Mathematical modeling courses for Media technology students

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Abstract

This paper addresses curriculum development for Mathematical Modeling course at Medialogy education. Medialogy as a study line was established in 2002 at Faculty for Engineering and Natural Sciences at Aalborg University, and mathematics curriculum has already been revised tree times, Mathematical Modeling on 6th semester being the latest addition. Some of the reasoning behind curriculum development, lessons learned and remaining issues are presented and discussed.

Introduction

Media Technology ("Medialogy") as a study line was established in 2002 at Faculty for Engineering and Natural Sciences at Aalborg University. It belongs to a kind of new multidisciplinary engineering studies, which combine engineering, humanities and design [7]. Students' main aim is developing interactive applications and interfaces for them. Mathematical tools for describing dynamical input and output of interactive media applications require comprehension of Calculus (integrals and differential equations). Although these topics belong to classical engineering curricula, Medialogy students are typically design/artistic inclined, so teaching them even slightly advanced mathematical concepts, especially if they need to implement those concepts in projects they develop, is a challenging task.

Teaching methodologies combine Problem based learning [4], [6], with classical teaching, as well as group collaborative working using appropriate software tools, like Matlab and Maple, as well as Maya, animation software tool that students use for production of animated movies during their project work .

This paper addresses years of work on adjustment of mathematics curriculum for Medialogy education, especially development of Differential equation course on 6th semester of Medialogy studies. Reasoning behind curriculum development, lessons learned and remaining issues are presented and discussed. Methodologies used to gather data for this paper are overview of the study plans and existing valuation documents, interviews with teachers teaching the courses and students who have graduated Medialogy bachelor studies. Questionnaires about attitudes towards mathematics are distributed for two generations of students twice – before they start and after they finish the Differential Equations course. Students' answers are compared and analyzed.

The paper is organized as follows. First the short description of Medialogy studies is given, and then a history of teaching mathematics at Medialogy is told in the second part. Some of the major challenges are listed in the third part. The fourth part of this paper presents some questions and ideas for future curriculum development, and fifth part is the conclusion.

Medialogy studies

Medialogy is 6 years old study line at engineering department of Aalborg University. The idea behind this education is to "educate global problem-solvers in the technology world", both on Bachelor and Masters levels. As it is stated on Medialogy web-presentation aimed for future students [9]:

"Medialogy focuses on education and research, which combine technology and creativity as means to design

new processes and tools for art, design and entertainment – we do this to meet the requirements of our contemporary media industry. In authoring and designing Interactive Media, it is becoming increasingly evident that the largest challenge lies in bringing together different disciplines. Medialogy's interdisciplinary approach acknowledges that mastering and combining such a variety of disciplines requires a strong technical foundation, both in theory and in practice."

The educational approach is Problem based learning [4],[6], as at all other studies at Aalborg University. Students are exposed to the curriculum which combines technical and humanistic courses, like screen media, digital sound synthesis, sensor technology, perception, aesthetic, media sociology, computer graphics, human-computer interaction, interface design, etc. Mathematics and programming are now thought on Bachelor level, as they are needed in order to understand technical courses needed for successful project work. However, mathematical and programming courses are not project-supporting courses, but individual courses which require a separate exam in order to pass the course. Study plans for these courses have been through tree main revisions since 2002, but since fall 2007, during the first two semesters the students are exposed to standard mathematics course for engineering students, comprising of 5ECTS of introduction to calculus and 3ECTS of introduction to linear algebra. On the 5th semester they have advanced linear algebra course, and on 6th a course on Mathematical modeling, that includes integrals and differential equations.

A short history of teaching mathematical modeling at medialogy

A new course on mathematical modeling, integrals and differential equations was established on the 6th semester, for the first time in spring 2008, with the idea to empower students with skills to deal with dynamic inputs for multimedia systems they will eventually develop during further studies and work. Initially this course was planned for 3ECTS, but the students complained in December 2007 before the course got the chance to be run for the first time in spring 2008. The students argued that 3ECTS course is too much of a burden for their bachelor project work, and that they do not want and do not need to use those skills for bachelor projects. Based on this input, the Study board has changed the duration of the course to 2ECTS, also changing the form of the exam from initially planned written to oral. The fact that the duration of the course got shortened allows for only brief introduction to differential equations.

Why should Medialogy students have differential equations course at all? There are two reasons. One is due to University regulation law, prescribed by the state in Denmark. As Medialogy studies are placed at Natural Sciences and Engineering faculty, in order to get a corresponding diploma, all undergraduates need to pass a certain amount of ECTS points of mathematics courses. The second reason is more essential – medialogy graduates will work in interplay between new technologies in e.g. films, TV, computer games, and actual human users. It is realistic to imagine that their future jobs will require developing of novel interfaces, or, at least, understanding the principles of their work. Phantom device (force feedback "mouse", haptic devices, Nintendo Wii controller require understanding of some calculus and differential equations. Thus, a course on differential equations and mathematical modeling makes sense in Medialogy curriculum.

Important issue is that the students are not aware of this need. On the 4th semester they work with digital input from sensors, but those are simple sensors (buttons, position sensors, angle sensor,..). Some use accelerometers, but just to detect direction/magnitude of acceleration.
During 6th semester, the students are typically too busy in developing their bachelor project, which is their main entry to the job market, and thus should be as good as possible. Thus, it is too risky to try to implement some novel and not quite well understood mathematical concepts, although Nintendo Wii, connected with Matlab, gives them a powerful example what could be done with devices for dynamical input.

Challenges of teaching mathematics at medialogy

1. Double entry point for studies

The double entry point for Medialogy studies creates a unique challenge for teaching mathematics, as some students

(typically after high school) start from the first semester, but another group of students (typically with some short tertiary education, like multimedia designers) join at the rd semester. These students typically have very different levels of mathematical knowledge [10].

2. Generally low level of mathematics knowledge among students

The independent evaluation study [12] conducted by Danish evaluation institute in 2005 has pointed to this problem. The problem is further illustrated in [10].

3. Students' attitude towards mathematics

As it has been mentioned in the short history of mathematics at Medialogy, the first mathematics course was organized on students' request. This means that majority of Medialogy students are aware that they need mathematics knowledge if they want to be successful in their profession.

The results of the questionnaire distributed to the students at the beginning of the 5th semester, fall 2007, support this claim. 45 out of 46 students enrolled into the semester answered the questionnaire, and on the question "Your attitude towards mathematics", 31 of the students have chosen the answer: "I could see that it might help with other technical subjects, so I am motivated to learn it, although I am not really good at it". 7 students claimed that they are good in mathematics or that they love it, but 7 others claimed that either they are very bad in mathematics, or that they cannot see a clear purpose of studying it at Medialogy.

Slightly different results were obtained with the same students during 6th semester, in spring 2008, just after their Differential Equations exam. 34 out of 42 students answered this questionnaire (4 have decided to leave the education during the school year). Now 12 students claimed that they are good in mathematics and could see its purpose on Medialogy, 11 could see the purpose, but still believe they are not good enough, and 11 claim that they cannot see the purpose of studying mathematics on Medialogy, and that they are bad in mathematics. On the exam, 36 out of 42 students have passed the exam, so there is significant number of students who have passed the exam, but still feel that they are bad in mathematics.

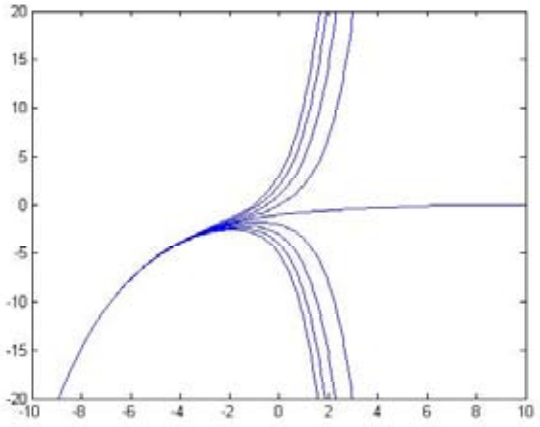
It is interesting to note that in both questionnaires, the answer "I am pretty good in mathematics, but I do not see why we should study it on Medialogy" was not chosen by a single student.

Another important input from students' answers is that while majority of the students pointed to usefulness of Advanced Linear Algebra course in other technical subjects, many of them wondered why they needed to study differential equations.

From these data a conclusion can be driven that a mathematics teacher on Medialogy studies faces a class of students with inadequate level of previous knowledge. The students are aware of their lack of knowledge, but willing to study Linear Algebra, as a vast majority of them can see the purpose. However, they are much less willing to learn Mathematical modeling, integrals and differential equations. Reasons that students note are lack of time to implement the knowledge in bachelor projects, so instead of a potentially useful tool, they see this course as an unneeded burden. Teaching such a class is a challenging task.
From one side, the students would like to see some application on the mathematics they learn to computer graphics, sound synthesis or physical interface design – but from the other side, general level of mathematics skills is so low, that the majority of time in the class is spent in explaining basic mathematics operations.

Figure 1. Excerpt from the homework in the course on differential equations on 6th semester of Medialogy. The comment by the end of the program is written by a student

```
inter = [-10 10 -20 20]
fplot('(-33/32)*exp(-x/3) - 4*exp(x)', inter)
hold on
for i = -3 : 4
   k = int2str(i);
   a = '(-33/32)*exp(-x/3) + ';
   b = '*exp(x)';
   fnch = [a, k, b];
   fplot(fnch, inter)
end
hold off
%it's like a beautiful flower  :)
```



There are also positive anecdotal examples from teaching mathematics to Medialogy students. During Mathematical modeling course the students were using Matlab, both for solving exercises during the course and for a final exam micro project, that required writing and explaining a program in Matlab for solving a class of differential equations. On Figure 1 is a part of the homework received on 6th semester differential equation course. The task was to write Matlab program which will produce a family of solutions to a given differential equation, and a student called the graph "a beautiful flower", just giving more evidence to famous saying of Henry Matisse "There are flowers everywhere, for those who bother to look".

Challenges for future medialogy mathematics curriculum development

The reality is that not the best mathematicians from high schools enroll into Medialogy studies. The reality is also that for many technical subjects the students need some mathematics basic. In current practice of teaching mathematics at Medialogy two approaches have been tried: teaching specialized mathematics courses to directly help technical courses, and teaching general mathematics courses. Strengths and weaknesses of both approaches have been experienced and learned.

The important question that still waits for a proper answer is not only what is minimal acceptable level of mathematics knowledge Medilogy students need, but also how to enable majority of the students to achieve (or even surpass) that level. This is also a valid question for many other technical and non-technical studies, even for those well-established through centuries like biology [1], [2]. Further on, there is a vast research how technology can help learning mathematics on a different level, providing the students with some meta-understanding without being able to do each single calculating step by hand, and vast research of effect of problem-based teaching approach to learning output, see for example [9], [2]. I believe that some transfer of experiences in teaching mathematics to different non-mathematics majors is possible and desirable.

All mathematics courses on Medialogy are so-called SE-courses. This means that they do not need to be used in the project work, but the students need to go on separate exams. However, as main Aalborg University teaching paradigm is problem-based learning, and the essence of mathematics is problem solving, it would be interesting to investigate whether mathematics courses on Medialogy could be taught somehow different, to emphasize problem-solving skills. Numerous issues, some of them partially mentioned in the third part of this paper are against this idea, but I believe that some work in this direction is still possible. Niss in [6] in details describes how Problem-based learning could be implemented for studying mathematics at undergraduate level. Roskilde University model and Aalborg University model are pretty similar, but there is a crucial difference. The issue is that Niss is looking at mathematics students, i.e. those with genuine interest for the matter. Medialogy students do not belong to the same category, and

thus a direct implementation of problem-based learning is not possible, but some modifications are needed.
The Medialogy Mathematics modeling curriculum needs to be further refined, maybe even without major changing the study plans, with tree major goals in mind:

1. Start from the actual knowledge that students have, but take their willingness to learn more as the positive starting point;
2. While giving them necessary basic apparatus, show how those tools could be used in technical subjects.
3. Try to connect mathematics learning with problem-based learning and project work.

Only if the goal 3 could be achieved, teaching of mathematics on Medialogy will become successful. However, that is a very ambitious and difficult goal.

Conclusion

Mathematics courses development at Medialogy department in Copenhagen has suffered from typical issues with new educations. The courses were established and changed in response to students' and teachers' observations during the years. The tendency was to add more and more mathematics courses. The last addition was 3ECTS Mathematical modeling course on the 6th semester. In some of the study plans, mathematical courses have been standard university calculus and linear algebra courses, and in some study plans they have been tailored towards specific Medialogy student needs, but without taking into consideration actual level of previous mathematics knowledge of an average Medialogy student.

According to the newest study plan, mathematical modeling course, which includes integrals and differential equations used to model dynamical input/output devices to an interactive system is placed on the 6th semester of bachelor studies. That causes lots of problems in teaching and learning such a course, taking into account Problem based education environment at Aalborg University. The course is placed too late in the education, so the students cannot use the tools from it for their bachelor project work. This means that majority of the students who do not have intention to continue on the masters' level, see this course just as obstacle to graduate, and see its content as useless.

There is still a huge work remaining in order to make this mathematics course more useful for majority of the students.

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