52
Integrating Different Subjects to Ease Students First-Year Experience

Göran Svensson
Professor in Inorganic Chemistry
IT-manager (CIO)
Eva-Karin Akar
Programme Co-ordinator
Student Counselor

Outline

• Presentation
• Why change?
• What did we do?
• Mathematics
• Chemistry
• Chemistry with Mathematics
• Conclusions

Basic facts

• Institute of Technology (Technical University)
• 8,000 Master/Bachelor Students (23 % women)
• 1200 PhD students (23 % women)
• 2500 employees (1500 teachers and researchers)
• 13 National Master of Science Program (4,5 year)
• 14 International Master of Science Program (1,5 year)
• Chalmers turnover ~ 2 billion SEK/year
People with an University degree

Goal and Consequences
Students compete for a place at an University
Universities compete for students
At the age of 25, 50 % should have started an University education
Number of students at University have increased by 50 %
Funding have increases by 15 %

The Swedish school system
Nine-year compulsory school
Upper secondary school
Three years

Swedish
English
Mathematics
Physics B (A-B)
Chemistry A (A-B)

ECONOMY
What we have to deal with (I)

Students with less knowledge from secondary school in
- Mathematics
- Chemistry
- Physics

Diagnostic test

1980

2004

What we have to deal with (II)

Univ

Sec. School

time

What we have to deal with (III)

In academia we solve problems that can be solved

Engineering deals with problems that have to be solved

Master of Science in Engineering
- Bio Engineering
- Chemical Engineering
- Chemical Engineering with Engineering Physics

From where to where?

The double helix, Math, and Chemistry

Secondary school

End of first year
Something had to be done

- Change the courses in Mathematics
- Include programming in Mathematics
- Merge several chemistry courses into one big
- Find natural links between Mathematics and Chemistry
- Get the student working from day one
- Continuous examination

Mathematics

- Change from an analytical to a more numerical approach
- Use MatLab as a tool (programming)
- Write new books
- Create an good learning environment
- Interact with Chemistry

Mathematics in Computer Studios

- Plenary lecture: 4 h/week
- Studio class: 4 h/week
- Class: 2 h/week

Eduardo Galeano

soul from body
and
mind from heart
New books i Mathematics

**Applied mathematics:**

Body and Soul is a mathematics education reform project developed at Chalmers University of Technology and includes a series of volumes and software. The program is motivated by the computer revolution opening new possibilities of computational mathematical modeling in mathematics, science and engineering. It consist of a synthesis of Mathematical Analysis (Soul), Numerical Computation (Body) and Application.

ISBN 3-540-00890-X

---

Main Features

- The program is based on a synthesis of mathematics, computation and application
- The program is based on new literature
- Emphasis is put on solving problems, project work and presentations
- The program contains most of the traditional material from basic courses in analysis and linear algebra

---

Two examples from the book

10.7 Graphs of General Polynomials

A general polynomial of degree greater than 2 or 3 can be a quite complicated function and it is difficult to say much specific about their plots. We chose an example in Fig. 10.10. When the degree of a polynomial is large, the tendency is for the plot to have large “wiggles” which makes it difficult to plot the function. The value of the polynomial shown in Fig. 10.10 is 0.253.21.8 at \( x = 3 \).

---

What do the student think?

- The new litterature (to heavy, for those who already know)
- MatLab (Difficulties with the syntax, need more MatLab-knowledge)
- Computer Studios (Differences between the two groups)
- Extra material (as a complement to the text book)
- In general

<table>
<thead>
<tr>
<th>Rating</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>48</td>
</tr>
<tr>
<td>4</td>
<td>34</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>U</td>
<td>50</td>
</tr>
</tbody>
</table>
The Chemistry Course
Merge one complete course with part of five others

• Introductory Chemistry
• Inorganic Chemistry
• Nuclear Chemistry
• Organic Chemistry
• Physical Chemistry
• Analytical Chemistry
• Biochemistry

“Buzz” words
Team-work (Academic teachers, from different disciplines, working as a team)
Projects
Continues examination
Focus on student learning
Course evaluation
PBL (problem based learning)
LMS-system (learning management system)
Selfdirection for life long learning
Portfolio
Learning by doing

Teachers and teaching

• One plenary lecture (2*45 min) every week by invited lecturers (180 stud)
• Two lectures (2*45 min) every week, five parallel groups lead by professors (25-40 stud)
• 2*45 min for practice with a professor available
• Teachers from chemistry and mathematics together in class when appropriate
• Work in the laboratory (~once a week)

The new plan

The first year
180 students
5 lecture groups
15 laboratory groups
Lectures by professors
Lab. by PhD-students

15 points (22.5 ECTS)
14 points (21.0 ECTS)
Experiences

• Teachers should be close (same building) (Biochemistry the first year!!!!!!)
• One lecture group can have several lecturers (1,2 or 3). Responsible for everything!
• People from chemistry and mathematics must meet more
• Information, synchronize ......(>30 people)

LMS-system

• Control of compulsory moment
• Hand in results and comments from laboratory work
• Examination online
• Questions and answers
• No discussion forum!
• Alerts

Administration

• WWW for distribution of information
• Lecture notes handed out prior to lectures and later on the webb
• E-mail
• Learning managment system

33 Compulsary moments in 21 weeks
3 examination weeks
One final exam
21 bonus points available
**Security test, online**

Multiple choice

Stochiometry

The periodic table

Nomenclature

(Online)

The elements

**3D geometry of molecules**

(math)

Oral exam

Written text

The elements (exibition)

The elements (exibition and presentation)
3D geometry of ethane and ethene

4 hour computer laboratory exercise
Electrostatic repulsion potentials
Matrix transformation
Polar coordinates

MatLab

HyperChem

Mathematics in Chemistry

- Acids and bases
- Differential equations and kinetics (MatLab)

Real problems as e.g.
- The ozone problem
- Organic reactions

System of Non-linear equations and equilibrium analysis

About 10 problems to chose from:
One is about the old Swedish ship VASA

H₂S Fe → S → H₂SO₄

How to solve this problem?
VASA and the S problem

- Instructors from Mathematics (MatLab)
- Instructors from Chemistry (the Chemistry)

Chemist can help with the mathematics and MatLab (often)
The reverse don’t work

Tests

Biochemistry
- Multiple choice with 0-5 correct alternatives
- Maximum three times

Equilibrium
- Three questions
  - Encouraged to use MatLab (in their toolbox)
  - Maximum three times

And they who don’t pass??
Chemicals in products

- Project running from second to last week
- Supervised by a senior student (project leader course, 3p)
- Intermediate reports and a final one
- Should work as a project group with leader, secretary, webbmaster, etc. (rotates)
- Groups with 4-6 students

Molecular orbitals by the Hückel method

- The method is introduced by maths and chemistry teachers during a shared lecture
- The students do some simple calculations by hand
- Move to a Hückel program written in Matlab.
- Calculate the absorption maximum for lycopene and β-carotene.
- Compare with results from the practical session at lab.

**Theory and practice gave very different answers**

Final exam

- Written exam
- 10 problems in 5 hours
- All three text books are allowed
- Notes are allowed, of all kinds as long as they are hand written (labnotes)
- Tests for understanding
- The way to the answer is more important than the answer itself

Evaluation

- Evaluation by independent experts (e.g. interviews with teachers and students)
- Independent evaluation by the students
- Interviews with second-year teachers, e.g. "Fundamental and technical thermodynamics"
- Regular meetings with student representatives and teachers
- On-line evaluation in the LMS-system
About Chemistry?

- Highest gradings for the webb and the LMS-system (as always!)
- Students are very positive
- MatLab is a problem
- To small lecture rooms
- Problems with the online tests
- To much to do, do not have time to prepare
- The final exam was to difficult

Final remark

- Integration between Chemistry subjects have been very sucessful, but it is more to do
- Greater interaction between Chemistry and Mathematics is the way to go
- A ”Mathematics for Chemist” toolbox based course will never be our goal

Chemistry and Mathematics

Good idea
This is what the education is all about
The Kinetics project worked very well

MatLab
Difficult to get help, one question/session
Difficult to know who knows what

The idea is good but it was a big failure