can be shared as well as the developed content. The platform MUMIE can be improved and extended by the use of other interested university partners.
In this paper we report the results and evaluation of a pilot study performed in May 2013 where the developed material for the bridging course Numerical Analysis was offered to 100 students from the Civil Engineering Department. The focus of the evaluation is on the experience, satisfaction and grades of the students that have participated in the pilot and have used the MUMIE platform.

The pilot was implemented, covering the theory for non-linear equations and numerical quadrature together with two homework exercises for bisection, two exercises for fixed point methods and an exercise for integral approximation. Next to the results we describe briefly our experience with the development of this bridging course in MUMIE.

1 MUMIE e-learning platform

MUMIE is an open source e-learning platform. It uses modern web technology, is written in java and supports any kind of multimedia components (interactive visualizations, audio, video). MUMIE is multi-lingual supporting presently German and English. Learners need nothing but a standard browser. Authors write their content in an comfortable authoring environment based on an eclipse plugin and write mathematical text in the standard Latex (MUMIE-dialect). The e-learning platform MUMIE is inclusive and combines theory with interactive demos, training, exercises and wiki-like dedicated social networks for virtual tutorials and self-organized learning enhancing cognitive and meta-cognitive skills. Powerful authoring tools support the production of new content. This opens the door to new, challenging and more efficient pedagogical scenarios. We expect that offering bridge courses in this inclusive e-learning format will have more impact on better preparation of students for advanced mathematics master courses. MUMIE has been developed at the TU Berlin and is offered mainly to first year students to support their learning in Calculus and Linear Algebra. In 2009 the TU Delft has translated the German course Lineaire Algebra into English and has adjusted the course to the TU Delft demands. Since 2010 we offer this course to first year students of the Faculty Aerospace Engineering and Information Science parallel to the regular course. It was an advantage that we could use the powerful interactive visualisations already developed in the German course. With the interactive visualisations students can play and use various parameters in order to understand how the mathematical concept works.

2 Bridging course Numerical Analysis

The development of the course had to begin from scratch, developing all the MUMIE TeX documents and Java applets ourselves. This is a considerably different setting then the development of the Linear Algebra course which was done earlier, where most applets could be taken from the German course. The development of applets is however the step that takes most time and which, up to this point in time, was not done at TU Delft, mainly due to the lack of people. After the approval of our proposal in the frame work of the Long Life Learning Programme a team has formed to define the necessary topics, to design and develop the bridging course, to develop an effective entrance test and an evaluation scheme. The topics defined are reviewed by all the partners in the project in order to be able to use the developed bridging courses at all the universities. Part of the bridging course is also an entrance diagnostic test so students can find out which topics they already understand and which topics have to be mastered. The entrance test will be reviewed by all partners and gives also information about de various standards necessary to take the advanced master courses.

2.1 Some impressions of the e-learning platform MUMIE

To give an idea what students see when they use MUMIE some illustrations are shown.

Fig.1. This print screen shows topics student can choose to study; behind the topics students can choose for theory and home work assignments with demos and training.

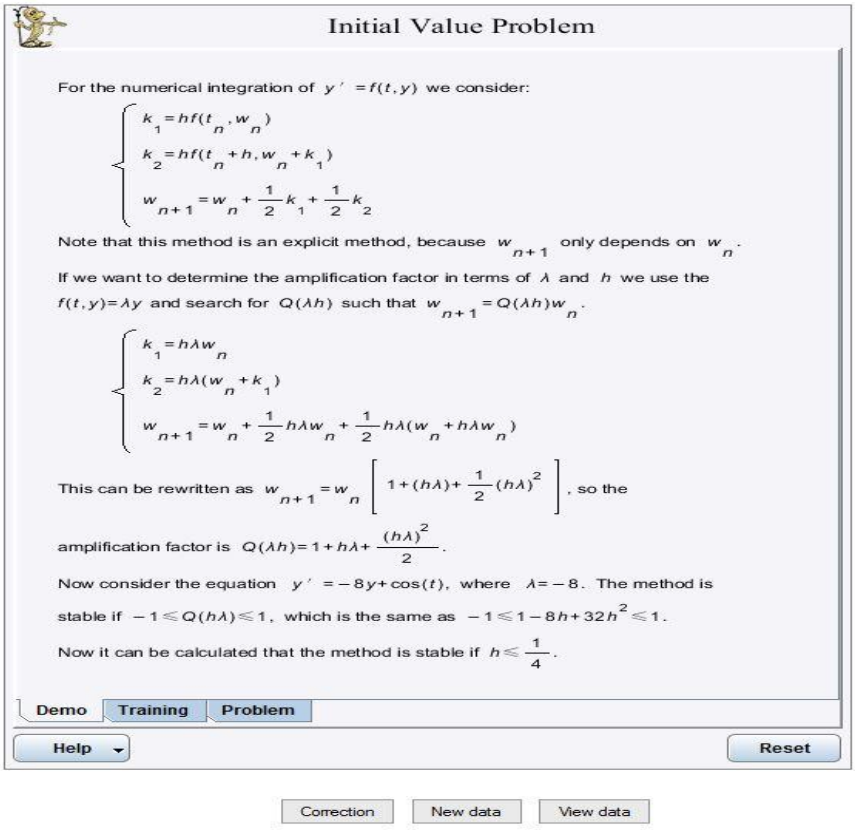

Fig.2. This print screen shows a demo and students can click the tabs for extra training and other problems/assignments.

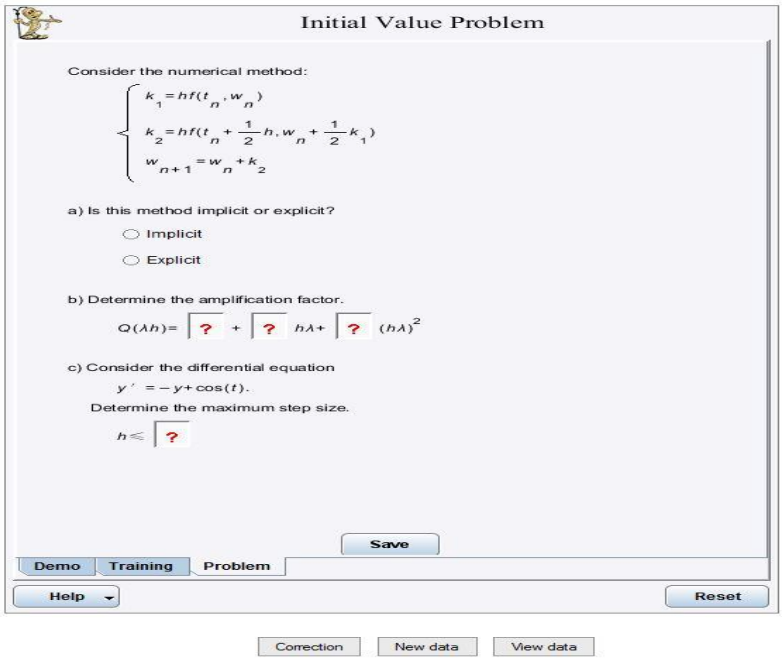

Fig.3. This illustration shows an example of a problem.

3 Evaluation of the pilot bridging course Numerical Analysis

The aimed goal was to have a pilot course, covering two topics within Numerical Analysis, ready by the beginning of May 2013 such that it could be used at the Numerical Analysis regular course for Civil Engineering students. Progress was initially quite slow, due to the fact that most people were new to MUMIE. However the pilot was successfully implemented, covering the theory for non-linear equations and numerical quadrature together with two homework exercises for bisection, two exercises for fixed point methods and an exercise for integral approximation. The results and evaluation of the pilot will be discussed next.

3.1 Exam results

Participation in the MUMIE pilot was voluntary. By participating in the pilot, 0.5 bonus point could be earned for the next exam, under the condition of having at least 60% of all homework exercises correct. From the 234 students who took the exam there were 100 students which participated in the pilot.
The results for the exam grades of both groups are displayed in Figure 4. From the figure it is clearly visible that the group participating in the pilot generally has a higher grade then the group not participating. The same result can be observed in Table 1, which shows the percentage of students passed and the average grade for both groups.

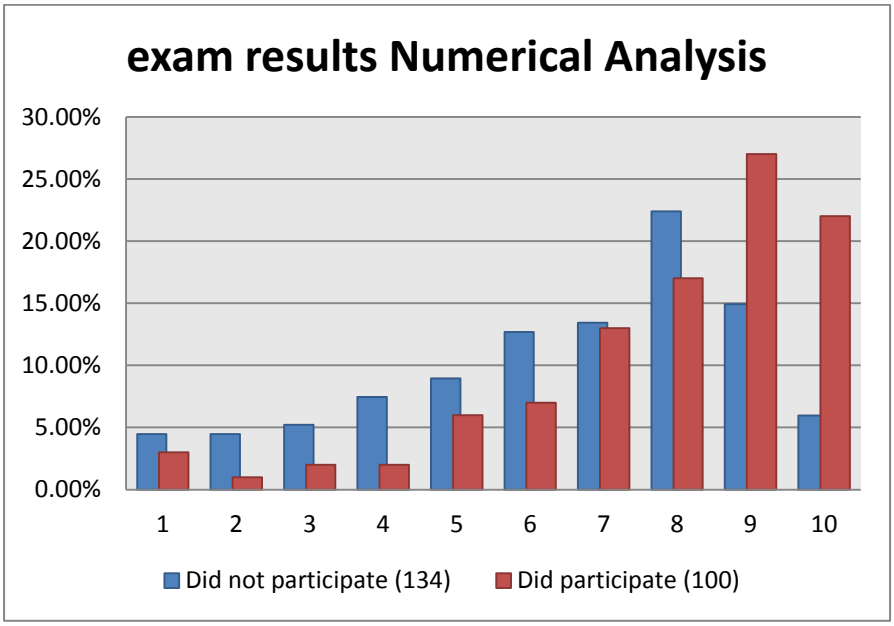

Fig.4. A comparison of the NA exam grades from CE, between students that participated in MUMIE against the students that did not. Participating in MUMIE is defined as receiving the bonus point. The percentage for each group has been normalized. Bonus points are not included in the grades plotted in this Figure.

	No MUMIE	Excl. Bonus	Incl. bonus
Percentage passed	67%	86%	90%
Average exam grade	6.25	7.58	8.02

Table 1. The percentage of students passed, and the average NA grade for the two groups, belonging to the data of Figure 1.

Trying to find an explanation for the differences is not easy due to the fact that many variables are involved. What we do know is that students participating in the MUMIE pilot are stimulated to frequently spend time studying the material and not wait until last moment. Students who participate in MUMIE are willing to put extra effort in the course in order to pass the exam.
To say that students perform better because of the MUMIE course itself is hard say. The pilot only covered a small part of the material and the material that was covered was relatively easy. Nonetheless, adding the MUMIE material to the course does have a positive influence on the student exam grades.

3.2 Student evaluation of the Numerical Analysis pilot course for CE

Not only were the exam grades analyzed. The students also had to fill in a survey at the end of the course. The survey consisted of 13 multiple choice question and an open question for further remarks / suggestions / comments. In total of 109 CE students filled in the survey. Below you find the highlights of the survey outcome.

3.2.1. Highlights of multiple choice questions

Regarding the difficulty of the homework exercises in MUMIE, the majority of students (approximately 70%) indicated that they were (too) easy. This result was to be expected, as the exercises in the pilot were relatively easy and certainly not at the level as the exam. Having questions that are too easy can be dangerous in the sense that students can underestimate the difficulty of the course. On the other side, by having easy questions, this can motivate students that initially struggle with the course to keep on going. The majority of the students (approximately 70%) also indicated that the applets in MUMIE helped them understand the course material and motivated them to learn the course. This, together with the result that almost 80% of the CE students would recommend to use MUMIE for the Numerical Analysis course is quite a strong indicator that MUMIE has a positive stimulating effect on students.

3.2.2. Highlights of open question

The results of the feedback questions have been categorized and summarized below, ordered by most frequently mentioned category.

Java problems (15 entries)
The main problem students encountered were Java related, this is a problem that is not only related to this course, but to MUMIE in general. With the latest Java releases, security policies have changed such that older versions of Java are blocked by the browser by default. Because the computer networks at TU Delft were not running the latest version of Java, MUMIE would not work as expected on these computers.
Updating to the latest Java version would solve this problem and is recommended to students working on their own computer, however several students still complained about a lot of security confirmation pop-ups, every time an applet had to be loaded, this not being very user friendly.
Also, students mentioned slow loading pages regarding applets and exercises. This also has to do with the Java part in MUMIE. Especially when applets are loaded for a first time on a computer it can take a few seconds for it to load, which can be understandably quite annoying.

Increase difficulty (8 entries)
Secondly, students made remarks that the exercises were (too) easy. At least there should be exercises that are approximately the same level as exam questions. This is a valid point that is addressed by the students. However this was still a pilot test. Also, development of the exercises (in the form of applets) is still a new process to the team and therefore the initial progress was quite slow.

Positive (6 entries)
Next are students leaving a positive remark. Having MUMIE as an extra possibility was found useful and motivated (some) students for the course.

Limited scope (5 entries)
Several students suggested that the material that was covered in MUMIE should be increased, since it currently only covers a limited amount of subjects. This remark could be expected beforehand, knowing that this pilot only covered two specific topics from the NA course.

Bugs in homework exercise(s) (4 entries)
Furthermore, a few students remarked that the training exercises were to similar to the homework exercises. In such a way, that the training exercises would generate exactly the same parameters as the homework exercise.

Add more questions (3 entries)
This category is, similar to the limited scope, strongly related to the fact that this MUMIE course was still in the pilot stage. There were only a very limited number of exercises available.
Unclear on grading of an exercise (2 entries)

Finally, there were a couple of students who had trouble to see how well they performed on the exercises.

4 Conclusions, discussion and further actions

As mentioned before at the TU Delft we consider MUMIE as an interesting and useful inclusive e-learning platform for the Mathematics domain. It is open source ware, so developed content can be used, further developed and extended by other institutes of higher education. The bridging courses can be combined with the regular lectures in order to create a blending learning arrangement.
In the frame work of the Long Life learning we have the possibility to develop four bridging courses.

Our experience with developing the Numerical Analysis bridging course shows that it is an advantage but also a challenge to develop such course. Teachers have to rethink the content, the use of interactive visualizations and training necessary for students to study independently the knowledge necessary to prepare for the master courses. The MUMIE platform has a lot of possibilities: theory, demos, visualizations, web lectures and all kind of assignments with automatic feedback can be added, but it also takes a long learning curve for teachers to be able to fill the platform with content. This is especially true for the development of the interactive visualizations.

The pilot course, with a sample of the topics, has given us valuable information to improve the content and to make the MUMIE platform more robust and also more user friendly. But the proof of the pudding will be to test how our target group for the bridging course will be able to use the bridging course and how this course supports their understanding of the Numerical Analysis concepts.
We are also aware of the fact that the development in this area of digital material offered by the publishers is highly competitive. It has a lot of advantages to develop and share the development of good educational content but it also costs a lot of work. However we support the policy of more and more highly valued universities to offer the courses for free (Coursera, EdX, O.C.W. and so on) but we think it is realistic to combine free (open educational resources) and paid educational resources.

4.1 Careful wit dissemination

We expect to be able to offer the developed bridging courses in October 2014. However we will only disseminate them after thoroughly testing so the users will not encounter annoying difficulties when they use the platform.
If you're interested in using the developed courses in MUMIE please contact ILC (Integral Learning Company in Berlin: http://www.integral-learning.de/ to discuss the possibilities. More information on the S3M2 project (support successful student mobility with MUMIE; Bridging programmes by e-learning tools for Mathematics: Encourage and improve successful student mobility by effective and goal-oriented preparation): http://www.s3m2.eu/

5. ACKNOWLEDGMENTS

With the support of the Lifelong Learning Programme of the European Union

REFERENCES

[1] Vuik, C, Daalderop A.G.M., van Kints, R., Baksteen, T., Schaap, B. (2011), Report 11-10, Evaluation MUMIE – Online Math Education, Reports of the Delft Institute of Applied Mathematics, ISSN 1389-6250.

[2] Kints van R., Daudt J.P.R.B., Vuik, C, (2011), MUMIE, een internationaal wiskundig E-learning package en platform, Proceedings NIOC 2011, Karel Lemmen en Evert van de Vrie, Heerlen, Vol. 1, pp. 119-122.

[3] Vuik,C, Daalderop, A.G.M., van Kints, R. (2012), Report 12-13, Evaluation MUMIE - Online Math Education, Reports of the Delft Institute of Applied Mathematics, ISSN 1389-6250.

[4] Vuik,C, Daalderop, A.G.M., van Kints, R., Wilders, P., Daudt, J.P.R.B., Wu, X, Koolstra, K., Oever van den, J., Lobbezoo, B. (2013), Report 13-16, Evaluation MUMIE - Online Math Education, Reports of the Delft Institute of Applied Mathematics, ISSN 1389-6520.