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JEM- Joining Educational Mathematics

Proceedings of Workshop 5

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

Contents

1 Introduction 4

2 Roche: ICT in the Portuguese Education, the initiatives EECM, PmatE, TexMat, and IntBooks, and the importance of Abstract Abilities 5

3 Ollo Martio: Mathematics curriculum development in Finland – unexpected effects 24

4 Dominiqur Archambault & Donal Fitzpatrick: Impact of ICT on the Teaching of Maths to VIP (Visually Impaired People) 29

5 Aarne Ranta: Collaborative Enhancement of Mathematical Grammar Libraries 43

6 Marja-Leena Viljanen, Johanna Ojalainen and Matti Pauna: Using Web-Based Assignments in Secondary School Mathematics 49

7 Mika Seppälä: Should we still teach kids to multiply and to divide? 56

8 Valerie Shute: You Can't Fatten A Hog by Weighing It – Or Can You? Evaluating an Assessment for Learning System Called ACED 65

9 Laureano Gonzalez-Vega: Newsbrief from the InterGeo project 77

10 Rein Prank, Marina Issakova-Lepp, Dmitri Lepp, Vahur Vaiksaar, Eno Tnisson: T-algebra– Intelligent Environment for Expression Manipulation Exercises 80

11 Gueudet: Digital resources and mathematics teachers' documents 86

12 J. Saludes: Reviewing Exercises on an e-ink Reader 93

13 J Keller: Engaging learners and instructors in innovative mathematics technology-based applications 99

14 Chris Sangwin & Simon Hammond: Enhancing traditional teaching through the STACK CAA system 108

15 J. Lagrange: Developing and experimenting a Dynamic Geometry and Computer Algebra environment 110

16 Christian Schöne, Nils deBuhr, Julika Mimkes: New features in 'physik multimedial' 122

17 Marco Burkschat: EMILeA-stat 2.0– A web-based learning environment in applied statistics 123

18 Teresa Sancho-Vinuesa, César Córcoles, M. Antnia Huertas, Antoni Prez-Navarro, Daniel Marqus, Joana Villalonga: Automatic Verbalization of Mathematical Formulae for Web-based Learning Resources 131

19 Ramon Eixarch: WIRIS Quizzes, enhancing Moodle quizz system with mathematical capabilities 140

20 M. Antonia Huertas, César Córcoles, Mireia Pascual, Roger Griset, Lourdes Meler: Rodolf: open repository of formulae locutions 144

1 Introduction

This is part 1 of deliverable 3.4.5 containing the proceedings of the fifth Jem workshop. The proceedings of the final workshop can be found in part 2 of this deliverable.

The focus of the fifth Workshop is the Impact of Technology on the Teaching of Mathematics. On one hand, technology is affecting the content of the mathematics curricula at different levels, and, on the other hand, technology supports traditional teaching, and makes the delivery of mathematics education more efficient.

The theme of the workshop is to discuss the extent to which technology should change the actual content of the various mathematics curricula, and how it could be best used to enhance traditional teaching. This includes the use and the further development of various assistive technologies.

In Norway, dynamic geometric programs, such as GeoGebra, are being introduced in the high school classrooms. In the US, the TERC reform has lead to a new mathematics curriculum, which is being accompanied by the reform affected by the book Everyday Mathematics. The workshop will address these and related themes from the European point of view.

Topics include but are not limited to:

- impact of ICT on mathematics curriculum
- pedagogical aspects of ICT in the classroom
- case studies on ICT in mathematics
- assistive technologies in mathematics education
- cognitive studies relevant to mathematics education

2 Roche: ICT in the Portuguese Education, the initiatives EECM, PmatE, TexMat, and IntBooks, and the importance of Abstract Abilities

In this talk, we will discuss three main issues: (a) the importance of ICT in the Portuguese Education System (PES), including new national initiatives and their impact in the New Curriculum for the Portuguese Basic Education; (b) the initiatives EECM, PmatE, TextMat, and IntBooks; and (c) our point of view regarding the current PES, the TERC reform in the US, and how the AA model may help to clarify some questions in Education.

Recently, the Portuguese State started several initiatives that in the whole aim to give 'One Computer to Each Student'. This includes children in Primary Schools, where the Portuguese made computer 'Magalhäes' is being distributed. An outstanding idea that still misses several important issues in the educational scenario. Teachers are now less reluctant in using technology, but still do not used it conveniently, e.g., although widely spread among Basic and Secondary Schools, e-learning systems are not properly used. It is clear that, in the future, the teaching tools will change and push an increasing demand of good digital tools and quality content, which is now lacking behind. In fact, the New Curriculum for the Portuguese Basic Education (NCPBE) has already considered such changes. As stated in the NCPBE, the learning goals in Mathematics involve the knowledge of mathematical concepts, mathematical representation, connection between distinct concepts, mastering procedures, problem solving, reasoning and communication. The use of technology (computers and calculators) is one of the resources recommended mainly in investigational tasks as, for instance, in the exploration of geometrical and numerical patterns. The NCPBE gives special emphasis to Euclidean transformations (isometries and similarities) and the use of dynamic geometrical software (Geogebra, Cabri, Geometer's Sketchpad) is highly recommended since, as it is well established, it enriches the knowledge of geometry. Through the three cycles of Basic Education the students must use calculators and computers to perform difficult calculations, representing information and geometrical objects. They should take advantage of the possibilities of experiencing a hand full of cases in real time. It is a real resource power in domains like geometry, algebra and data analysis.

There are several academic and private initiatives following such guidelines. Here we will describe, and exemplify with living examples, the initiatives EECM, PmatE, TexMat, and IntBooks of the University of Aveiro. The EECM initiative, based on the Russian model of the St. Petersburg school for young education, aims to develop mathematical qualities in children (from 4 years old) to students of all grades of the compulsory school. They run several events, e.g., involving parents in the process of how to teach advanced concepts to children, summer schools, and other events at local schools.

Since 1990, PmatE has been developing a platform only available in the Internet that develops contents either in the way of competition (e.g., Equamat'2008 which involved 4.000 students from 160 schools), or in the formative mode (evaluation, diagnosis and practice). PmatE has currently three main pillars: the communication and diffusion of science; school intervention; and cooperation with countries who share the same Official Language – the Portuguese (e.g., Mozambique). The platform is mainly based on an innovative system of questions randomly generated by models that has been used, not only as aforementioned, but also as complementary material in college courses in areas ranging from Mathematics, Biology, Physics and Portuguese Language.

The TexMat initiative has developed a highly interactive digital book covering the new curricula in mathematics for the 5th and 6th grades of the Portuguese Education System. Its design includes several features and capabilities as multilingual, modularity, the ability of been easily extendable by teachers (e.g., adding Geogebra constructions), model generated exercises, open questions, and centralized gathering of students statistics and assessments.

The IntBooks initiative aims to develop a platform to improve and make much easier the production of interactive digital content from any text editor. It addresses some of the common technical issues as: (a) how should mathematics be delivered and displayed in a large set of devices (PCs, PDAs, etc.); (b) how users interaction should be made and statistics collected; and (c) how authors may reuse and mesh up content from different web repositories.

Finally, and depending on time, we will discuss our point of view concerning some general issues of education, connected with the current Portuguese Education System and the TERC reform in the US. In particular, we will present the Abstract Abilities model (AA model) and how we believe it may improve Education.

ICT in the Portuguese Education, the initiatives EECM, PmatE, TexMat, and IntBooks, and the importance of Abstract Abilities

Eugénio A.M. Rocha
Dept. of Math., University of Aveiro,
PORTUGAL

(joint work with R. Amélia, A. Breda, and P. Oliveira)

Outline

Chapt. 1 - Technology and Education in Portugal
1.1 How ICT are currently used in (portuguese) education?
1.2 ICT initiatives for education
1.3 The impact of ICT on the new portuguese curricula

Chapt. 2 - The Initiatives EECM, PmatE, TexMat, and IntBooks
2.1. A brief description of (our) initiatives
2.2 The EECM initiative
2.3 The PmatE initiative
2.4 The TexMat initiative
2.5 The IntBooks initiative

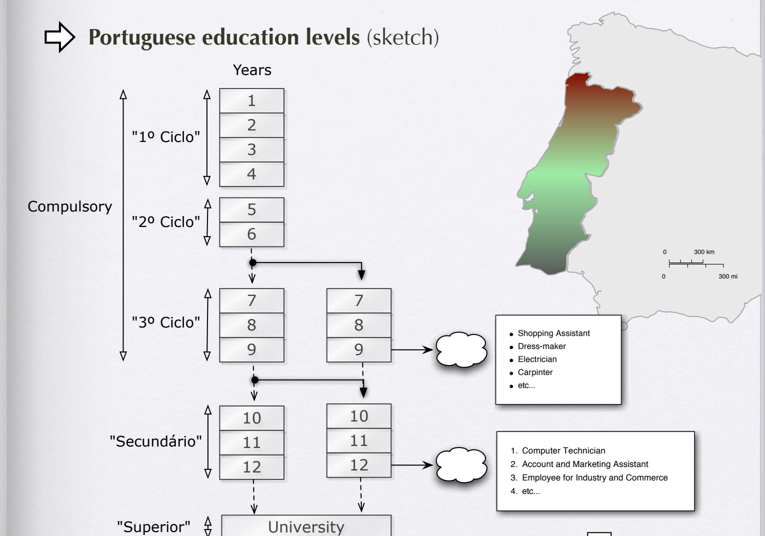
Chapt. 3 - The Importance of Abstract Abilities
3.1 YouTube: "Math Education: An Inconvenient Truth"
3.2 A simplified education model
3.3 Some trivial and disconnected ideas
3.4 Our point of view

Chapter 1

Technology and Education
in
Portugal

1.1 How ICT are currently used in (portuguese) education?

⇨ **Portuguese education levels** (sketch)

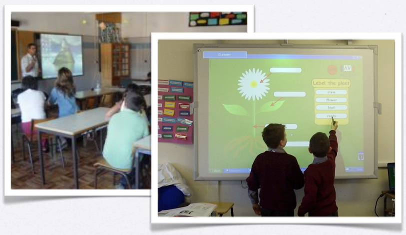


http://www.min-edu.pt/

1.1 How ICT are currently used in (portuguese) education?

5TH JEM WORKSHOP

Computer Rooms



Interactive boards

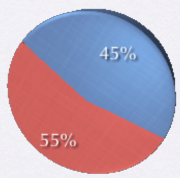
E-learning

http://www.elearning-pt.com/

Learning Management Systems

Classes de Entidades Utilizadoras	Nº Entidades
Ensino Superior Universitário	224
Ensino Superior Politécnico	97
Ensino Básico e Secundário	154
Centro de Form. Gestão Participada	34
Entidades com Acreditação para Formação (IQF)	1601
Entidades com Acreditação IQF ns componente específica para eLearning	46
Empresas Prestadoras de Serviços de Formação	448
Administração Pública	48
Grande Empregador	29
Grande Volume de Negócios	21
Com plataforma (LMS) nacional	98
Outros c/ Elevado Grau de Descentralização	14

Globally



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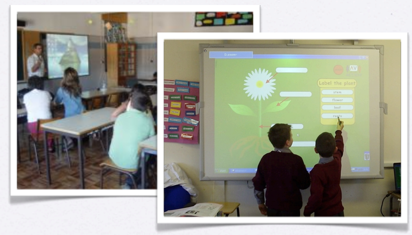
5TH JEM WORKSHOP

Computer Rooms



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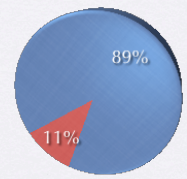
Universities



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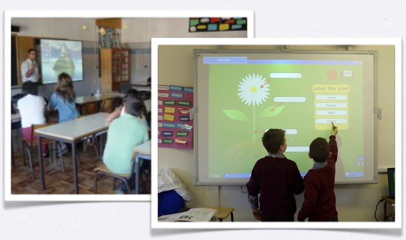
5TH JEM WORKSHOP

Computer Rooms



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E-learning

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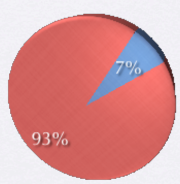
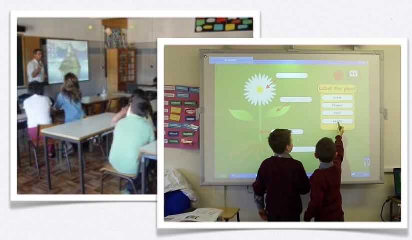
Schools



1.1 How ICT are currently used in (portuguese) education?

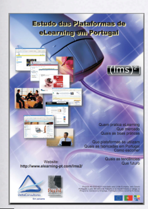
5TH JEM WORKSHOP

Computer Rooms



Interactive boards

E-learning



http://www.elearning-pt.com/

Learning Management Systems

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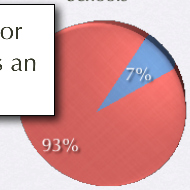
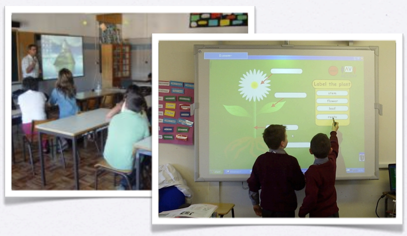
A big majority just use it for forums, mailing-lists and as an archive

Schools



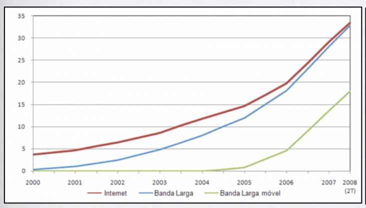
1.1 How ICT are currently used in (portuguese) education?

Computer Rooms

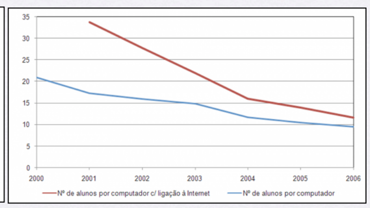


Interactive boards

Computers and Internet



Nº Clients / Total Population

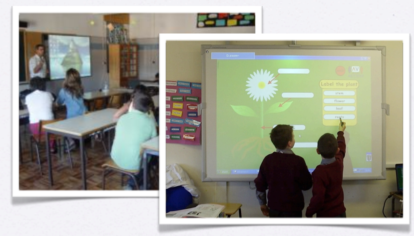


Nº Students / Computer (with internet)

5TH JEM WORKSHOP

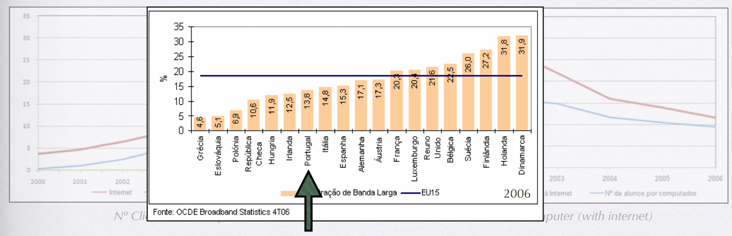
1.1 How ICT are currently used in (portuguese) education?

Computer Rooms



Interactive boards

Computers and Internet



5TH JEM WORKSHOP

1.2 ICT initiatives for education

e.escola CADA ALUNO UM COMPUTADOR

http://www.eescola.pt

One Computer for Each Student

Computers with 3G-Broadband access

- SCHOOLS
- TEACHERS
- STUDENTS
  - OTHER LEVELS
  - PRIMARY SCHOOL

PARTNERS: Telecom comp., computer manufactures, etc.

5TH JEM WORKSHOP

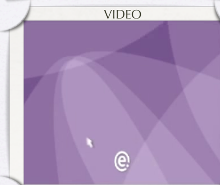
1.2 ICT initiatives for education

e.escola CADA ALUNO UM COMPUTADOR

http://www.eescola.pt

One Computer for Each Student

VIDEO



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Computers with 3G-Broadband access

- SCHOOLS
- TEACHERS
- STUDENTS
  - OTHER LEVELS
  - PRIMARY SCHOOL

Prices:

- TEACHERS
  - comp.(150€) + net (17,5€ x 36m)
- STUDENTS (other levels)
  - comp.(150€) + net (17,5€ x 36m)
  - L2: comp.(0€) + net (15€ x 36m)
  - L1: comp.(0€) + net (5€ x 36m)
- STUDENTS (primary school)
  - "Magalhães": 0€, 20€ and 50€

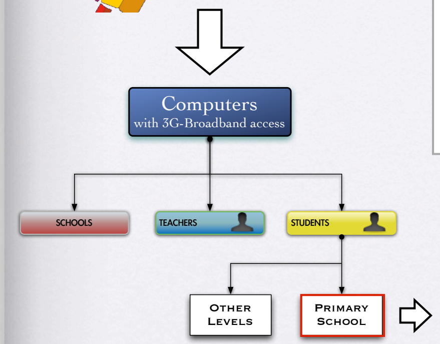
PARTNERS: Telecom comp., computer manufactures, etc.

1.2 ICT initiatives for education

escola
CADA ALUNO
UM COMPUTADOR

http://www.eescola.pt

One Computer for Each Student



Computer "Magalhães"

VIDEO

http://www.portatilmagalhaes.com/

PARTNERS: Telecom comp., computer manufactures, etc.

1.3 The impact of ICT on the new portuguese curricula

As stated in the **New Curriculum for the Portuguese Basic Education** (NCPBE).

- The **learning goals** in Mathematics involve:
  -- the knowledge of mathematical concepts,
  -- mathematical representation,
  -- connection between distinct concepts,
  -- mastering procedures,
  -- problem solving, reasoning and communication.

- The use of **technology** (computers and calculators) is one of the resources recommended mainly in investigational tasks as, for instance, in the exploration of geometrical and numerical patterns. Through the three cycles of Basic Education the students must use calculators and computers to perform difficult calculations, representing information and geometrical objects. They should take advantage of the possibilities of experiencing a hand full of cases in real time. It is a real resource power in domains like geometry, algebra and data analysis.

- The NCPBE gives special emphasis to the Euclidean transformations (isometries and similarities) and the use of **dynamic geometrical software** (*Geogebra*, *Cabri*, *Geometer's Sketchpad*) is highly recommended since, as it is well established, it enriches the knowledge of geometry.

Chapter 2

The Initiatives EECM, PmatE, TexMat, and IntBooks

2.1. A brief description of (our) initiatives

EECM - "Escola de Educação Complementar em Matemática" http://eecm.mat.ua.pt

The EECM initiative, based on the **Russian model** of the St. Petersburg school for young education, aims to develop mathematical qualities in **children** (from 4 years old) to students of all grades of the compulsory school. They run several events, e.g., **involving parents** in the process of how to teach "advanced" concepts to children, summer schools, and other events at local schools.

PmatE - "Projecto Matemática Ensino" http://pmate.ua.pt

Since 1990, PmatE has been developing a platform only available in the Internet that has been used either in the way of **competition** (e.g., Equamat'2008), in **formative mode** (evaluation, diagnosis and practice), or as complementary material in **college courses** in areas ranging from Mathematics, Biology, Physics and Portuguese Language.

TexMat - "Texto em Matemática" http://www.intbooks.org/

The TexMat initiative has developed a **highly interactive** digital book covering the new curricula in mathematics for the 5th and 6th grades of the Portuguese Education System. Its design includes **several features and capabilities** as multilingual, modularity, the ability of been easily extendable by teachers (e.g., adding *Geogebra* constructions), model generated exercises, open questions, and centralized gathering of students statistics and assessments.

IntBooks - "Intelligent, Intuitive, Interactive Books" http://www.intbooks.org/

The IntBooks initiative aims to develop a platform to improve and make much easier the production of interactive **digital content from any text editor**. It addresses some of the **common technical issues** as: (a) how should mathematics be delivered and displayed in a large set of devices (PCs, PDAs, etc.); (b) how users interaction should be made and statistics collected; and (c) how authors may reuse and mesh up content from different web repositories.

The Initiatives
EECM, PmatE, TexMat, and IntBooks

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2.2 The **EECM** initiative

CEM (Experimental Circle of Mathematics) | **alphaMat** (on-line problems) | **CurVe** (Summer Schools)

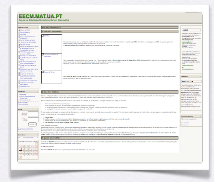
EECM was created in 2005 by a group of teachers of DMat UA with the support of a Russian researcher. It appeared from the recognition of a **lack of mathematical culture** of the Portuguese society in general and the preconception against mathematics.

EECM reflects a collective need to promote a positive relation with mathematics. Since the beginning, our action consists in developing **activities in non formal teaching** that are implemented in the community, involving a wide spectra of it: children of 4-13 years old, parents, educators, teachers and young people.

The teaching is developed in **two different ways**:
-- ***on-line***;
-- with the ***presence*** of the students.

Present elements of the project: Adelaide Valente, Alena Aleksenko, Andreia Hall, Evgeny Lakshtanov, Liliana Costa, Lucinda Serra, Maria Emília Silva, Sofia Lopes, Rosa Amélia Martins, Virgínia Santos.

Project Contact: Rosa Amélia Martins (rosaamelia@ua.pt)



website (portuguese)

2.2 The **EECM** initiative

	CEM (Experimental Circle of Mathematics)	**alphaMat** (on-line problems)	**CurVe** (Summer Schools)
Target audience:	1- Children from 4 to 6 years old. 2- Students of the elementary school. 3- Students from the 5th grade to the 9th grade.	1- Elementary and High School students. 2- General public.	1- High School and University students. 2- Recently, for little ones – Junior Summer School.
Main idea:	The questions are more important than the answers.	Problem solving available to all, regardless of their location.	To develop mathematical abilities using games and problem solving.
Process:	– Work sessions with small groups of children where one "discovers" Mathematics through the observation of our surroundings, using and promoting the children's curiosity and sense of observation. – The individualized care and attention allow the children to answer for themselves to the proposed problems, developing their skills and facing Mathematics as natural.	– The core of this component is interactive problem solving, through information technologies.	– Actual sessions where individual and group work are carried trough, being outstanding the mathematical "fight" and the mathematical "battle".

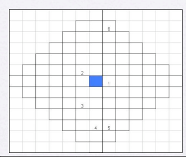
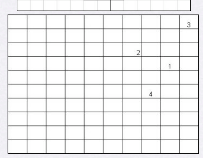
2.2 The **EECM** initiative - EXAMPLE 1/5

For 5-6 years old CEM




◀ **Stories with Mathematics**
(Story with a die)

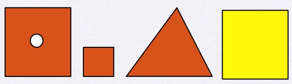
Some different metrics
(Where is the treasure?)
▼

2.2 The **EECM** initiative - EXAMPLE 2/5

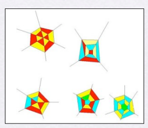
Hanoi Tower
and
"The farmer, the wolf, the sheep and the cabbage "
▼

What is different?
▼



4-colours theorem

Colouring each one with the minimum of colours
▼



2.2 The **EECM** initiative - EXAMPLE 3/5

5TH JEM WORKSHOP

CEM

◄ **"Missing piece"**

CEM (Closing Party 2006)

Combinatorics ►

CEM (Closing Party 2007)

◄ **Robot game**

2.2 The **EECM** initiative - EXAMPLE 4/5

5TH JEM WORKSHOP

CEM

Soma cube (Junior Summer Course 2008)

◄ Planning

Construction ►

Competition
▼

Setting up ►

2.2 The **EECM** initiative - EXAMPLE 4/5

5TH JEM WORKSHOP

...and Mathematics Workshops for parents

CEM

The Initiatives
EECM, PmatE, TexMat, and IntBooks

PmatE - "Projecto Matemática Ensino" http://pmate.ua.pt

Since 1990, PmatE has been developing a platform only available in the Internet that has been used either in the way of **competition** (e.g., Equamat'2008), in **formative mode** (evaluation, diagnosis and practice), or as complementary material in **college courses** in areas ranging from Mathematics, Biology, Physics and Portuguese Language.

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The platform is mainly based on an innovative system of **questions randomly generated by models** that has been used not only as aforementioned but also as complementary material in college courses in areas ranging from Mathematics, Biology, Physics and Portuguese Language.

(http://pmate.ua.pt)

PmatE has a new "aided teaching" platform such that:
-- One may create groups of students, according to their profiles of knowledge;
-- Create tests and see the results online;
-- One student / one test.

The platform is mainly based on an innovative system
of
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The platform is mainly based on an innovative system
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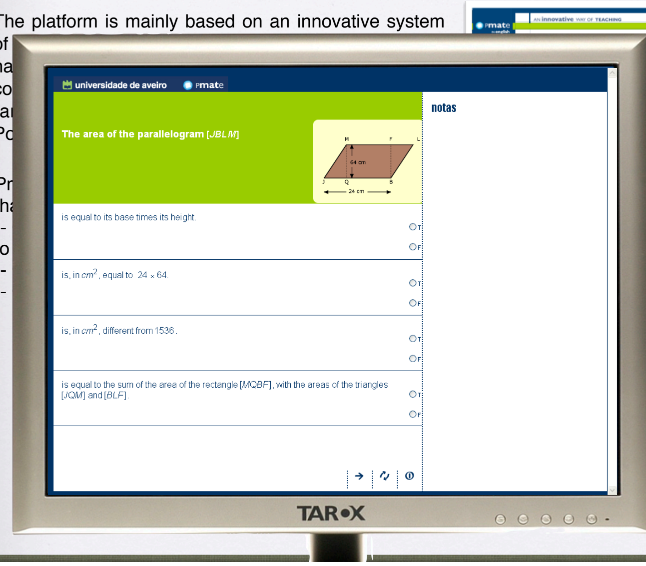

The platform is mainly based on an innovative system

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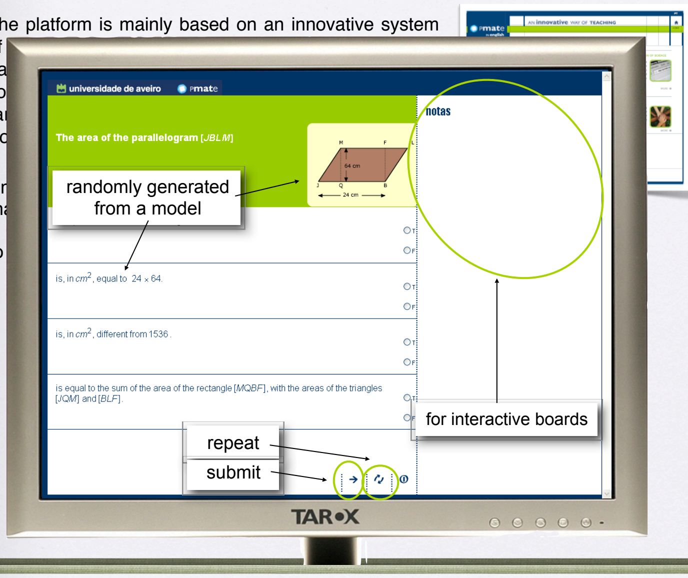

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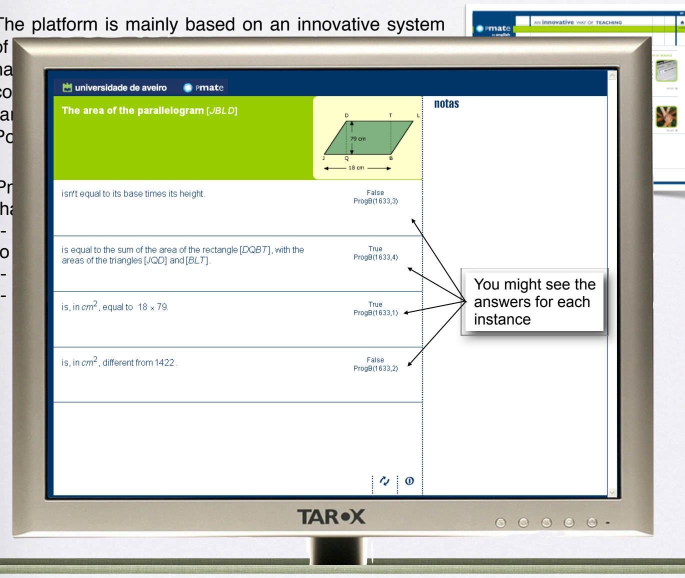

The platform is mainly based on an innovative system

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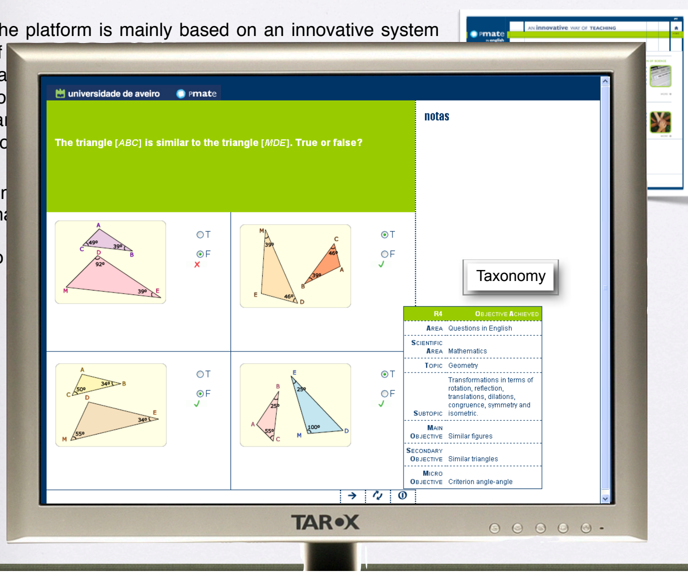

The platform is mainly based on an innovative system of questions randomly generated by models that has been used not only as aforementioned but also as complementary material in college courses in areas ranging from Mathematics, Biology, Physics and Portuguese Language.

(http://pmate.ua.pt)

2008 Statistics

Event	Area	Grades	Schools	Participants
Minimat	mathematics	3rd and 4th	270	+- 6.000
Minibio	biology		113	
Maismat	mathematics	5th and 6th	254	
Dar@lingua (1st ed)	portuguese	7th	11	+- 6.500
Equamat (19th ed)	mathematics	7th, 8th and 9th	**367**	
bio 10 11 12	biology	10th, 11th and 12th	75	+- 3.000
mat12	mathematics	12th	181	
fis12	physics		62	
REDEmat	mathematics	7th - 12th	151	+- 8.500
REDEbio	biology			

+ Mozambique (5th ed) - 7th to 9th grades

+- 15.900

The Initiatives
EECM, PmatE, TexMat, and IntBooks

TexMat - "Texto em Matemática" http://www.intbooks.org/

The TexMat initiative has developed a **highly interactive** digital book covering the new curricula in mathematics for the 5^{th} and 6^{th} grades of the Portuguese Education System. Its design includes **several features and capabilities** as multilingual, modularity, the ability of been easily extendable by teachers (e.g., adding *Geogebra* constructions), model generated exercises, open questions, and centralized gathering of students statistics and assessments.

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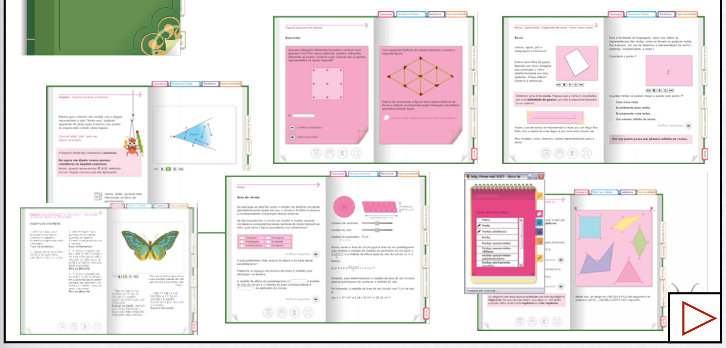
2.4 The **TexMat** initiative

A highly interactive digital book (5^{th}-6^{th} grades):
- more than 1.000 pages;
- covering the New Curriculum in Mathematics;
- model generated exercises and open questions;
- centralized gathering of students stats and assessments;
- multilingual, modular and extendable;
- and several others features...



The Initiatives
EECM, PmatE, TexMat, and IntBooks

IntBooks - "Intelligent, Intuitive, Interactive Books" http://www.intbooks.org/

The IntBooks initiative aims to develop a platform to improve and make much easier the production of interactive **digital content from any text editor**. It addresses some of the **common technical issues** as: (a) how should mathematics be delivered and displayed in a large set of devices (PCs, PDAs, etc.); (b) how users interaction should be made and statistics collected; and (c) how authors may reuse and mesh up content from different web repositories.

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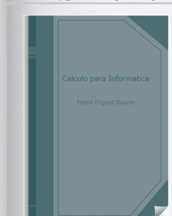
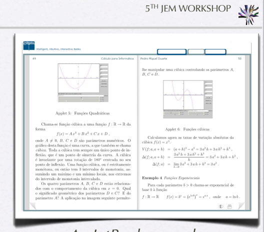
2.5 The **IntBooks** initiative

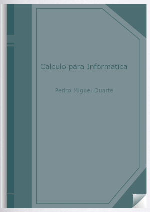


The IntBooks initiative aims to develop a platform to improve and make much easier the production of **interactive digital content** from any **text editor**.



An IntBook example

__**Common technical issues**__:
(a) how should mathematics be delivered and **displayed** in a large set of devices;
(b) how **users interaction** should be made and statistics collected;
(c) how authors may **reuse and mesh up** content from different web repositories.



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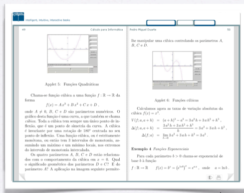

An IntBook example

Common technical issues:

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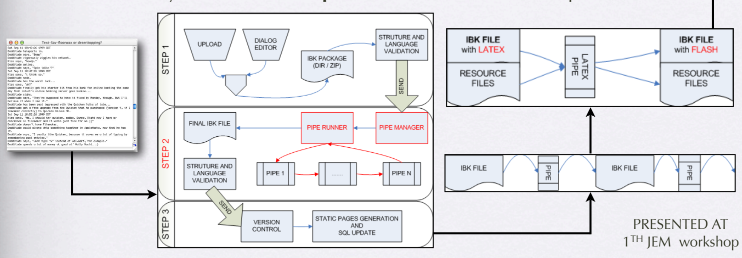
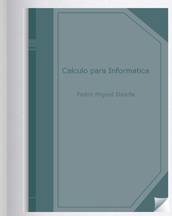


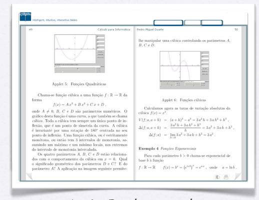
PRESENTED AT
1TH JEM workshop

2.5 The **IntBooks** initiative

5TH JEM WORKSHOP



The IntBooks initiative aims to develop a platform to improve and make much easier the production of **interactive digital content** from any **text editor**.



An IntBook example

Common technical issues:

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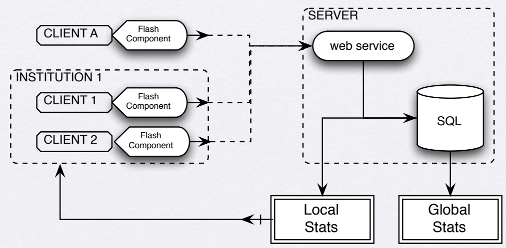
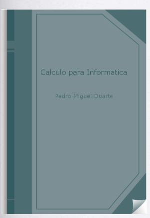


2.5 The **IntBooks** initiative

5TH JEM WORKSHOP



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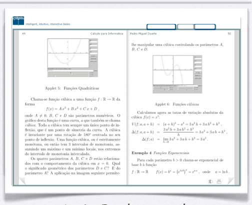

An IntBook example

Common technical issues:

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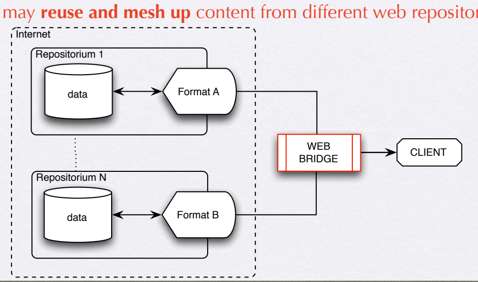

2.5 The **IntBooks** initiative

5TH JEM WORKSHOP

Com
(a)
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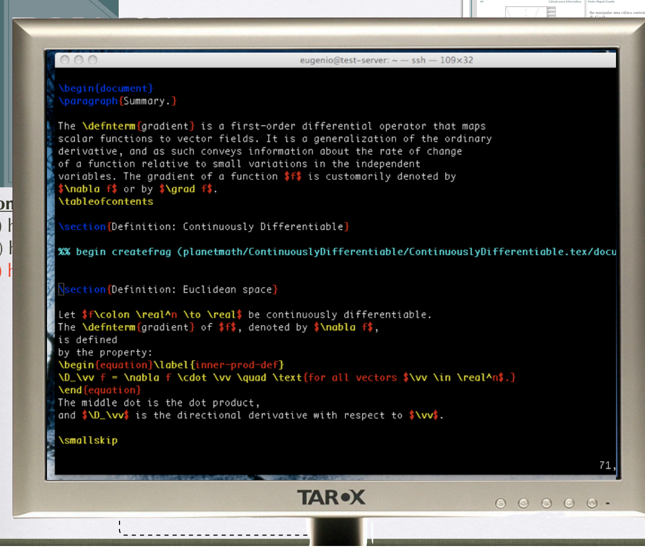

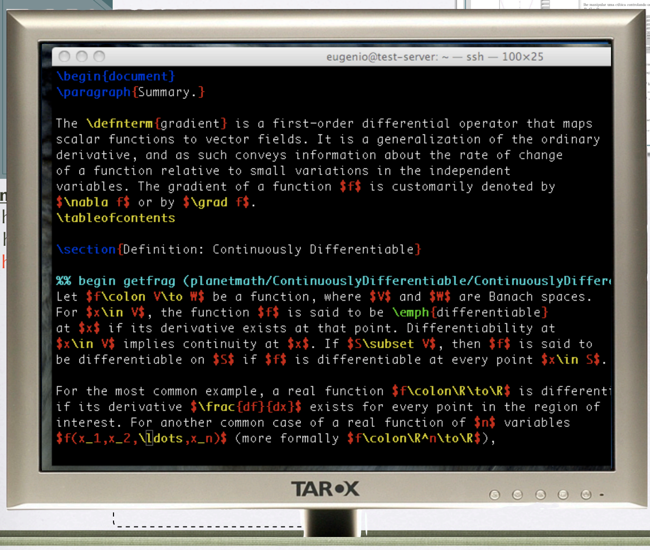

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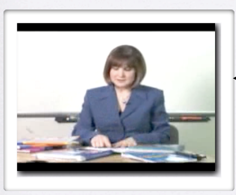
Chapter 3

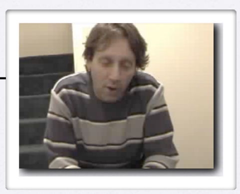
The Importance of Abstract Abilities

(a personal point of view)



M.J. McDermott

response



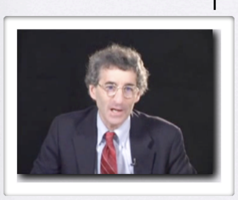
"jamesblackburnlynch"

5th JEM

support

YouTube Broadcast Yourself

comedy

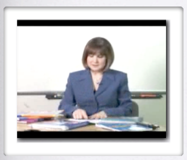


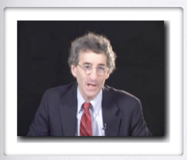
Clifford Mass

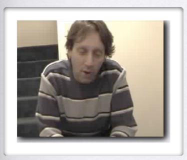
Tom Lehrer

3.1 YouTube: "Math Education: An Inconvenient Truth"

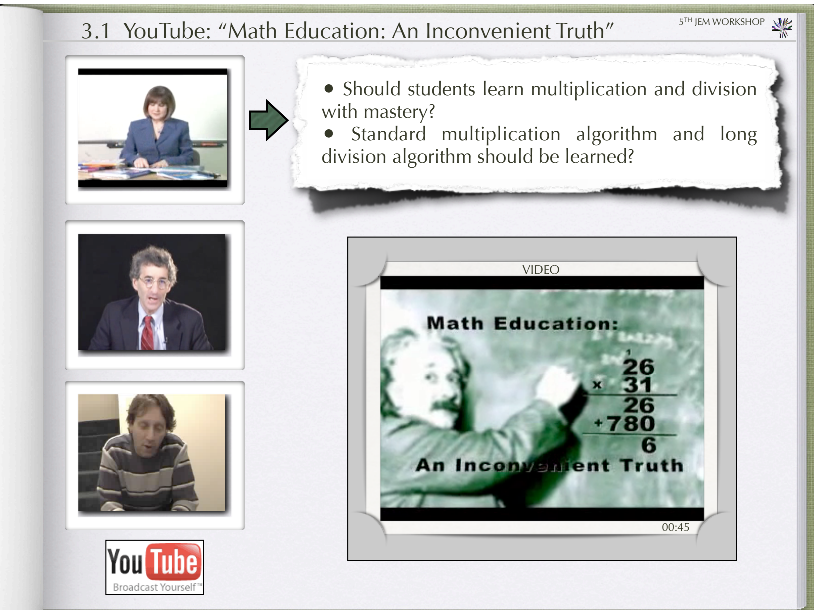
5TH JEM WORKSHOP





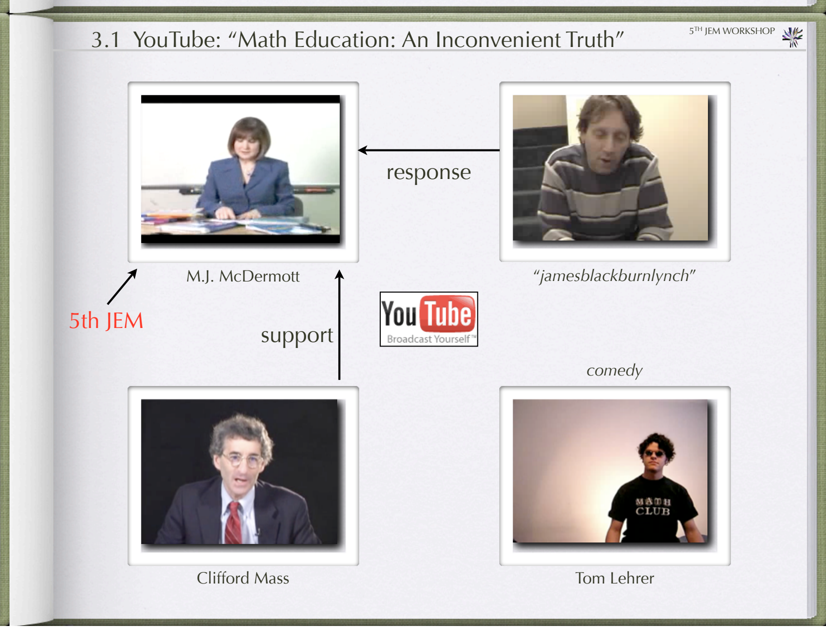


YouTube Broadcast Yourself


3.1 YouTube: "Math Education: An Inconvenient Truth"
5TH JEM WORKSHOP
• Should students learn multiplication and division with mastery?
• Standard multiplication algorithm and long division algorithm should be learned?
VIDEO
Math Education:
26
× 31
26
+780
6
An Inconvenient Truth
00:45
You Tube
Broadcast Yourself

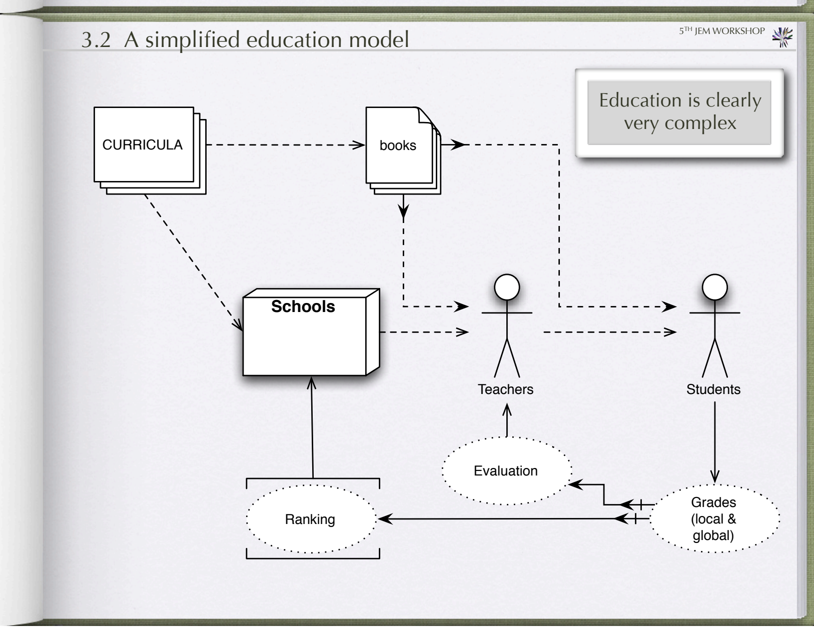

3.1 YouTube: "Math Education: An Inconvenient Truth"
5TH JEM WORKSHOP
• Should students learn multiplication and division with mastery?
• Standard multiplication algorithm and long division algorithm should be learned?
VIDEO
Objective Evidence
The UW Gave the Same Pre-Calculus Assessment Exam Between 1990 and 1999
02:00
You Tube
Broadcast Yourself

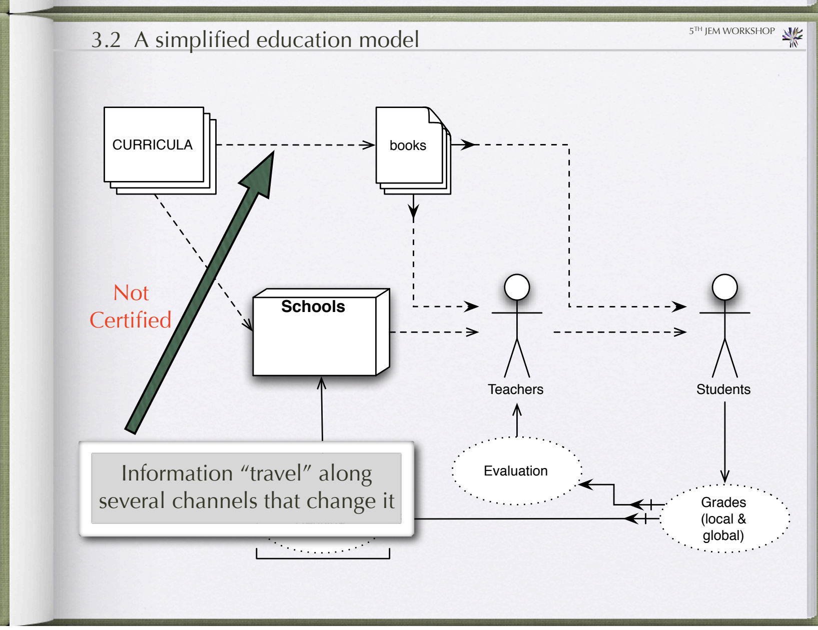

3.1 YouTube: "Math Education: An Inconvenient Truth"
5TH JEM WORKSHOP
VIDEO
• Should the focus be in "multiplication tables" and "algorithms"... and why?
• Maybe that is obsolete because of calculators
• We should teach them how to THINK ...
HOW DO WE TEACH SOMEONE TO THINK?
You Tube
Broadcast Yourself

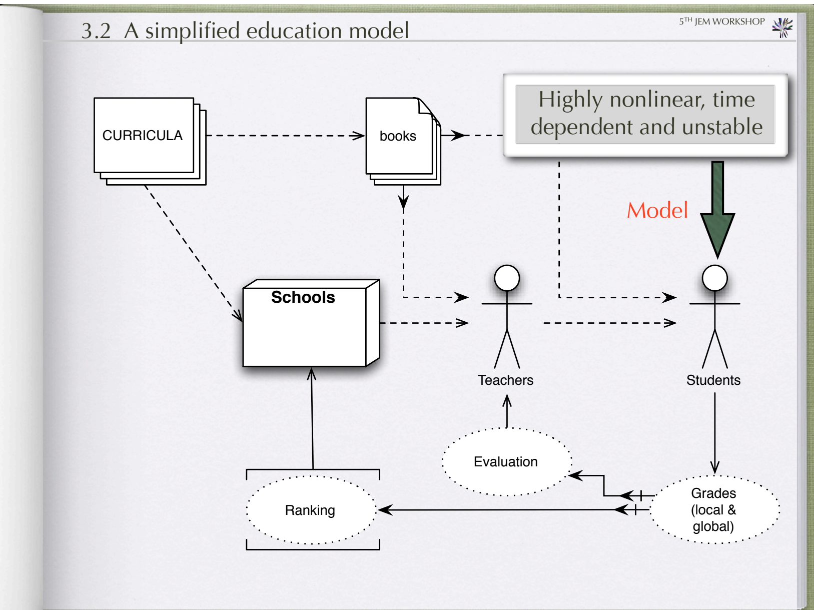

3.1 YouTube: "Math Education: An Inconvenient Truth"
5TH JEM WORKSHOP
response
M.J. McDermott
"jamesblackburnlynch"
5th JEM
support
You Tube
Broadcast Yourself
comedy
Clifford Mass
Tom Lehrer

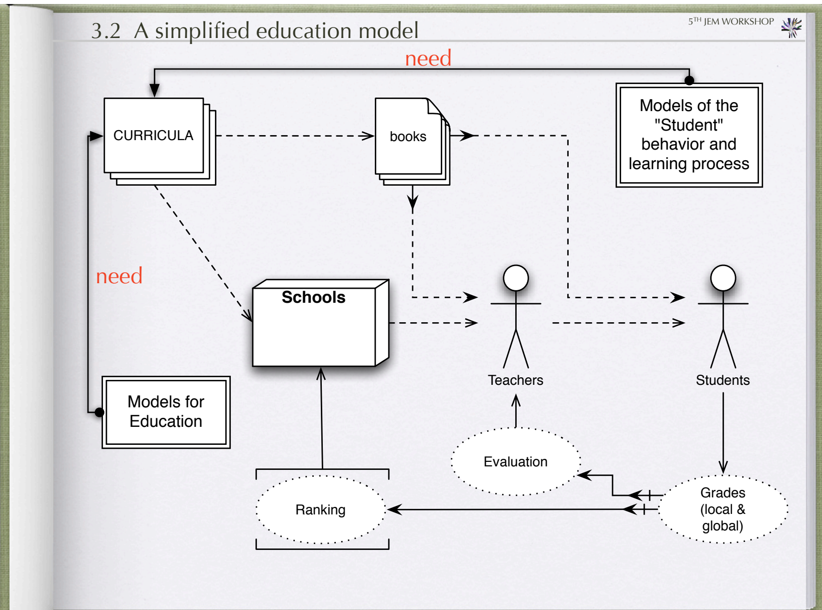

3.1 YouTube: "Math Education: An Inconvenient Truth"
5TH JEM WORKSHOP
And what is the general opinion?
VIDEO
SUBTRACTION
MATH CLUB
01:05 -> 02:20
M.J. Mc
5th JEM
Clifford Mass
Tom Lehrer

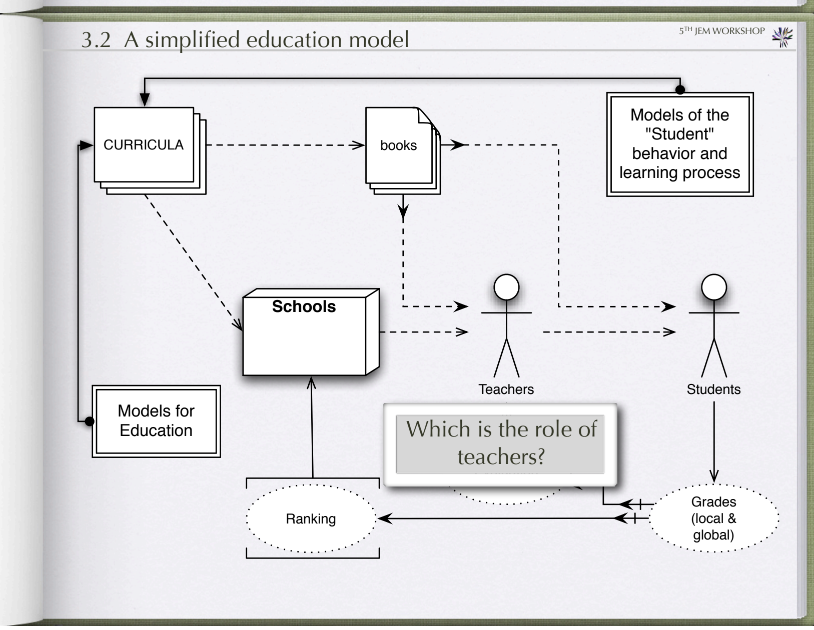

3.1 YouTube: "Math Education: An Inconvenient Truth"
5TH JEM WORKSHOP
Let us first ZOOM OUT our perspective
(from the Finnish Institute)
(to Space)

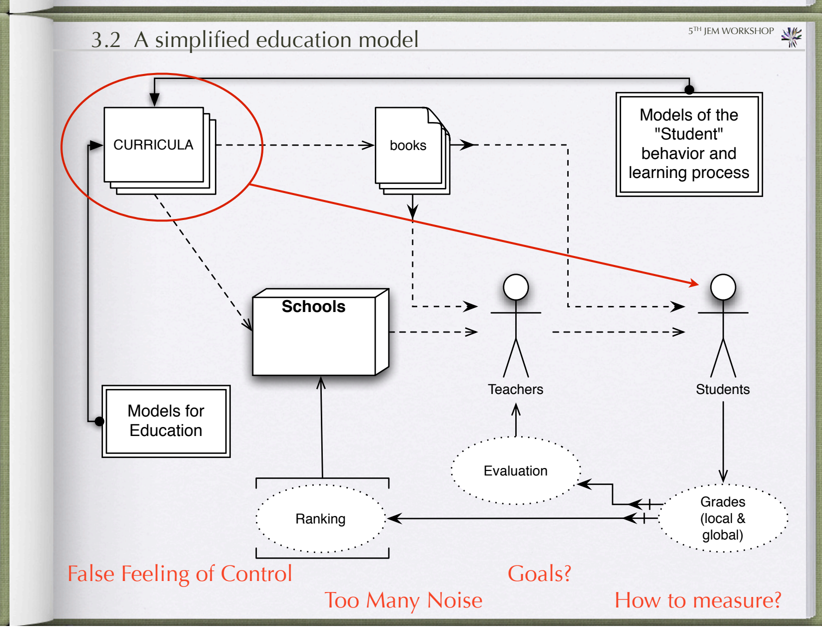

3.2 A simplified education model
5TH JEM WORKSHOP
Education is clearly very complex
CURRICULA
books
Schools
Teachers
Students
Evaluation
Ranking
Grades (local & global)


3.2 A simplified education model
5TH JEM WORKSHOP
CURRICULA
books
Schools
Teachers
Students
Not Certified
Evaluation
Grades (local & global)
Information "travel" along several channels that change it


3.2 A simplified education model
5TH JEM WORKSHOP
CURRICULA
books
Highly nonlinear, time dependent and unstable
Model
Schools
Teachers
Students
Evaluation
Ranking
Grades (local & global)

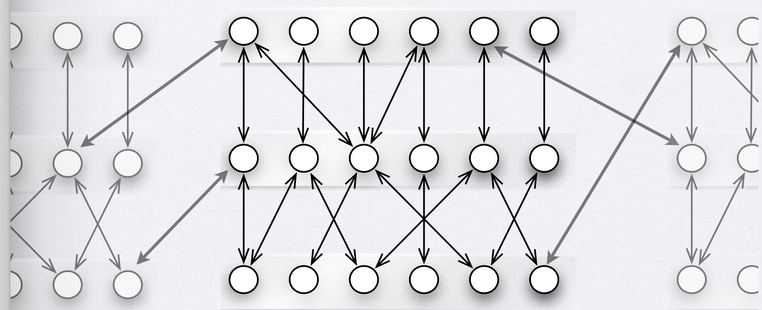

3.2 A simplified education model
5TH JEM WORKSHOP
need
CURRICULA
books
Models of the "Student" behavior and learning process
need
Schools
Teachers
Students
Models for Education
Evaluation
Ranking
Grades (local & global)


3.2 A simplified education model
5TH JEM WORKSHOP
CURRICULA
books
Models of the "Student" behavior and learning process
Schools
Teachers
Students
Models for Education
Which is the role of teachers?
Ranking
Grades (local & global)


3.2 A simplified education model
5TH JEM WORKSHOP
CURRICULA
books
Models of the "Student" behavior and learning process
Schools
Teachers
Students
Models for Education
Evaluation
Ranking
Grades (local & global)
False Feeling of Control
Goals?
Too Many Noise
How to measure?

⇨ Knowledge is stratified and incomplete (by nature)

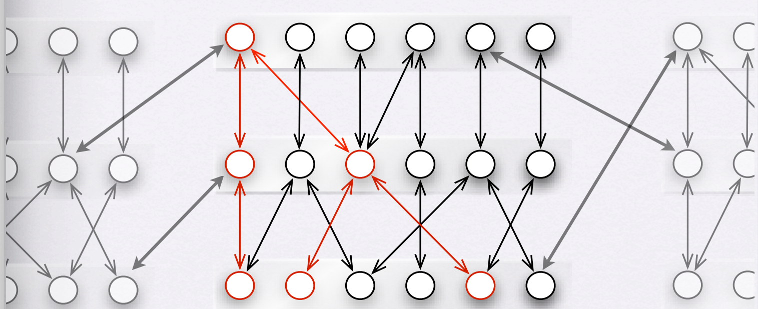
Ex-1: The classical vs global reading method in primary school



STRUCTURED IN LAYERS

⇨ Knowledge is stratified and incomplete (by nature)

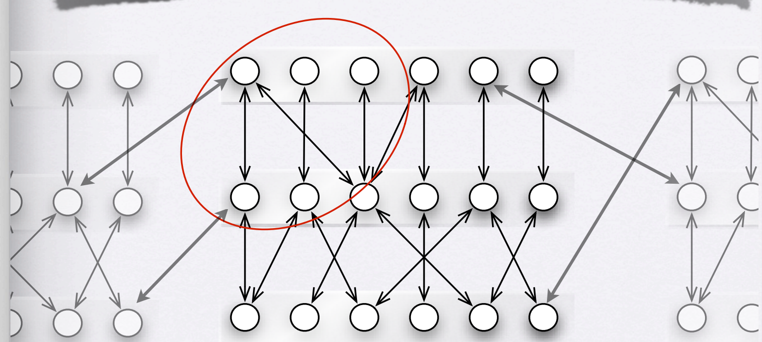
Ex-1: The classical vs global reading method in primary school



"CLASSICAL VIEW"
(highly layer dependent)

⇨ Knowledge is stratified and incomplete (by nature)

Ex-1: The classical vs global reading method in primary school



"GLOBAL/LOCAL VIEW"
(plenty of unknown concepts)

Knowledge is stratified and incomplete (by nature)

Ex-1: The classical vs global reading method in primary school

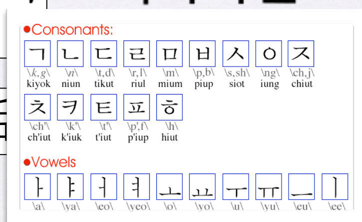
Math proficiency needs a lot of work

Ex-1: How different learning Math is from learning Korean

세계인류의 평화가 이룩되도록

백과사전

普通话/普通话



Knowledge is stratified and incomplete (by nature)

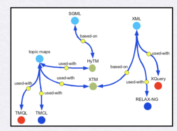
Ex-1: The classical vs global reading method in primary school

Math proficiency needs a lot of work

Ex-1: How different learning Math is from learning Korean

Generally, we codify knowledge as symbolic data and relations are what matters...

Ex-1: milk Ex-2: Ontologies (OLPs) Ex-3: Merlin Donald cognitive theory



Knowledge is stratified and incomplete (by nature)

Ex-1: The classical vs global reading method in primary school

Math proficie...

Ex-1: How dif... ...ean

Generally, we ... ...ta and relations are what matters...

Ex-1: milk ... Donald cognitive theory

Nobody can reasoning without a "base knowledge"

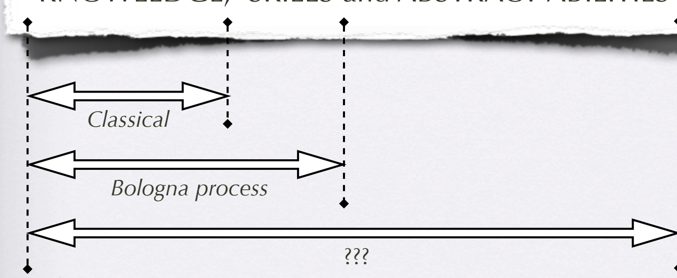
Ex-1: YouTube video "division example"

How to answer the questions:

A. What is the main goal of the education process?
B. What does it mean: "*They should learn to think.*"
C. Student: "*Why do I ever need to learn this?*"

There should be a clear difference between

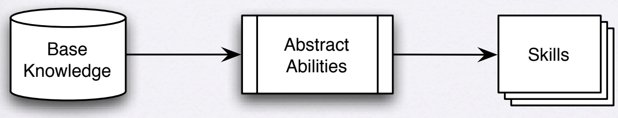
KNOWLEDGE, SKILLS and ABSTRACT ABILITIES



3.4 Our point of view

How to answer the questions:

A. What is the main goal of the education process?
B. What does it mean: “*They should learn to think.*”
C. Student: “*Why do I ever need to learn this?*”



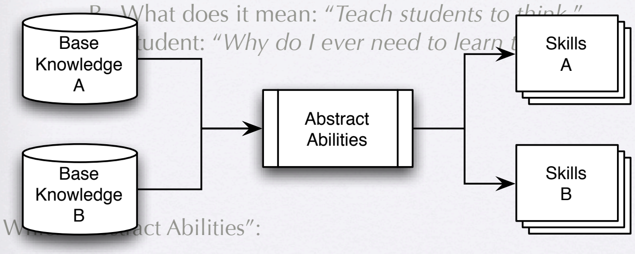
Which “Abstract Abilities”:

1. Induction and deduction
2. Analysis and synthesis
3. Marshaling, merging and decoupling
4. Classes, hereditary and polymorphism
5. Instantiation, substitution and evaluation
6. Organization and transmission of ideas/concepts
7. Partial knowledge

3.4 Our point of view

How to answer the questions:

A. What is the main goal of the education process?
B. What does it mean: “*Teach students to think.*”
C. Student: “*Why do I ever need to learn t*



Which “Abstract Abilities”:

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3. Marshaling, merging and decoupling
4. Classes, hereditary and polymorphism
5. Instantiation, substitution and evaluation
6. Organization and transmission of ideas/concepts
7. Partial knowledge

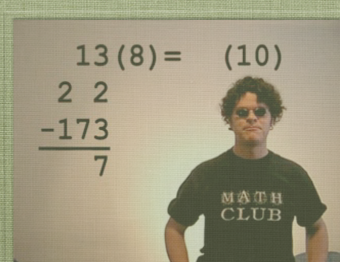
New Math (YouTube)

Tom Lehrer

00:07

--- Thank you ---

New Math (YouTube)



Tom Lehrer

3 Ollo Martio: Mathematics curriculum development in Finland – unexpected effects

Curricula changes in the Finnish school system have happened in ten year intervals. In mathematics they have followed the international trends. The most obvious changes are the following:

1. Mathematics at school became descriptive - exact definitions and proofs were largely omitted. 2. Geometry and trigonometry were neglected. 3. Computations were performed by calculators and numbers and not on a more advanced level.

The effects of these changes have now penetrated the whole educational system. There are few studies on long range effects but a study of L. Naveri deserves special attention. This is compared to the PISA 2003 and TIMMS 1999 surveys. Also the feedback of the changes from professional schools and colleges is discussed.

Mathematics curriculum development in Finland – unexpected effects

Olli Martio
University of Helsinki, Marticulation Board in Finland
olli.martio@helsinki.fi

Curricula changes in the Finnish school system have taken place in 8-10 year intervals. They have been recorded in the official curricula for schools by the Finnish Ministry of Education. However, these texts do not provide a complete picture since they are rather short of details. Schools can freely choose their textbooks and there is neither an official inspection nor an official approval for the textbooks. The system is based on the free market principle. Because of this textbooks, and the practice of teaching, should also be studied in order to understand the Finnish mathematics curriculum. A similar situation prevails in many other countries.

The leading ideas, from the point of view of people working in pedagogy, from 1960 on were ”New Math” (1960-1970), ”Back to Basics” (1968-80) and “Problem Solving”(1978-), see [M1] and [PAL]. These trends have appeared in many other countries as well. However, these key words do not give a proper picture what really happened in the mathematics curriculum and education.

In Finland these trends had the following effects on the mathematics curriculum.

Mathematics at school became descriptive - exact definitions and proofs were largely omitted.
Geometry and trigonometry were neglected.
Computations were performed by calculators and numbers and not on a more advanced level.

“Problem Solving” and putting emphasis on calculators have taken time from explaining the basic principles and ideas in mathematics. It should be also remembered that with the invention of calculators and computers the pressure to traditional mathematics teaching increased enormously since a general believe in 1960-70 was that all the mathematical problems can be solved by computers and hence the traditional school mathematics is useless. This criticism did not come from ordinary laymen only but from well known scientists as well and this attitude was very much adopted by people working in education and didactics. These ideas had a profound effect on the changes in the Finnish school curriculum.

A typical effect has been that although sums and other operations with numbers are taught to the students to be performed in their head in the lower stage of comprehensive school such calculations are not practised any more later on. Calculators are used instead. This prevents the students to learn the effects of computations and the feeling of the magnitude of numbers also disappears. It also prevents the students to practice calculations in everyday life because many of them soon forget how to do such calculations. This very much applies to students who are not among the best in mathematics.

L. Näveri [N] has studied the effects of the curriculum changes in Finland. Two similar tests were performed in mathematics in 1981/87 and in 2003. Participants belonged to the age group 15-16 year old (9. grade); this corresponds to the age group in the PISA survey since the school starts at the age of seven in Finland. The number of participants in both surveys was more than 350. The problems were identical and no calculators were allowed. Samples of the questions in the study are presented below.

The first samples of questions and the percentages of the correct answers dealt with multiplication. Here the question was: Correct or incorrect?

Multiplication	1981	2003
$5 \cdot 5 \cdot 5 \cdot 5 = 5^4$	95,2 %	90,1 %
$(-3)^2 = 9$	67,8 %	47,5 %
$18 \cdot 4 \cdot 32 \cdot 15 = 15 \cdot 32 \cdot 4 \cdot 18$	93,2 %	85,9 %
$0{,}015 \cdot 248 = 0{,}15 \cdot 24{,}8$	66,8 %	62,3 %
$0 \cdot 8436 = 0 \cdot 0{,}536$	79,0 %	65,6 %

In the questions concerning rational numbers the performance drop from 1981 to 2003 was the highest, 20 %.

Rational numbers	1981	2003
26 + 17 =	98,5 %	89,8 %
$(1/2) \cdot (2/3) =$	56,4 %	36,9 %
$(4/5) \cdot 5 =$	66,3 %	44,4 %
$(1/6) \cdot (1/2) =$	56,5 %	28,3 %
$(1/5) : 3 =$	49,2 %	27,5 %
1278 / 2 =	55,1 %	36,8 %

Also in the algebra section of the study the results did not give a promising picture of the effects of the curriculum changes.

Algebra	1981	2003
$10^3 \cdot 10^2 =$	72,5 %	43,3 %
$x^4\, x^5 =$	71,7 %	47,3 %
$(59^2)^3 = (59^3)^2$	61,1 %	31,7 %

If calculators were allowed in the test, the results would have most likely shown different figures. However, these figures show, beyond any doubt, that students' ability to perform simple calculations in their head or with a pencil and paper has dropped significantly in the time period 1981-2003. It is difficult to imagine other reasons for this than the changes in the mathematics curriculum and the extensive use of calculators.

The final effectiveness of the Finnish school system can be observed in the matriculation examination. Almost everybody finishing the high school (gymnasium) participates in the matriculation examination at the age of 18. There are about 35.000 students each year participating in the examination. Mathematics test is not obligatory. The matriculation test is 150 years old and its mathematics part has essentially remained the same for the last hundred years. In mathematics a student may choose a basic or an advanced test. The advanced test is chosen by 12.000 students and the basic test by 14.000 students. Both tests consist of 15 problems written on an A4 sheet. A student can choose at most 10 problems out of 15. In practice, solving two problems, or slightly less, he or she is able to pass the test. Eight problems for the highest grade is the standard requirement but this varies annually. The students are graded using seven grades whose distribution is the same each time. Maybe it is not a surprise that the share of those candidates who do not pass the mathematics test is higher than in other tests. Because the distribution of the grades is essentially the same each time, it is a mistake to use the grades as an indication of the mathematics level. The problems have changed considerably during the last decades; the problems are based on the aforementioned, rather loosely stated official curriculum although the text books used at school also play an important role in the tests. The level of problems in the basic test has dropped during the last two decades.

The Finnish matriculation test in mathematics is described in [L] in more detail.

Students, who have passed the matriculation test, do not only go to universities to study. Many of them go to professional schools (for example, training schools for nurses, various engineering colleges) – usually, but not necessarily, these are students who have got low grades in the matriculation test.

During the last ten years teachers in professional schools, and not only mathematics teachers, have complained increasingly of the mathematical skills of the students. These complaints have not been so widespread in the universities and technical high schools. One reason is that the professional schools now use more mathematics than before and assume that their students have learned mathematics at school. Several tests have been performed to find out the mathematical skills of the students starting their studies in professional schools.

The following has been taken from the report [T]. "Basic" and "Advanced" refers to those students who have passed the basic and the advanced matriculation test, respectively. The percentage shows the portion of correct answers. The questions were not written as below - standard expressions were used instead.

	Basic	Advanced
Sqrt(3**2 + 4**2) =	55 %	78 %
(1/3 – 1/7)/4 =	25 %	54 %
a**2 – (a + 1)**2 + 2a =	17 %	50 %
Find R from the formula U = E - IR	26 %	68 %
ln (x**2) – 2 ln x =	7 %	34 %

Since calculators were not allowed in the test, the results clearly indicate that the students who had taken “basic mathematics” have not learned, or at least forgotten, even basic concepts.

The above studies show that the changes in the mathematics curriculum in Finland have had marked effects on learning of mathematics at school. This seems mainly to concern people who are not interested in mathematics at school but who later need some mathematical skills.

In conclusion

- Calculators in teaching mathematics are not properly used at school. Some of the effects have been disastrous.
- The architecture of the mathematics curriculum, as it now stands in Finland, does not produce skills which are later needed.
- “Problem solving” has been overstressed since it has not been able to respond to the needs of the modern society.

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4 Dominiqur Archambault & Donal Fitzpatrick: Impact of ICT on the Teaching of Maths to VIP (Visually Impaired People)

The study of Mathematics has always been particularly difficult for blind individuals. Indeed we can observe that a large majority of blind pupils do not succeed in maths studies, while the average mainstream pupil succeeds more easily. As maths is crucial in most science disciplines, this limits study options and future job opportunities for blind people. We assert that there is no reason that mathematical semantics can not be understood because of blindness; rather the biggest barrier is access to mathematical content, which can only be through speech or Braille. During the last 2 decades a number of research projects have proposed partial solutions to this problem: projects focusing on access to mathematical literature and preparation of mathematical information, as well as projects trying to improve the presentation of content to the reader. Today, we need new software tools that support the work of blind users, facilitating their understanding and helping them to carry out calculations, while facilitating inclusion in the mainstream environment. Indeed more and more such pupils attend mainstream schools, so it is important that these tools are usable with teachers who are not particularly familiar with Braille.

Impact of ICT on the Teaching of Maths to VIP (Visually Impaired People)

Dominique Archambault[1], Dònal Fitzpatrick[2]

[1]Interfaces Non Visuelles et Accessibilité
Département d'Informatique, UFR d'Ingénierie
Université Pierre et Marie Curie - Paris 6
>>> http://chezdom.net/blog <<<

[2]School of Computing, **Dublin City University**
>>> http://www.computing.dcu.ie/ dfitzpat <<<

5^{th} *JEM Workshop – Joining Educational Mathematics*
Institut Finlandais – Paris – 2008/11/27

Access to Maths as always been a problem to VIP

Access to mathematics

- There is no reason that mathematical semantics can not be understood because of blindness.
- The biggest barrier is in fact access to mathematical content

Where does lie the problem?

- Non visual representations
- Additional modalities used by the sighted

Access to Maths as always been a problem to VIP

Access to mathematics

- There is no reason that mathematical semantics can not be understood because of blindness.
- The biggest barrier is in fact access to mathematical content

Where does lie the problem?

- Non visual representations
  - *Speech*
  - *Braille*

  $\Longrightarrow$ Linear representations
- Additional modalities used by the sighted

Access to Maths as always been a problem to VIP

Access to mathematics

- There is no reason that mathematical semantics can not be understood because of blindness.
- The biggest barrier is in fact access to mathematical content

Where does lie the problem?

- Non visual representations $\Longrightarrow$ *Linear*
  - No global perception (2D)
  - Formulas can be very long and complex
- Additional modalities used by the sighted

Access to Maths as always been a problem to VIP

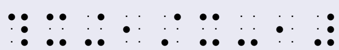
Access to mathematics

- There is no reason that mathematical semantics can not be understood because of blindness.
- The biggest barrier is in fact access to mathematical content

Where does lie the problem?

- Non visual representations $\Longrightarrow$ *Linear*

  $\frac{x+1}{x-1}$ (7 symbols) $(x+1)/(x-1)$ (11 symbols)

  In Braille (Nemeth) 9 symbols
- Additional modalities used by the sighted

Introduction State-of-the-Art What's next Motivation Learning @science

Access to Maths as always been a problem to VIP

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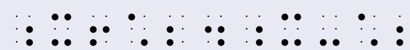
- The biggest barrier is in fact access to mathematical content

Where does lie the problem?

- Non visual representations $\Longrightarrow$ *Linear*

  $\frac{x+1}{x-1}$ (7 symbols) $(x+1)/(x-1)$ (11 symbols)

  In Braille (French) 11 symbols
- Additional modalities used by the sighted

Dominique Archambault, Dònal Fitzpatrick Teaching Maths to Visually Impaired People

Introduction State-of-the-Art What's next Motivation Learning @science

Access to Maths as always been a problem to VIP

Access to mathematics

- There is no reason that mathematical semantics can not be understood because of blindness.
- The biggest barrier is in fact access to mathematical content

Where does lie the problem?

- Non visual representations $\Longrightarrow$ *Linear*

  $\frac{x+1}{x-1}$ (7 symbols) $(x+1)/(x-1)$ (11 symbols)

  In Braille (Marburg) 14 symbols and 4 spaces
- Additional modalities used by the sighted

Dominique Archambault, Dònal Fitzpatrick Teaching Maths to Visually Impaired People

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Access to Maths as always been a problem to VIP

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Where does lie the problem?

- Non visual representations $\Longrightarrow$ *Linear*
- Additional modalities used by the sighted

$$(x+1)(x-1) = x^2 - \cancel{x} + \cancel{x} - 1 = x^2 - 1$$

Dominique Archambault, Dònal Fitzpatrick Teaching Maths to Visually Impaired People

Mathematical Braille Notations

The double penalty

Learning maths for Blind kids

Difficulty of Maths + Difficulty of Maths notations

- Goals of Mathematical Notations is too reduce length of formulas using context sensitive grammars
- Therefore they are extremely complex
- As more and more pupils are in inclusive education, an increasing number can't learn them (depending on countries)
- a certain number of country are using, officially or not, a standard linear code, with a set of special symbols...

@Science Thematic Network

Funded by the European Union (eContent*Plus* Programme)

to facilitate access to **digital scientific resources** for both visually impaired students and researchers by bringing together and sharing **best practises** and **producing guidelines** concerning the **accessibility of digital scientific resources**.

- Università degli Studi di Milano, Italy (coordinator)
- Johannes Kepler Universität Linz, Austria
- Katholieke University Leuven, Belgium
- Comenius University, Slovakia
- Union of the Blind in Verona, Italy
- Université Pierre et Marie Curie, France

State of the Art

Assistive technology

Since 20 years a number of research projects and commercial tools aim at supporting Visually Impaired people, in 3 main kinds:

- converting producing
- reading, understanding
- manipulating, calculating, solving (doing maths)

see [Archambault et al. 2007] Upgrade (Cepis) paper:
`http://www.upgrade-cepis.org/issues/2007/2/upgrade-vol-VIII-2.html`

Converters

Braille production

Create Braille books for pupils and students

Mainstream to Braille

- [Miesenberger et al.] Labradoor: LaTeX to Marburg
- [Schwebel] Bramanet: MathML to French Braille
- [Crombie et al.] math2braille: MathML to Dutch Braille
- [Stanley]: MathML to Nemeth
- [Archambault et al.] **UMCL** (Multilingual)

Maths OCR

- [Suzuki et al.] Infty: paper, PDF, handwriting to MathML, Japanese Braille, LaTeX...

Converters
Helping inclusive education

Allow sighted teachers to access Braille documents created by pupils or students.

Paper Braille to Mainstream

- [Gupta et al.] Insight: complete chain to process Braille documents (paper)
  - Braille OCR
  - Mathematical Braille to Latex
  - Merging with text
  - graphical output (printout)

Converters
Helping inclusive education

odt2dtbook

odt2dtbook is an OpenOffice.org writer extension, enabling export to DTBook XML (part of the *DAISY* Digital Talking Book specification).

- odt2dtbook is very simple to install and to use.
- odt2dtbook is OpenSource.
- odt2dtbook supports Mathematical content conforming to the MathML Modular extension of DTBook

http://odt2dtbook.sourceforge.net.

Converters
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odt2dtbook received a *Gold Award* from Sun Microsystems, at the OpenOffice Community Innovation Program

http://odt2dtbook.sourceforge.net.

Reading, understanding
Reading maths documents

Help to access/understand long and complex Braille maths expressions

Maths Player [Design Sciences]

Internet Explorer plug-in allowing MathML to be displayed graphically.

- Enlarges formulas with specific background: improves readability for partially sighted (and actually to anybody)
- Create relevant sentence to be read by a screen reader: Provide speech synthesis support
- Converts to Braille using UMCL (in development): Provide support for Braille displays
- Document format: HTML+MathML or xHTML+MathML

Reading, understanding
Reading maths documents

Help to access/understand long and complex Braille maths expressions

Maths Genie [Karshmer et al.]

Formula browser

- provides enlarged graphical formulas
- speech synthesis
- collapse/expand feature (cf later on)
- based on MathML

Doing Maths
Manipulating, calculating, solving

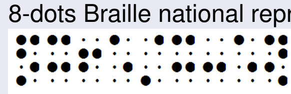
The Lambda project [Nicotra et al.]

Specific linear code

- graphical representation *"sighted-readable"*

  //x+1 ⁄ x−1\\

- 8-dots Braille national representations

  $\lambda-$*Italian*

- Asynchronous display of graphical formula (λ to MathML)

Doing Maths
Manipulating, calculating, solving

Now we need to go further and to provide support to students for doing calculations.

- without solving the Maths problems
- helping to cope with the representation specific issue in the same idea that sighted people use additional modalities around the expressions.

Doing Maths
Manipulating, calculating, solving

Now we need to go further and to provide support to students for doing calculations.

- without solving the Maths problems
- helping to cope with the representation specific issue in the same idea that sighted people use additional modalities around the expressions.

$$(x+1)(x-1) = x^2 - \cancel{x} + \cancel{x} - 1 = x^2 - 1$$

MaWEn
Mathematical Work Environment

MaWEn is a prototype scientific editor allowing *multimodal and collaborative works* on scientific documents including *mixed text content and mathematical formulas*.

MaWEn is a tentative to overcome the problems presented above

- Synchronisation of formulas in Braille and Graphics;
- Bi-directional pointing possibilities;
- Navigation through formulas by collapse and expand functionality synchronised with both views;
- Support of mathematical manipulation.

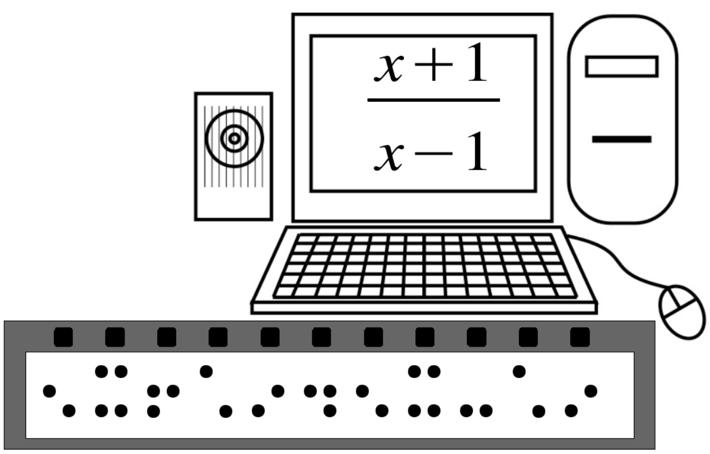
Synchronisation

Support collaborative work

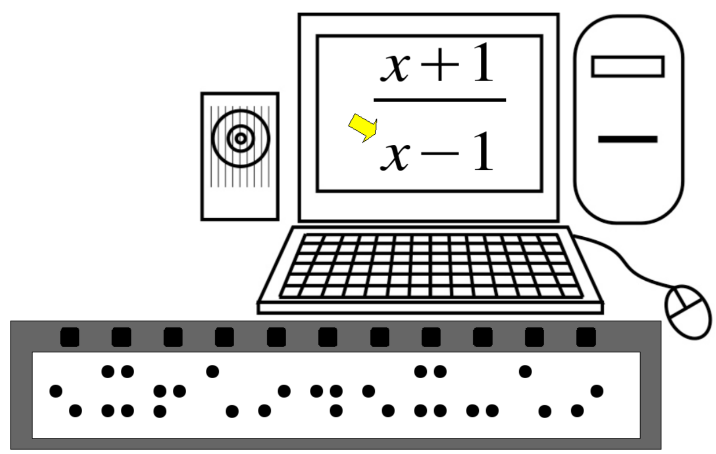
the same content is presented in 2 different modalities:

- **it must be the "natural representation" for each user**
- the 2 views **always** display the same content
- support **pointing** at a location
- support **selecting**
- ...as well for text and Maths expressions

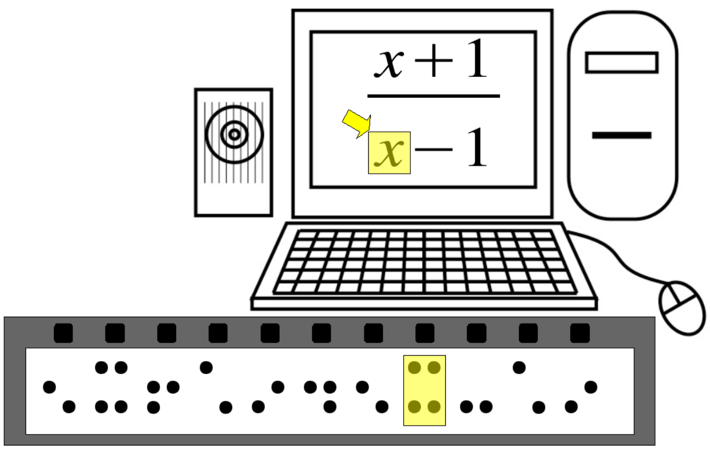
Synchronisation
Synchronise Graphical and Braille representations of formulas



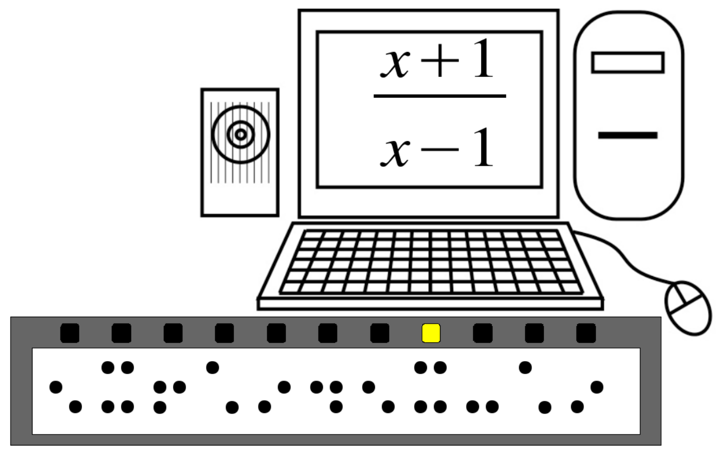
Synchronisation
Bi directional pointing (1)



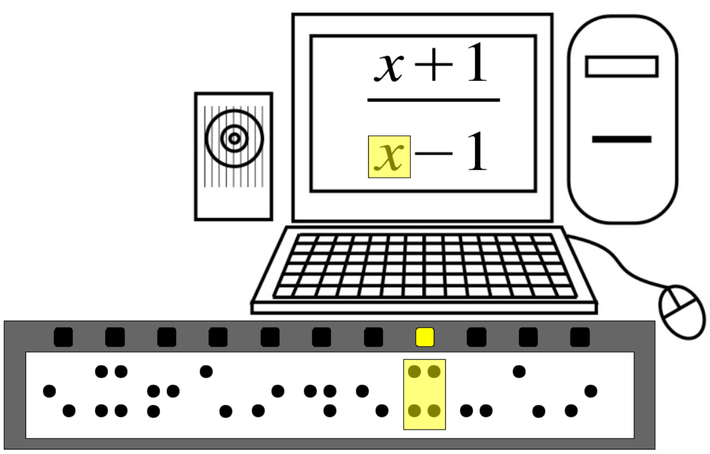
Synchronisation
Bi directional pointing (2)



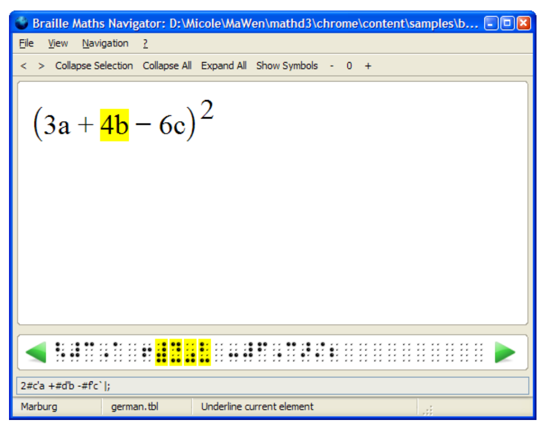
Synchronisation
Bi directional pointing (3)



Synchronisation
Bi directional pointing (4)



Synchronisation
Screen shot: MaWEn-d3



Navigation
Collapse/Expand

$$L_1 = L_0 . \sqrt{1 - \frac{v^2}{c^2}}$$

$$L_1 = L_0 . < block >$$

$$L_1 = L_0 . \sqrt{1 - < block >}$$

Introduction State-of-the-Art What's next Issues MaWEn prototypes Examples of features

Navigation
Collapse/Expand

$$L_1 = L_0 . \sqrt{1 - \frac{v^2}{c^2}}$$

Dominique Archambault, Dònal Fitzpatrick Teaching Maths to Visually Impaired People

Introduction State-of-the-Art What's next Issues MaWEn prototypes Examples of features

Navigation
Collapse/Expand

$$L_1 = L_0 . \sqrt{1 - \frac{v^2}{c^2}}$$

$$Eq$$

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Introduction State-of-the-Art What's next Issues MaWEn prototypes Examples of features

Navigation
Collapse/Expand

$$L_1 = L_0 . \sqrt{1 - \frac{v^2}{c^2}}$$

$$Eq$$

$$L_1 = L_0 . Sq$$

Dominique Archambault, Dònal Fitzpatrick Teaching Maths to Visually Impaired People

Navigation
Collapse/Expand

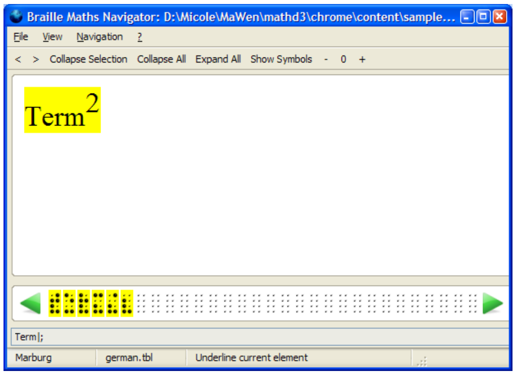
$$L_1 = L_0 . \sqrt{1 - \frac{v^2}{c^2}}$$

Eq

$$L_1 = L_0 . Sq$$

$$L_1 = L_0 . \sqrt{1 - F}$$

Screen shot: MaWEn-d3



Teaching Mathematics the Audio way

Dónal Fitzpatrick
School of Computing
Dublin City University
Glasnevin, Dublin 9 Ireland
dfitzpat@computing.dcu.ie
http://www.computing.dcu.ie/~dfitzpat

Outline

- What are we trying to do?
- Why relevant?
- Introduction to **prosody**
- Depicting Equations
- Thoughts on teaching.

Why use audio?

- Specific case:
- Many blind people do not read Braille
- Figures for Ireland suggest less than 10%
- We need to find an alternative modality.
- Solution: audio representations created using synthetic speech.

General Case

- The emergence of VLE and other online teaching resources make this relevant to all
- Imagine a lecturer creating online content to which they wish to attach audio content.
- Also, even more generally, communication of mathematics is a problem.
- Would guidelines to verbalisation help students and educators alike?

Problems Representing Math Using Audio

- Mathematics is a 2-d representation The semantics are altered by spatial location.
- Speech is a serial form of communication; so we need to find a way to represent space.

How Do People Read?

- Eyes move in a series of saccades (jumps) and fixations.
- A non-linear progression.
- The book is the passive partner, reader is the active participant.
- Roles reversed in the traditional audio domain.

What is Prosody?

- The unscientific definition is *inflection*
- More precisely, that set of characteristics which lasts longer than a syllable.
- two views: temporal or acoustic.
- Acoustic view broken down into <u>duration, pitch, amplitude.</u>

How to Speak Formulae

Reduce equations to a linguistic approximation

Thus the sub-expressions of mathematics can be mapped to clause boundaries in (for example) English.

So sentence, clause, character = formula, sub-expression, operators or operands

$$a+b+c+d+e$$

$$a+\frac{b+c}{d}+e$$

$$\frac{a+b}{c+d}+e$$

The Linear Versions.

1. a+b+c+d+e
2. a+(b+c)/(d)+e
3. (a+b)/(c+d)+e

What To Speak?

Do we use lexical cues or not?
If yes, then which cues?
However, will cues make the utterance too long?
This will have impacts on cognitive load.
Why? Because speech is a transient signal.

$$a+b+c+d+e$$

$$a+\frac{b+c}{d}+e$$

$$\frac{a+b}{c+d}+e$$

Another Linear Version

1. a+b+c+d+e
2. a+, begin fraction, begin numerator, b+c end numerator begin denominator, d end denominator end fraction, +e
3. Begin fraction, begin numerator a+b, end numerator, begin denominator, c+d, end denominator, end fraction, +e

Thoughts on Teaching

- Good communication of mathematics instills confidence, interest and enthusiasm in students.
- One way to improve this, is to be aware of how it is being presented.
- This means not just the visual presentation of the formulae.

Thoughts on Teaching (II)

- What of online delivery of mathematics?
- With no face-to-face contact, the proper presentation in the audio domain becomes even more important.
- Using **learning objects containing both auditory and visual information means that to ensure a good learning experience both must be at a comparable standard.**

Future Work

- Various experiments to ascertain:

1. what language to use;
2. How people decompose (deconstruct) formulae.

5 Aarne Ranta: Collaborative Enhancement of Mathematical Grammar Libraries

The WebALT project created a translator of mathematical teaching material from OpenMath formulas to seven European languages. This translator has recently become open-source, which opens new ways to develop and extend it. One of the main ambitions is to extend the system to cover all of the 23 official languages of the European Union. This goal requires organized collaboration of voluntary work. The main part of the work is the implementation of the GF Resource Grammar Library to new languages. This work is applicable not only in the WebALT grammars but also in other projects that use the library. In addition, WebALT requires a lexicon of mathematical terms to be built for each language. The talk will explain the main scientific issues of the task, as well as what skills and how much work is required, and how we intend to boost the development by organizing a Resource Grammar Summer School in 2009.

More on the summer school: http://www.cs.chalmers.se/Cs/Research/Language-technology/GF/doc/gf-summ...

Collaborative Enhancement of Mathematical Grammar Libraries

Aarne Ranta

JEM Meeting, Paris, 27 November 2008

Introduction

WebALT (2005-2006): automatic translations of exercises from OpenMATH to seven languages

- Catalan: *Demostra que* π*no és igual a l'arrel quadrada de* π*.*
- English: *Show that* π*isn't equal to the square root of* π*.*
- Finnish: *Osoita että* π*ei ole yhtäsuuri kuin* π*:n neliöjuuri.*
- French: *Démontrer que* π*n'est pas égal à la racine carrée de* π*.*
- Italian: *Dimostra che* π*non è uguale alla radice quadrata di* π*.*
- Spanish: *Demuestra que* π*no es igual a la raíz cuadrada de* π*.*
- Swedish: *Visa att* π*inte är lika med kvadratroten av* π*.*

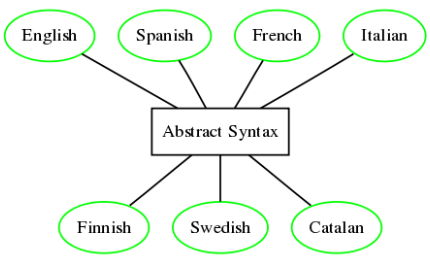
Demo translator

`tournesol.cs.chalmers.se:41296/fridge/`

We want to extend this to new applications - and to all the 23 EU languages.

Technology

GF = Grammatical Framework, a multilingual grammar formalism



Translation in GF

Interlingua: **abstract syntax** with semantic structures

Translation: composition of reversible mappings (**concrete syntaxes**)

Quality is achieved by restriction to a **domain**

- formal semantics possible -> translation preserves meaning
- ambiguity minimized
- translation can use domain idioms

So we don't solve the same problem as Systran (Babelfish) and Google translation.

Grammar writing

Port a system to a new language = write a new concrete syntax.

A lot of work to get it right.

```
(Even x)  x is even     x est pair          x ist gerade
                        x soit pair         ist x gerade
                        x est paire         x gerade ist
                        x soit paire
(Even xs) xs are even   xs sont pairs       xs sind gerade
                        xs soient pairs     sind xs gerade
                        xs sont paires      xs gerade sind
                        xs soient paires
```

Language-dependent details: inflection, agreement, word order.

The library solution

GF Resource Grammar Library: the basic grammars of 12 languages

Syntax function: noun phrase and adjective to clause

```
mkCl : NP -> A -> Cl
```

Morphology function: string to adjective

```
mkA : Str -> A
```

Defining the concrete syntax of a new predicate

```
Even x = mkCl x (mkA "even")    -- English
Even x = mkCl x (mkA "pair")    -- French
Even x = mkCl x (mkA "gerade")  -- German
```

The current library

80 syntactic categories, 200 syntactic functions

Complete sets of morphological functions

500-word lexicon

Languages: 12 + 1 + 5

- 12 complete: Bulgarian, Catalan, Danish, English, Finnish, French, German, Italian, Norwegian, Russian, Spanish, Swedish
- 1 complete artificial: Interlingua
- 5 under construction: Arabic, Hindi/Urdu, Latin, Polish, Thai

What is needed to use the library

Domain expertise: in WebALT, mathematical terminology and idiom

Excellent practical knowledge of target language (better than for library)

GF can be learnt in 1-2 days

Add a language: just instantiate a lexicon

What is needed to add a language to the library

Work: 2 to 7 months

Level: advanced MSc, doctoral, senior

Skills:

- programming (optimally: functional programming e.g. Haskell or ML)
- grammatical concepts (strong school grammar, some introductory linguistics)
- theoretical knowledge of target language (need not be native)
- GF can be learnt in 1-2 weeks

To add a lexicon

Smart paradigms

```
mkV "play" ---> play, plays, played, played, playing
mkV "cry"  ---> cry,  cries, cried,  cried,  crying
mkV "use"  ---> use,  uses,  used,   used,   using
mkV "die"  ---> die,  dies,  died,   died,   dying
```

E.g. in Finnish, 80% of nouns and 90% of verbs are predictable from one form.

A relief for the library user - a challenge for the library programmer.

The summer school

Goal: to implement the library for the remaining 14 EU languages

Method: pick 2 programmers per language, help them to do it

Timeline

- Now: spread the word, use contacts to find good programmers
- February: announcement of the summer school and a coding contest
- April: on-line web course and assignment wiki
- May: submission of assignments
- June: selection of travel grant winners
- August 17-28: summer school in Gothenburg
- December: collect and publish all resulting grammars

Incentives

Get a deep understanding of your native language

A cool programming project, international collaboration

Possible publications

Credits: 15 ECTS course points at Chalmers University, MSc thesis...

Travel grants: EUR 1,000 to cover travel and stay

Exploiting the results

Library licensed under LGPL

Exportable from GF to many formats: JavaScript, Nuance speech recognition...

Used in many applications and demos

- WebALT, GeoGebra
- spoken dialogue systems
- Attempto controlled language, ontologies
- multilingual Wiki pages
- creation of open-source dictionaries
- language teaching

What we need

Money for travel grants

- Erasmus?
- NGSLT?
- Google summer of code?

Good students

- the on-line course
- the GF programming contest

Some more teacher contribution (and money for it)

Families of EU languages

Baltic: Latvian Lithuanian

Celtic: Irish

Fenno-Ugric: Estonian Finnish Hungarian

Germanic: Danish Dutch English German Swedish

Hellenic: Greek

Romance: French Italian Portuguese Romanian Spanish

Semitic: Maltese

Slavonic: Bulgarian Czech Polish Slovak Slovenian

The summer school web page

digitalgrammars.com/gf/doc/gf-summerschool.html

6 Marja-Leena Viljanen, Johanna Ojalainen and Matti Pauna: Using Web-Based Assignments in Secondary School Mathematics

This paper reports experiences in constructing web-based questions and assignments and delivering weekly exercises and formative tests in mathematics at upper secondary level in the Helsinki School of Natural Sciences.

During the WebALT project 2006-2007 and after it we have been constructing over 1000 algorithmic and interactive web-based questions for upper secondary level. The software we have used is MapleTA.

The new version of MapleTA has given possibilities to construct step-by-step questions and we have combined this feature also for constructing find from the graph-questions.

The assignments can be graded automatically. We can also ask questions where students write an essay as the answer. This type of questions cannot be graded automatically. Including 'essay'-parts in questions the teacher is able to study the ways the students are thinking. At the end of an assignment one can also request feedback from the students and their self evaluation.

During spring 2009 we are going to test groups of last year high school students using WebALT assignments. We will study the correlation between students results for these tests and their results at the matriculation examination.

We also report about experiences of using these exercises in lower secondary school mathematics and at the schools for practical nurses in drug calculation.

Using Web-Based Assignments in Secondary School Mathematics

Marja-Leena Viljanen
Johanna Ojalainen
Matti Pauna

University of Helsinki

Background

- From 2005 the WebALT group has developed interactive web-based exercises with the MapleTA system for mathematics education
- Now over 2000 algorithmic questions in Finnish (over 1000 in English)
- Classified according to the standard MathTax (Living Taxonomy)

Introduction

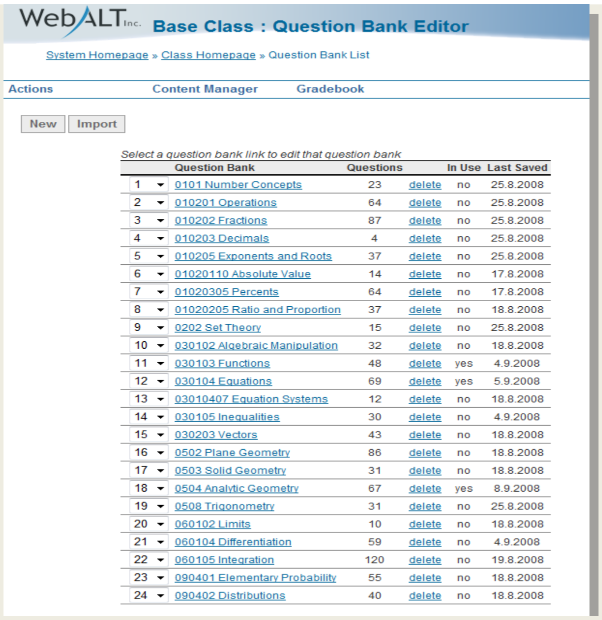
- We all work in the WebALT group and Marja-Leena Viljanen teaches mathematics at the Helsinki School of Natural Sciences
- We describe new material developments and its uses in upper secondary level
- Finally we present further study topics

Classification: Living Taxonomy, aka MathTax

"Core" Subject Taxonomy for Mathematical Sciences Education 4/29/2005

1.0 Numbers and Computation
- 1.1 Number Concepts
  - 1.1.1 Natural
  - 1.1.2 Integers
  - 1.1.3 Rational
  - 1.1.4 Irrational
  - 1.1.5 Algebraic
  - 1.1.6 Real
  - 1.1.7 Complex
  - 1.1.8 Famous Numbers
    - 1.1.8.1 0
    - 1.1.8.2 pi
    - 1.1.8.3 e
    - 1.1.8.4 i
    - 1.1.8.5 Golden Mean
- 1.2 Arithmetic
  - 1.2.1 Operations
    - 1.2.1.1 Addition
    - 1.2.1.2 Subtraction
    - 1.2.1.3 Multiplication
    - 1.2.1.4 Division
    - 1.2.1.5 Roots
    - 1.2.1.6 Factorials
    - 1.2.1.7 Factoring
    - 1.2.1.8 Properties of Operations
    - 1.2.1.9 Estimation
  - 1.2.2 Fractions
    - 1.2.2.1 Addition
- 1.4 Measurement
  - 1.4.1 Units of Measurement
    - 1.4.1.1 Metric System
    - 1.4.1.2 Standard Units
    - 1.4.1.3 Nonstandard Units
  - 1.4.2 Linear Measure
    - 1.4.2.1 Distance
    - 1.4.2.2 Circumference
    - 1.4.2.3 Perimeter
  - 1.4.3 Area
    - 1.4.3.1 Area of Polygons
    - 1.4.3.2 Area of Circles
    - 1.4.3.3 Surface Area
    - 1.4.3.4 Nonstandard Shapes
  - 1.4.4 Volume
  - 1.4.5 Weight and Mass
  - 1.4.6 Temperature
  - 1.4.7 Time
  - 1.4.8 Speed
  - 1.4.9 Money
  - 1.4.10 Scale

2.0 Logic and Foundations
- 2.1 Logic
  - 2.1.1 Venn Diagrams



Select a question bank link to edit that question bank

	Question Bank	Questions		In Use	Last Saved
1	0101 Number Concepts	23	delete	no	25.8.2008
2	010201 Operations	64	delete	no	25.8.2008
3	010202 Fractions	87	delete	no	25.8.2008
4	010203 Decimals	4	delete	no	25.8.2008
5	010205 Exponents and Roots	37	delete	no	25.8.2008
6	01020110 Absolute Value	14	delete	no	17.8.2008
7	01020305 Percents	64	delete	no	17.8.2008
8	01020205 Ratio and Proportion	37	delete	no	18.8.2008
9	0202 Set Theory	15	delete	no	25.8.2008
10	030102 Algebraic Manipulation	32	delete	no	18.8.2008
11	030103 Functions	48	delete	yes	4.9.2008
12	030104 Equations	69	delete	yes	5.9.2008
13	03010407 Equation Systems	12	delete	no	18.8.2008
14	030105 Inequalities	30	delete	no	4.9.2008
15	030203 Vectors	43	delete	no	18.8.2008
16	0502 Plane Geometry	86	delete	no	18.8.2008
17	0503 Solid Geometry	31	delete	no	18.8.2008
18	0504 Analytic Geometry	67	delete	yes	8.9.2008
19	0508 Trigonometry	31	delete	no	25.8.2008
20	060102 Limits	10	delete	no	18.8.2008
21	060104 Differentiation	59	delete	no	4.9.2008
22	060105 Integration	120	delete	no	19.8.2008
23	090401 Elementary Probability	55	delete	no	18.8.2008
24	090402 Distributions	40	delete	no	18.8.2008

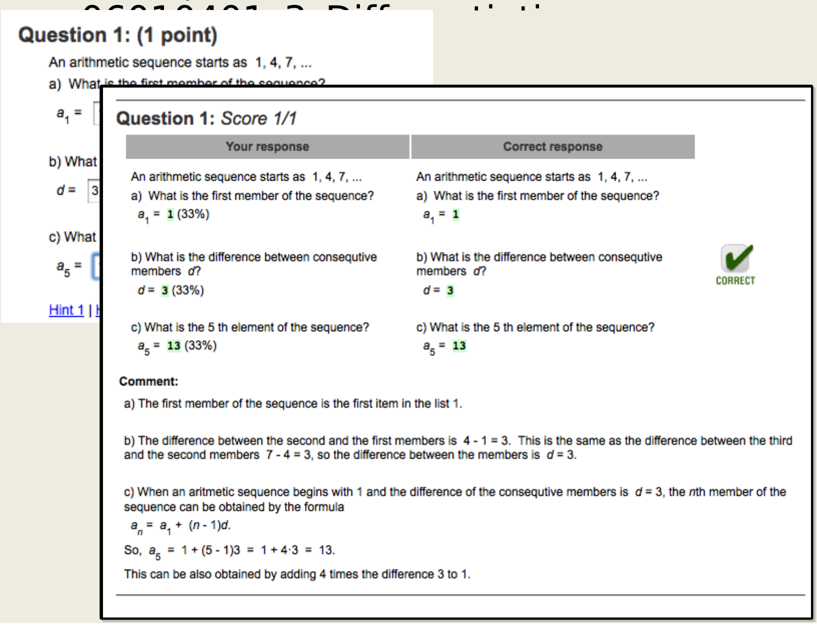
Difficulty

- 1: Lower secondary
- 2: Upper secondary, short math
- 3: Upper secondary, long math
- 4: Upper secondary, advanced questions
- 5: College, technical engineering school
- 6: University

- Example:

Recent development of question design

- Feedback from users:
  - simple question
  - ask basic concepts
  - standard answering formats
- New version makes it easier to write stepwise questions

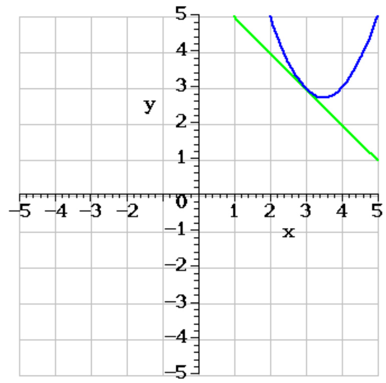


Find from the graph questions

- Easy to author and make algorithmic
- Help to understand concepts, perceptional approach

Question 2: (1 point)

Below is the graph of a function and its tangent line at the point (3, 3).

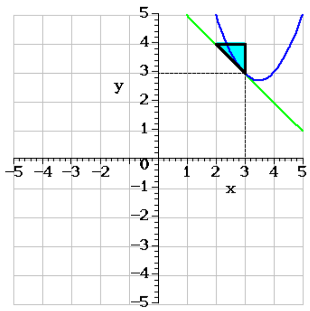


The value of the function at $x = 3$ is 3

The slope of the tangent line of the graph of the function at the point (3, 3) is -1

The derivative of the function at $x = 3$ is -1

Comment:



The value of the function at the point $x = 3$ can be determined by for example drawing a vertical line from the point 3 to the graph and from that point a horizontal line to the y-axis. The value of the function is then the point of the y-axis where this line meets it, in this case 3.

The slope of the tangent line can be determined by drawing a triangle at a suitable place in the line. The slope is then the ratio between change of the y-coordinates and the change of the x-coordinates.

So the slope is $\frac{3-4}{3-2} = -1$.

The derivative of the function at $x = 3$ is the same as the slope of the tangent line drawn at point (3, 3) of the graph of the function. So in this case it is -1.

Essay questions

- For expressing mathematical thinking verbally
- For self evaluation
- Implemented as essay questions or essay parts in exercises and they cannot be graded automatically

Question 3: (1 point)

A rumor has it that in a conference about emissions of pollutions to the Baltic Sea there was a statement:
"If Finland reduces its emissions by 15%, Russia 20%, Denmark 30% and Poland 15%, then the emissions are reduced altogether by 100%."
What do you think about this kind of reasoning?

Question 4: (1 point)

What have you learned about calculating with percents?
Is there something that is still unclear to you?

Answers

"It cannot be true. The emission decrease 100% only if all the Baltic countries decrease their emission to the Baltic Sea 100%. "

"Everything is clear."

"It cannot be true because every country decreases from its own emission. For instance Finland would decrease 15% of its own emission, not of the emission of the whole world. "

"I learned to work out better normal problems with percents. The coefficients I did not understand very well."

"If the emissions would decrease 100%, there should not be any emission left."

"I learned some old concepts. Equations I did not get clear."

Practices of using assignments

- Students of short math have weekly revision sessions in computer lab
- Students of long math are introduced to the system a couple of times and they have possibility to use at home
- Adult high school: self study students practice until they have 80 % right before going to course examinations

Nursing schools

- Teachers see drilling to be important for drug calculations
- It is challenging to include in normal teaching

Question 5: (1 point)

After a mouth surgical procedure a patient is prescribed a drug called Caprilon 500 mg. The daily dose of the patient is 1.5 g.
How many pills do you give to the patient a day?

Number

Hint 1

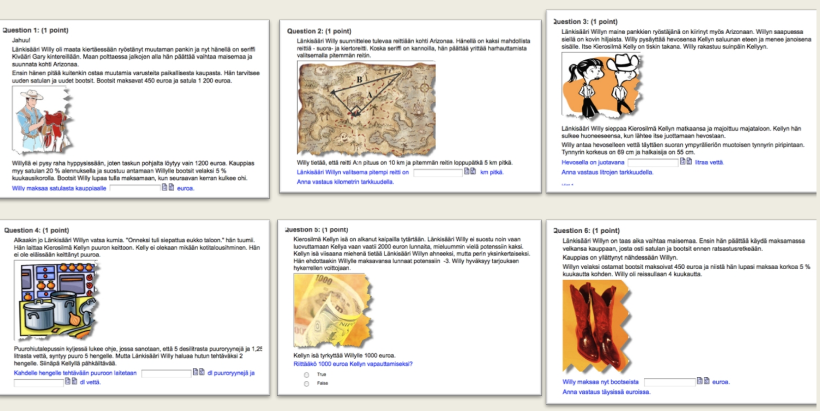
Question 5: *Score 1/1*

After a mouth surgical procedure a patient is prescribed a drug called Caprilon 500 mg. The daily dose of the patient is 1.5 g.
How many pills do you give to the patient a day?

CORRECT

Your Answer: 3
Correct Answer: 3
Comment: One Caprilon 500 mg pill contains 500 mg of this drug.
Three pills contain 1.5 g.
So the daily dose is three pills.

How to make assignments more interesting: stories

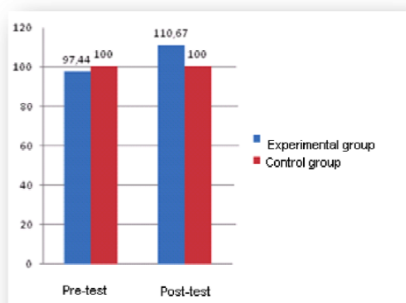


Research plans

- School has applied to get mini laptops for a group students for using at school and at home
- Further study of languaging
- How the results of WebALT tests correlate with final matriculation exam grade

Research: Johanna Ojalainen

Figure 2 Differences between the experimental group and control group in the pre- and post-tests.



Lower secondary arithmetic.

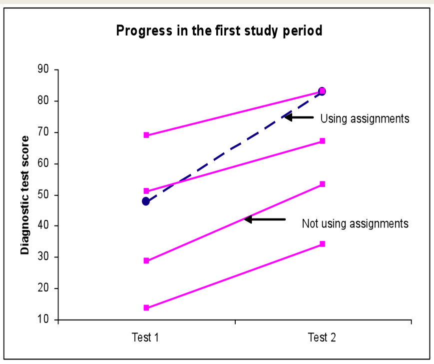
Blue group n = 15 practiced weekly with online exercises.

Red group n = 19 did not.

Johanna is continuing these studies.

http://jem-thematic.net/en/node/571

Research: Kari Lehtonen



Diagnostic tests and practicing in **technical engineering school.** Results in the test before and after practicing.

Purple (four groups) n = 80, not using online assignments.

Blue group n = 40, using online assignments.

http://jem-thematic.net/en/node/872

7 Mika Seppälä: Should we still teach kids to multiply and to divide?

The number of students studying sciences in Europe has steadily declined to such an extent that this is seen as a threat to the competitiveness of Europe. In France the decline has been about 5% each year during the past several years. Inquiry Based Study, IBS, is the paradigm that is generally seen as a possible way to increase students interest in sciences. In mathematics this approach has lead to the TERC reform in the US and to a new curriculum, which uses the book 'Everyday Mathematics'. It has been deemed necessary to 'relearn to teach arithmetic'. In this talk I will discuss the pitfalls of relearning to teach arithmetic, and other school mathematics topics. It seems that the need to revise mathematics curriculum comes up every now and then, like bubbles in economy. When the bubble bursts, we return back to basics until a new generation, which does not know that there was a burst, comes up with their own revisions.

Should we still teach kids to multiply and to divide?

Mika Seppälä

Rational Functions

Consider a rational function

$$f(x) = \frac{P(x)}{Q(x)}.$$

Assume that f is defined at $x = 0$, i.e., that $Q(0) \neq 0$.

Leading Term

$P(x)$ a univariate polynomial in x.

$LT(P)$ = the highest order term of P with non-zero coefficient.

$LC(P)$ = the coefficient of the leading term of P.

$LM(P) = x^n$, $n = \deg(P)$.

Division Algorithm

```
PolyDivide(A,B)
    Q ← 0, R ← A
    while R ≠ 0 and d = deg(R) - deg(B) ≧ 0 do
        T ← (LC(R)/LC(B))x^d
        Q ← Q+T, R ← R - BT
RETURN(Q,R)
```

Example

$$x^2 - 4\,\overline{\big)\,3x^3 + 2x^2 - 11x - 8}$$

$$\frac{3x^3 + 2x^2 - 11x - 8}{x^2 - 4}$$

Example

$$\begin{array}{r|l} & 3x \\ \hline x^2 - 4 & 3x^3 + 2x^2 - 11x - 8 \\ & -\,3x^3 \qquad\quad \overset{+}{\cancel{-}}\,12x \\ \hline \end{array}$$

Example

$$\begin{array}{r|l} & 3x \\ \hline x^2 - 4 & 3x^3 + 2x^2 - 11x - 8 \\ & -\,3x^3 \qquad\quad \overset{+}{\cancel{-}}\,12x \\ \hline & \qquad\quad 2x^2 + x - 8 \end{array}$$

Example

$$\begin{array}{r|l} & 3x + 2 \\ \hline x^2 - 4 & 3x^3 + 2x^2 - 11x - 8 \\ & -\,3x^3 \qquad\quad \overset{+}{\cancel{-}}\,12x \\ \hline & \qquad\quad 2x^2 + x - 8 \\ & \qquad\quad 2x^2 \qquad - 8 \end{array}$$

Example

$$
\begin{array}{r|l}
 & 3x + 2 \\
\hline
x^2 - 4 & 3x^3 + 2x^2 - 11x - 8 \\
 & -\,3x^3 \quad \overset{+}{\cancel{-}}\ 12x \\
\hline
 & \quad 2x^2 + x - 8 \\
 & \quad -\,2x^2 \quad \overset{+}{\cancel{-}}\ 8 \\
\hline
 & \qquad\qquad x
\end{array}
$$

$$\frac{3x^3 + 2x^2 - 11x - 8}{x^2 - 4} = 3x + 2 + \frac{x}{x^2 - 4}$$

Trailing Term

TT(P) = the lowest order term of P with non-zero coefficient.

TC(P) = the coefficient of the trailing term of P.

TM(P) = the monomial of the trailing term.

Inverted Division

```
iPolyDivide(A,B,n)
    Q ← 0, R ← A, k ← 0
    while k < n+1 do
        d ← deg(TM(R))
        T ← (TC(R)/TC(B))x^d
        Q ← Q+T, R ← R - BT
        k ← k+1
RETURN(Q,R)
```

$$
\begin{array}{r|l}
 & 1 \\
\hline
1-x & 1 \\
 & 1-x
\end{array}
$$

$$f(x) = \frac{A(x)}{B(x)} = \frac{1}{1-x}$$

$$\begin{array}{r|l} & 1 \\ \hline 1-x & 1 \\ \text{subtract} & 1-x \\ \hline \end{array}$$

$$\begin{array}{r|l} & 1 \\ \hline 1-x & 1 \\ - & 1\overset{+}{\cancel{-}}x \\ \hline \end{array}$$

$$\begin{array}{r|l} & 1 \\ \hline 1-x & 1 \\ - & 1\overset{+}{\cancel{-}}x \\ \hline & \quad x \end{array}$$

$$\begin{array}{r|l} & 1 + x \\ \hline 1-x & 1 \\ - & 1\overset{+}{\cancel{-}}x \\ \hline & \quad x \\ & \quad x - x^2 \\ \hline \end{array}$$

$1 + x$

$1-x \,\big)\, 1$

$-\; 1 \overset{+}{\cancel{-}} x$

x

subtract $\quad x - x^2$

$1 + x$

$1-x \,\big)\, 1$

$-\; 1 \overset{+}{\cancel{-}} x$

x

$-\; x \overset{+}{\cancel{-}} x^2$

x^2

$1 + x + x^2$

$1-x \,\big)\, 1$

$-\; 1 \overset{+}{\cancel{-}} x$

x

$-\; x \overset{+}{\cancel{-}} x^2$

x^2

$x^2 - x^3$

$1 + x + x^2$

$1-x \,\big)\, 1$

$-\; 1 \overset{+}{\cancel{-}} x$

x

$-\; x \overset{+}{\cancel{-}} x^2$

x^2

$-\; x^2 \overset{+}{\cancel{-}} x^3$

x^3

iPolyDivide

$$\frac{1}{1-x} = 1 + x + x^2 + \frac{x^3}{1-x}.$$

More Generally

$$f(x) = \frac{A(x)}{B(x)} = a_0 + a_1 x + \cdots + a_n x^n + \frac{R(x)}{B(x)}.$$

$$f(x) = a_0 + a_1 x + \cdots + a_n x^n + g(x) x^{n+1}.$$

where g is differentiable at $x = 0$.

Observe

For all $k = 0,\ldots,n$:

$D^{(k)}(g(x)x^{n+1})$ vanishes at $x = 0$.

Hence

$$f(x) = a_0 + a_1 x + \cdots + a_n x^n + g(x) x^{n+1}.$$

For all $k = 0,\ldots,n$:

$D^{(k)}(f)(0) = k!a_k$.

Conclude

iPolyDivide(A,B,n) yields the Taylor polynomial of degree n for the rational function f = A/B.

$$f(x) = \underbrace{a_0 + a_1 x + \cdots + a_n x^n}_{\text{Taylor Polynomial of } f.} + g(x)\,x^{n+1}.$$

Steps needed:

- Polynomial division
  - Polynomials
- Long Division of Numbers

If you have not mastered long division

- you will not learn long polynomial division
- you cannot appreciate topics like the one discussed here

Every Mathematics, TERC

- Do not teach the rigorous basics of arithmetic
- Students leaving middle school, arrive with a handicap to high schools and later to universities

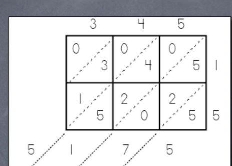
Every Mathematics, TERC

- Correspond to learning to play instruments by ear, not by notes
- Or learning a language without ever learning the grammar

Comments of a 5th Grader

- TERC and Everyday Math are MUCH more complicated than the standard algorithm.
- Nobody in class has problems with long division. It is easy, and works every time.

$$
\begin{array}{r}
\overset{1}{3}45 \\
15 \\
\hline
{}^{1}1725 \\
3450 \\
\hline
5175
\end{array}
$$



Thank you for your attention!

8 Valerie Shute: You Can't Fatten A Hog by Weighing It – Or Can You? Evaluating an Assessment for Learning System Called ACED

The purpose of the study that I'll describe at JEM was to evaluate the efficacy of an assessment for learning system named ACED (Adaptive Content with Evidence-based Diagnosis). We used an evidence centered design approach (Mislevy, Steinberg, & Almond, 2003) to create an adaptive, diagnostic assessment system in relation to the pre-Algebra topic of 'sequences' (e.g., geometric and arithmetic sequences). ACED includes five main models: competency, evidence, task, presentation, and assembly (Shute, Graf, & Hansen, 2005). We also included instructional support in the form of elaborated feedback. The key issue we examined was whether the inclusion of the feedback into the system (a) impairs the quality of the assessment (relative to validity, reliability, and efficiency), and (b) does, in fact, enhance student learning. Results from a controlled evaluation testing 268 high-school students showed that the quality of the assessment was unimpaired by the provision of feedback. Moreover, students using the ACED system showed significantly greater learning of the content compared with a control group. These findings suggest that assessments in other settings (e.g. large-scale, mandated tests) might be augmented to support student learning with instructional feedback without jeopardizing the primary purpose of the assessment. Time permitting, I'll also describe a version of the program for use by individuals with low vision and blindness–a talking tactile tablet version of ACED.

This paper will be published shortly. The citation of the full paper is: Shute, V. J., Hansen, E. G., & Almond, R. G. (2008). You can't fatten a hog by weighing it– Or can you? Evaluating an assessment for learning system called ACED. International Journal of Artificial Intelligence and Education, 18(4).

You Can't Teach a Hog to Dance by Weighing it… or Can You?

Evaluating ACED

Valerie Shute
Florida State University, College of Education
JOINING EDUCATIONAL MATHEMATICS (JEM) WORKSHOP
Paris, France (Nov. 26, 2008)

Acknowledgements

This material/study is based on work supported by the National Science Foundation under Grant No. 0313202.

I'm also grateful to the contributions to this project by my colleagues: Eric Hansen & Russell Almond.

The Plan

- What is assessment for learning?
- What is evidence-centered design?
- What is ACED, and what are the results from its evaluation?
- Answer any questions

What is Assessment *for* Learning?

NOTE:
- Assessment *for* learning = formative assessment
- Assessment *of* learning = summative assessment

Diffs Between FA♥ & SA

When the cook tastes the soup, that's formative; when the guests taste the soup, that's summative.

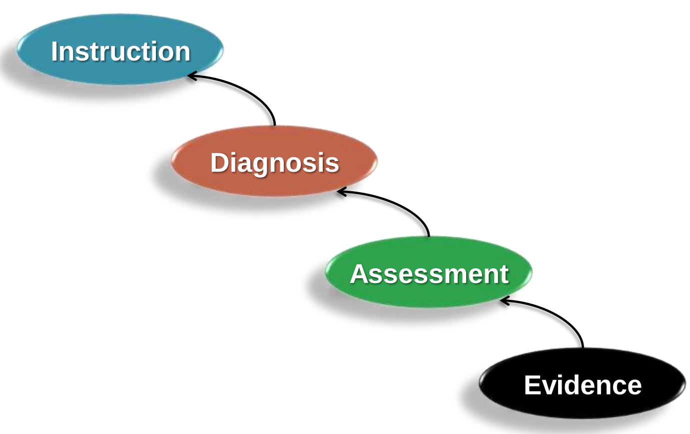
~Bob Stake

Diffs Between FA♥ & SA

If we think of our children as plants... summative assessment of the plants is the process of simply measuring them. The measurements might be interesting to compare and analyze, but, in themselves, they do not affect the growth of the plants. On the other hand, *formative assessment is the garden equivalent of feeding and watering the plants – directly affecting their growth.*

~Shirley Clarke

Simple Logic



The Educational Dilemma

Dual Needs. Teachers need to *instruct* important concepts/skills, and *assess* students' competencies.

Real Constraint. But their time is limited – so how best to juggle these two important activities?

Possible Solution. Merge assessment and instruction in a diagnostic, formative assessment.

- *Assessments for learning* (Paul Black & Dylan Wiliam)
- *Informative assessments* (Bob Glaser)
- *Educative assessments* (Grant Wiggins)
- *Assistments* (Ken Koedinger & Neil Heffernan)

The System

ACED

Adaptive Content with Evidence-based Diagnosis

Today's Story

System Design. Touch on the design and development of ACED (Adaptive Content with Evidence-based Diagnosis).

Evaluation. Describe results from recent evaluation of three main features of the ACED system in relation to their effects on learning:

- *Feedback*. Valid diagnoses and task-level feedback, designed to promote learning.
- *Adaptation*. Content (tasks) adapted to learners' specific and current situation.
- *Competency Estimation*. Bayes net used to update student model after each task.

Learning Questions

Overall Learning. For students using ACED assessment, does any learning occur?

Elaborated Feedback. What is the contribution (if any) of elaborated feedback to learning?

Adaptive Sequencing. What is the contribution (if any) of adaptive sequencing of tasks to learning?

Assessment Questions

Estimation Techniques. What is a sound (accurate and efficient) way to estimate students' competency levels?

Predictive Validity. How well do the estimated competencies match real outcome performance?

Development Summary

Year 1
- Infrastructure
- Content and Models

Year 2
- Competency Estimation
- Adaptive Algorithm

Year 3
- Outcome/Affective Measures
- Evaluation

Introducing…

What is ECD?

- Reasoning about assessment design
- Reasoning about student performance

Mislevy, R. J., Steinberg, L. S., & Almond, R. G. (2003). On the structure of educational assessments. *Measurement: Interdisciplinary Research and Perspectives, 1*, 3–62.

Assessment Design

Competency Model

What do you want to say about the person?

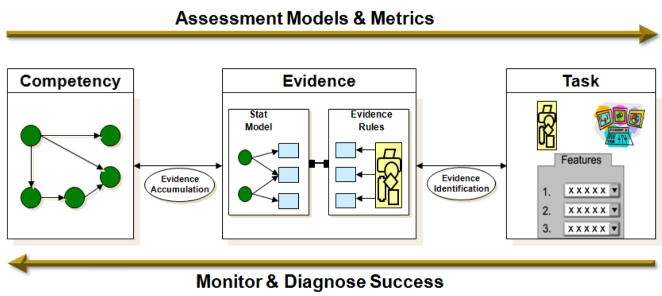
Evidence Model

What observations would provide best evidence for what you want to say?

Task Model

What kinds of tasks let you make the necessary observations?

Design & Diagnosis

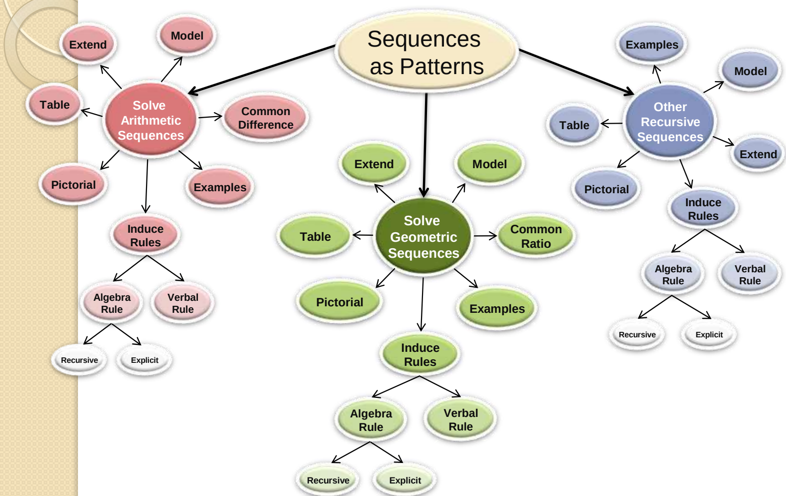


<u>**Competency Model**</u>: Organization of competencies & claims to be made about students, and current mastery estimates.

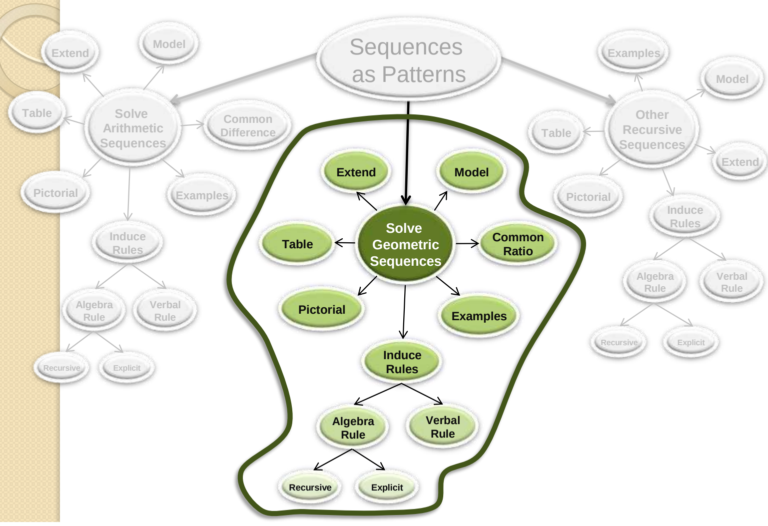
<u>**Evidence Model**</u>: Criteria or rubrics for *evidence* of claim (i.e., specific student performance data; observables).

<u>**Task Model**</u>: A range of templates and parameters for *task development* to elicit evidence needed for the evidence model.

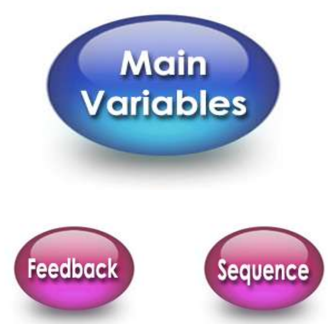
Competencies



Competencies



Learning

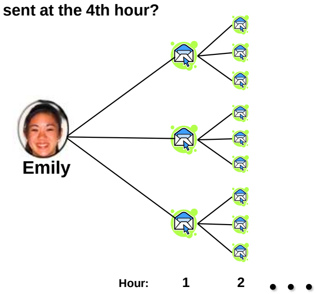


Verification Feedback

Emily receives an email message which states she'll have a "very lucky day" if she sends it out within one hour to exactly 3 people who, in turn, send it to exactly 3 people, and so on.

Emily forwards the email, and everyone she sends it to participates in the chain mail. How many emails would be sent at the 4th hour?

Enter your answer here: 27



Sorry, that's not correct.

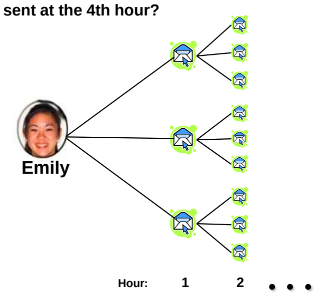
Elaborated Feedback

Emily receives an email message which states she'll have a "very lucky day" if she sends it out within one hour to exactly 3 people who, in turn, send it to exactly 3 people, and so on.

Emily forwards the email, and everyone she sends it to participates in the chain mail. How many emails would be sent at the 4th hour?

Enter your answer here: 27

Sorry, that's not correct. Three times as many emails go out every hour. That means 3 emails go out in the first hour, 9 go out in the second hour, and 27 emails go out in the third hour. The question asks about the number of emails in the *fourth* hour, which would be $3 \times 3 \times 3 \times 3 =$ **81**.



Sequencing

Linear (fixed)

CommonRatio1a
CommonRatio1b
CommonRatio2a
CommonRatio2b
CommonRatio3a
CommonRatio3b
ExamplesGeometric1a
ExamplesGeometric1b
ExamplesGeometric2a
ExamplesGeometric2b
ExamplesGeometric3a
ExamplesGeometric3b

⋮

63 tasks total

1 Easy
2 Medium
3 Hard
a Item type
b Isomorph

Sequencing

Adaptive

63 tasks total

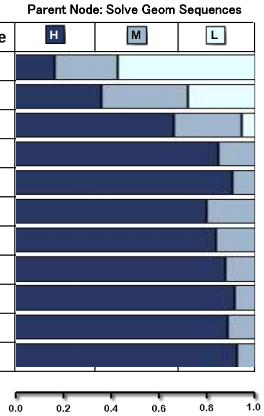
1 Easy
2 Medium
3 Hard
a Item type
b Isomorph

PRIORS (SGS)
H 0.18
M: 0.26
L: 0.56

Parent Node: Solve Geom Sequences

Task	Score
IdentifyGeometricSequence2a	0
IdentifyGeometricSequence3a	1
IdentifyGeometricSequence3b	1
Identify GeometricSequence2b	1
VisualExtendTable2a	1
SolveGeometricProblem1a	0
SolveGeometricProblem1b	1
VisualExtendVerbalRule2a	1
ModelExtendTableGeometric3a	1
ExamplesGeometric2a	0
VisualExplicitVerbalRule3a	1

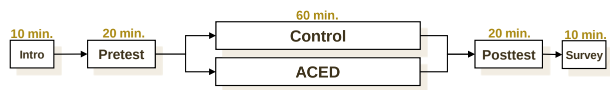
⋮



Method

Sample. N = 268 Algebra I students, 9th and 10th graders, heterogeneous group.

Procedure. 2 hr per session:



Tests. Two test forms, counter-balanced: Forms A and B. Students (randomly) received A-B or B-A. Tests had 25 items (paper & pencil), 20 min. per test, and calculators permitted.

Academic Level

Honors: Highest level of math abilities

Academic: Average to good level of math abilities

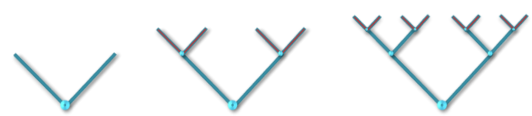
Regular: Average to low level of math abilities

Remedial: Low level math abilities (4 years to complete the 3 yr math requirement)

Special Education: Students who are sheltered, not mainstreamed

Example Test Items

Extend pictorial geometric sequence



If the pattern of growth continues as above, how many new branches will there be at **Stage 4**? _______

Generate example of geometric sequence

What are the first 3 terms of the geometric sequence with a starting term of $-\frac{1}{2}$ and a common ratio of $\frac{3}{2}$?

a. $-\frac{1}{2}, -\frac{3}{4}, -\frac{9}{8}$

b. $\frac{1}{2}, \frac{3}{4}, \frac{9}{8}$

c. $-\frac{3}{4}, -\frac{9}{8}, -\frac{27}{16}$

d. $-\frac{1}{2}, \frac{3}{4}, -\frac{9}{8}$

Conditions/Comparisons

Feedback

Sequencing	Elaboration	Verification
Adaptive	1 **Elab-Adaptive** (N = 71)	2 **Verif-Adaptive** (N = 75)
Linear	3 **Elab-Linear** (N = 67)	**N/A**

Comparisons

1, 2, 3 vs. Control—net contribution of **ACED**

1 vs. 2: **Feedback** effects

1 vs. 3: **Sequencing** effects

Key Issue

Does inclusion of feedback into the system:

(a) impair the quality of the assessment (relative to validity, reliability, & efficiency), and

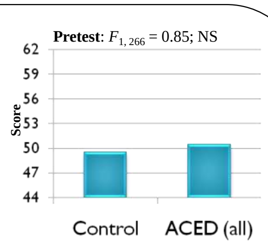
(b) enhance student learning?

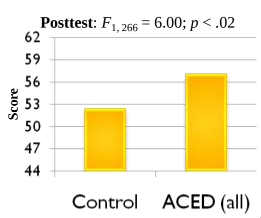
ACED vs. Control

1, 2, 3 vs. Control—net contribution of **ACED**

Question: Did students working with ACED (all 3 versions, combined) show evidence of any *learning* compared to Control group?

Yes. Although Control group began with slightly lower pretest scores than ACED group (NS) posttest scores of ACED students were significantly higher than Control.



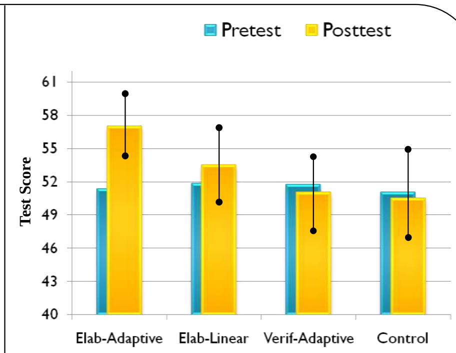


Posttest by Condition

Question: Were there any learning differences by *Condition* (1 - 4)?

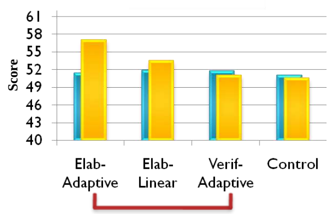
Answer: **Yes**. There was a main effect of *Condition* on posttest score. ($F_{3,247} = 3.4$, $p < 0.02$)

Effect size = **0.38**



Planned Comparison

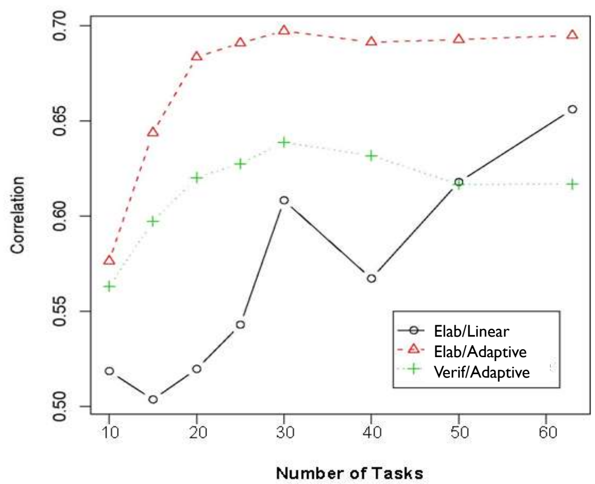
- Planned comparison (Bonferroni) among treatment conditions.
- Only difference: **Elab-Adaptive & Verif-Adaptive** (Mean Diff = 5.62, SE = 2.11; $p < 0.05$).



- Suggests ***elaborated feedback*** feature primarily responsible for the impact on learning outcome.

Learning Efficiency

EAP x Posttest Score Correlations



Predictive Validity

Question: Do competency estimates from our model predict posttest performance beyond that of pretest scores?

Simple correlations:

(1) pretest × posttest $r = .59$, $p < 0.01$

(2) pretest × EAP(SGS) $r = .50$, $p < 0.01$

(3) posttest × EAP(SGS) $r = .65$, $p < 0.01$

- Regression analysis: **posttest score** as DV and (a) **pretest score** and (b) **EAP(SGS)** as the IVs. Pretest score forced into the equation first, followed by EAP(SGS).
- Results: both IVs significantly predicted outcome: Multiple $R = .71$; $F_{2, 210} = 106.57$; $p < .001$. Pretest score and the general estimate of proficiency accounted for 50% of the outcome variance, with EAP(SGS) accounting for 17% of the unique variance over pretest score.

Summary

Instruction/Learning

Overall Learning. *For students using ACED assessment, does any learning actually occur?*	Yes. When ACED vs. Control groups compared, ACED showed significantly greater pre-to-posttest improvement compared to Control.
Feedback Type. *What is the contribution (if any) of elaborated feedback to learning?*	Learning is improved (in just 1 hr) using elaborated feedback embedded in a valid assessment. This was supported by the finding of significant outcome differences between the Elab-Adaptive vs. Verif-Adaptive conditions.
Task Sequencing. *What is the contribution (if any) of adaptivity to learning?*	There was no difference between Elab-Adaptive and Elab-Linear conditions, but that may be because the algorithm in ACED focused on maximizing *precision* of proficiency estimates (and not educational value of "next task").

Summary, cont.

Assessment

Estimation Techniques. *What is a sound (accurate and efficient) way to estimate students' competency levels?*	Using ECD to design diagnostic assessment tasks yields constructs that are valid, and links performance data to competencies & standards. Using Bayes nets permits more accurate (and fast) estimations of skill level and probabilistic predictions (e.g., posttest performance).
Predictive Validity. *How well do the estimated competencies match real outcome performance?*	Results from regression analysis showed just a single competency estimate can predict posttest performance, and when coupled with more information (e.g., Pretest, Extend, Table), the prediction is even stronger.
Efficiency. *What's the lower bound for tasks to accurately estimate competency level(s)?*	Adaptivity showed positive trend (EA vs. EL), and achieved its reliability maximum more efficiently than the linear test. Half hr asst with support for learning vs. 1 hr test.

Big Summary

- **Key issue**: Does inclusion of feedback into the system (a) impair the quality of the assessment (relative to validity, reliability, and efficiency), and (b) enhance student learning?
  - **Results—assessment**: Controlled evaluation testing 268 high-school students showed that the quality of the assessment was unimpaired by the provision of feedback.
  - **Results—learning**: Students using the ACED system showed significantly greater learning of the content compared with a control group.
- **Big Deal**: These findings suggest that assessments in other settings (e.g., state-mandated tests) might be augmented to support student learning with instructional feedback without jeopardizing the primary purpose of the assessment.

Next Steps

A Few Plans for the Future…

Feedback. More refined testing of feedback (FB) to determine incremental value added, such as:

- Assessment, no FB
- Assessment, acc FB (*Adaptive Verif*)
- Assessment, acc FB, error FB, no correct answer
- Assessment, acc FB, error FB, correct answer
- Assessment, acc FB, error FB, correct answer, how to solve

Fun Assessments: *"… it is imperative for progress in instructional methods that we deal simultaneously with cognition and motivation in our research . . . We already have too much medicine that is (cognitively) good for the patient—who will not take it—and medicine that patients find delicious—but that contributes little to their cognitive abilities. (Simon, 1995, p. 508).* Use games as vehicles to deliver embedded assessments that support learning.

Adaptive Algorithm

The index we use to determine the *next task* is the expected weight of evidence (**EWOE**):

$$EWOE(H:T) = \sum_{j=1}^{n} \log\left[\frac{P(t_j \mid h)}{P(t_j \mid \bar{h})}\right] P(t_j \mid h)$$

(Madigan & Almond, 1996)

EWOE (H **:** T) is the **expected weight of evidence** for the hypothesis of interest that will be obtained from a given task.

h : the hypothesis of interest is true
$\bar{h}$: the alternative hypothesis is true
t_j : the observation outcome ***j*** for a given task ***t***.

Return

Expected A Posteriori (EAP)

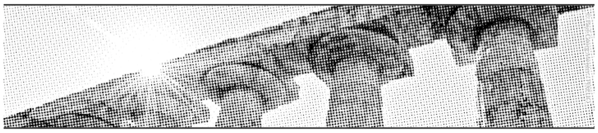
- EAP: $P(\theta_{ij} = \text{High}) - P(\theta_{ij} = \text{Low})$ where θ_{ij} is the value for Student *i* on Competency *j,* and 1**P*(High) + 0**P*(Med) + -1**P*(Low) = *P*(High) - *P*(Low). This results in a scale ranging from -1 to 1.
- We computed EAPs for the 8 main nodes in the competency model. Lower-level nodes feed evidence into the main node—Solve Geometric Sequences (SGS).
- Thus higher values of EAP(SGS) should be associated with greater knowledge and skills overall on geometric sequence topics.

Return

9 Laureano Gonzalez-Vega: Newsbrief from the InterGeo project

This short presentation is devoted to briefly introduce the InterGeo project and to present their most recent news, specially the search of country representatives and curricula decoders.

co-funded by the Community programme eContentplus



Intergeo

Interoperable Interactive Geometry for Europe

I2G INTERGEO

About the Project

- Start date: 01/10/2007
- End date: 30/09/2010
- Funding: 1.427.849 €
- Intergeo is co-funded by the Community programme eContent*plus*

Oct 2007	2008	2009	Oct 2010
▪ set up the central platform ▪ clarify licenses ▪ find associate partners etc.	▪ content is available ▪ local user meetings ▪ developing search engine	▪ more classroom testing ▪ Intergeo Conference	
Project start		Project transferred to community	

Project Aims

The main objective of Intergeo is to make digital content for mathematics teaching in Europe more accessible, usable and exploitable.

Intergeo will enable you to

Find exactly the **Content** you are looking for	**Use** your favourite **Software** – free or commercial	**Get** classroom tested **Quality** for teaching

Context: Dynamic / Interactive Geometry

Project Participants

University of Education Schwaebisch Gmuend	Germany
University of Montpellier	France
German Research Center for Artificial Intelligence	Germany
Cabrilog SAS	France
University of Bayreuth	Germany
University of Luxembourg	Luxembourg
University of Cantabria	Spain
Eindhoven University of Technology	Netherlands
Maths for More SL	Spain
University of South Bohemia	Czech Republic

Software Partners

ActiveMath	http://www.activemath.org
Cabri Geometry II, Cabri 3D	http://www.cabri.com
Cinderella	http://cinderella.de
GeoGebra	http://www.geogebra.org
Geonext	http://www.geonext.de
Geoplan/Geospace	http://www.aid-creem.org
OpenMath	http://www.openmath.org
TracenPoche	http://tracenpoche.sesamath.net
WIRIS	http://www.wiris.com

and others – see www.inter2geo.eu

Project Tasks (a few of them) and News

- Define a platform where to share geometric constructions, together with the corresponding annotations and their quality testing:
  - The new (beta) shared platform http://i2geo.net will be working early next year.
  - In one month more than 100 resources have been contributed to the platform in the i2g format (more than 3000 resources are waiting their annotations and quality testing: a 2009 task !).

Project Tasks (a few of them) and News

- Create a meeting point for Dynamic / Interactive Geometry developers and software makers.
- Design a common file format allowing easy communication between different Dynamic Geometry packages:
  - The new i2g format (beta) has been already implemented in GeoGebra, Cinderella and GeoNext.

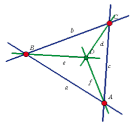
Project Tasks (a few of them) and News

- Define a meaningful cross-curriculum-search (across Europe) on Geometry allowing the use of the same geometric construction in different contexts:
  - Spanish and French curriculums on Geometry have been already initially encoded but their decoding in terms of competencies, skills, level, thematic area, ... is still work in progress.
  - The Intergeo curriculum decoding is to be linked with the annotations and quality testing issues on geometric resources.

New Members

Intergeo is constantly seeking for

- Country Representatives
- Curriculum encoders



If you would like to become a member of the Intergeo community, please visit **www.inter2geo.eu** for more information or send an e-mail to **info@inter2geo.eu**!

Find more information on **www.inter2geo.eu**

10 Rein Prank, Marina Issakova-Lepp, Dmitri Lepp, Vahur Vaiksaar, Eno Tnisson: T-algebra– Intelligent Environment for Expression Manipulation Exercises

T-algebra is an interactive learning environment for exercises in four areas of school mathematics: calculation of the values of numerical expressions; operations with fractions; solving of linear equations, inequalities and linear equation systems; operations with monomials and polynomials. The student solves the task step by step. At each solution step the student selects the operation, indicates the subexpression(s) to be changed and enters the result of conversion. The program checks all three stages of the step, gives feedback and hints. T-algebra implements 61 task types.

Interactive problem solving environment *T-algebra*

Rein Prank
University of Tartu
Institute of Computer Science
rein.prank@ut.ee

What is T-algebra?

T-algebra is a Tiger Leap project (2004-…) for creating an interactive problem solving environment for Basic School algebra:

2) calculation of the values of numerical expressions
3) operations with fractions
4) solving of linear equations, inequalities and linear equation systems
5) operations with monomials and polynomials

Team

- Working group:

  R.Prank – teamleader
  M.Issakova, D.Lepp, V.Vaiksaar – authors of chapters
  E.Tõnisson, P.Luik, T.Lasn,
  Mart Oja, Maire Oja
  also: T.Lepmann, A.Palu, H.Jukk, K.Kokk

Problem types (51). Fractions

Problem types are taken directly from the textbooks

3) reduction of fractions
4) extension of fractions
5) conversion of fractions to common denominator
6) comparing fractions
7) addition and subtraction of fractions with common denominator
8) conversion of improper fraction to mixed number
9) addition and subtraction of fractions with different denominators
10) addition and subtraction of mixed numbers
11) conversion of decimal fraction to common fraction
12) conversion of common fraction to decimal fraction
13) decimal approximation of common fraction
14) multiplication of fractions
15) finding reciprocal value
16) division of fractions

Motivation (1)

When the student solves an expression manipulation task, he should **at each solution step**:

2. **choose a transformation rule** corresponding to a certain operation in the algorithm (or some simplification or calculation rule known earlier),
3. **select the operands** (certain parts of expressions or equations) for this rule,
4. **replace them** with the result of the operation.

Some more “creative” tasks (such as factorization or integration) are taught in less algorithmic style but the solutions are expected to consist of steps of the same structure.

Motivation (2)

For proper learning of expression manipulation as well as for assessment and diagnosis of knowledge gaps, **we need an environment where**

all the decisions and calculations would be made by the student,

the environment would be able to understand the mistakes and give feedback.

What sorts of environments are available? (1)

Rule-based environments (Mathpert, EGPY (Stanford); CAS). Student selects (subexpression and) rule, computer applies the rule.

* MathXpert (Michael Beeson)
  http://www.helpwithmath.com/
  1) Student marks a subexpression,
  2) Program displays the menu with rules that are applicable to (some parts of) this subexpression,
  3) Student selects a rule and the program applies this rule

Student’s learning is passive.

Many mistakes are impossible.

What sorts of environments are available? (2)

Input-based environments (Aplusix).

APLUSIX
http://aplusix.imag.fr/
Student enters the solution line by line,
computer checks the equivalence and measures how well the subgoals are satisfied.

It is very hard to diagnose the errors more precisely than “not equivalent”

Prototype in Tartu

Formula Manipulation Assistant (H.Viira-Tamm, 1989-91)

- For Propositional Logic (expression of formulas through {¬,&}, {¬,v}, {¬, ⊃}; DNF), MS DOS text mode
- Object-Action scheme:
  1) marking a subformula,
  2) input / selection of rule from menu
- Program checks:
  syntactical correctness of subformula marking,
  equivalence/rule-suitability,
  reaching of goal

Java version for Propositional and Predicate Logic is written in 2003 (V.Vaiksaar)

T-algebra environment

T-algebra uses Action-Object-Input scheme:
each solution step consists of **three sub-steps**:

1) selection of the operation from the menu,
2) marking the operand(s) in expression,
3) entering the result of the operation.

- T-algebra requires precise selection of operands
- First two substeps are “mixed together”

Is A-O-I-scheme very expensive?

(in comparison with pure-input interface)

- A = one selection in menu
- I (=Input of changed part) - is necessary in pure-input too
- But O (= marking of operands) is necessary for :
  - a) Copy whole line+(mark operands+Delete)+I,
  - b) Copy whole line +change/delete operands,
  - c) (Mark and copy unchanged parts) + I,
  - d) Input of whole line

In general our scheme requires the same amount of input as pure-input scheme!

Input modes in T-algebra

For entering the result the program has **three input modes**:

2. **Free,**

$9ab^2 \boxed{-4a^2b} + 2ab - (5ab^2) - 2ab + abb$

4. **Structured,**

$9ab^2 \boxed{-}\boxed{4}\boxed{a}^{\boxed{2}}\boxed{b}^{\boxed{}} + 2ab - (5ab^2) - 2ab + abb$

6. **Partial**

$9ab^2 \boxed{-}\boxed{4}a^2b + 2ab - (5ab^2) - 2ab + abb$

Input mode for the task is fixed in task file

What can we diagnose in A-O-I-interface? (1)

Application of selected operation

- is impossible
- does not correspond to the algorithm

T-algebra uses first when Hint is asked

What can we diagnose in A-O-I-interface? (2)

Selection of operands

- Marked term is not a syntactically correct expression,
- Marked term is not a proper subexpression (order of operations misunderstood),
- Marked term has not the form required for selected rule,
- Operands do not satisfy the compatibility requirements (are not like terms, etc.),
- Operands do not satisfy the location requirements (do not belong the same sum, fraction, product etc.)

4),5) => parallel conversions not allowed

What can we diagnose in A-O-I-interface? (3)

Entered subexpression (result of conversion)

- is not a syntactically correct expression,
- should be preceded by a sign,
- should be put in parentheses (order of operations),
- has not the structure required for selected-rule (marked-operands) =… (not a monomial, wrong number of members etc),
- is not equivalent with marked part,
- Concrete parts of Input do not have right value
- Selected operation with marked terms is not performed (nothing reduced, terms are not moved to other side, …)

Some problems (1)

For clearer diagnosis we want the conversions to consist of only one application of the rule:

- No multi-rule conversions
- No parallel conversions

But nevertheless:

- How much pre-processing to accept by marking?
- How much post-processing to accept by input?

Probably we will have standards for this in year 20??

Conclusions

Three-stage dialogue for expression manipulation

- Is intuitively understandable for the students
- Requires the same amount of keyboard/mouse work as pure input
- Provides the program with information about intentions of the student
- Allows to point in error messages to real places of mistakes

Requires

- Standardization of understanding the rules
- Separation of mathematical errors and conflicts with customs of concrete program

11 Gueudet: Digital resources and mathematics teachers' documents

The generalized availability, and the abundance, of digital resources for mathematics teachers entail a complete metamorphosis of the curriculum material, still in progress. They also yield a deep change in teachers professional knowledge and development. This statement leads to study mathematics teachers documentation work: looking for resources, selecting/designing mathematical tasks, planning their succession, managing available artifacts, sharing recombined resources etc. This documentation work is at the core of teachers professional activity and professional development. Building on previous and ongoing research projects (about secondary school mathematics), I will display an approach of individual and collective aspects of this documentation work, enlightening changes brought by digital resources.

References Gueudet, G., Trouche, L. (online) Towards new documentation systems for mathematics teachers? Educational Studies in Mathematics. Gueudet, G., Trouche, L. (2008) Collective documentational activity as a mode of teachers training : which methodological assistants ? ECER Conference, Gteborg. Bueno-Ravel, L., Gueudet, G (2007) Online resources in mathematics: teachers genesis of use, in Pitta-Pantazi, D. and Philippou, G. Proceedings of the fifth congress of the European Society for Research in Mathematics Education, CERME 5, Larnaca, Chypre, http://ermeweb.free.fr/CERME5b/.

Digital resources
and
mathematics teachers' documents

Ghislaine Gueudet
(IUFM de Bretagne-UBO, CREAD)
with the contribution of Luc Trouche, INRP

5th JEM Workshop

Outline

1. Digital teaching resources
2. Teacher's resources and documents
3. Documentation and teachers' communities
4. Conclusion

1. Digital teaching resources

« How could technology be best used to enhance traditional teaching? » (JEM 5th workshop question)

How could productive uses of digital resources in class be supported?

Digital resources for the teaching of mathematics

✓ Hardware: computers, interactive whiteboards;

✓ Software: spreadsheets, dynamic geometry systems;

✓ Online resources: a generalized availability, different kinds of websites (commercial, individual, collective, institutional).

Virtual Learning Environments, multiple associated resources.

Digital resources (for students, for teachers, for teacher trainers) yield evolutions in teachers' professional activity.

1. Digital teaching resources

A focus a secondary school mathematics teachers; national context, in France

✓ A generalization of connected computers equipment at secondary schools (one computer for 6.2 students from grade 6 to 9, for 4.4 from grade 10 to 12, Ministry study, 2006);

✓ No official website covering the whole mathematics curriculum, but a certification from the education ministry for online resources (not for textbooks!), projects: a national platform presenting possible resources, generalisation of Virtual Learning Environments in schools (2012);

✓ A very popular associative website, Sesamath (Mathenpoche, e-exercises covering grade 6 to 9; digital textbooks; Sesaprof, collaborative platform): 1.3 million connexions each month;

✓ Few teachers' collective work; fostered by Internet.

1. Digital teaching resources

Drawing on digital resources: which changes in the mathematics teachers' professional activity and development?

Different trends in educational research

Digital vs non-digital, a blurred border

- ✓ research about ICT (Ruthven 2007, Guin *et al.* 2005);
- ✓ research about curriculum material (Remillard 2005, Pepin 2007).

Research about teachers' professional activity and development

- ✓ teachers knowledge and beliefs (Ball *et al.* 2005, Cooney 1999);
- ✓ collective teachers' activity and professional development (Krainer 2003, Jaworski 2006, Goos & Bennison 2008).

2. Teacher's resources and documents

A new perspective on teachers' professional activity

(Gueudet & Trouche, online)

Previous research:

✓ uses by teachers of e-exercises bases (Bueno-Ravel & Gueudet 2007, Artigue & Gueudet 2008);

✓ICT integration (Guin *et al.* 2005); the SFoDEM (teacher training, collective design of lessons with ICT, Guin & Trouche 2005)

An exploratory study:

✓ 9 secondary school mathematics teachers, aged between 40 and 50, more than 10 years of teaching;

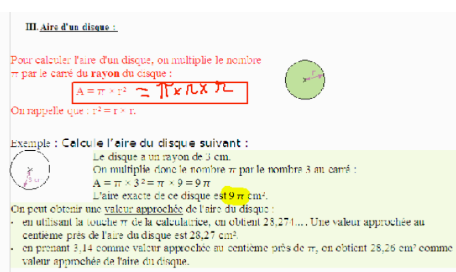
✓ various degrees of ICT integration (Assude 2007), and of collective involvements.

Interviewed at their homes (Margolinas *et al.* 2007), collection of their resources.

2. Teacher's resources and documents

A case study: Marie-Pierre, aged 40, teaching from grade 6 to 9, 14 years of professional experience. Use of dynamic geometry systems, spreadsheets, online resources; a digital textbook (Sesamath). An Interactive Whiteboard (IWB) in her class, students equipped with laptops, a VLE of the school.

Example of a course: introduction of the circle's area



III. Aire d'un disque :

Pour calculer l'aire d'un disque, on multiplie le nombre π par le carré du rayon du disque :

$\boxed{A = \pi \times r^2 = \pi \times r \times r}$

On rappelle que : $r^2 = r \times r$.

Exemple : Calcule l'aire du disque suivant :

Le disque a un rayon de 3 cm.

On multiplie donc le nombre π par le nombre 3 au carré :

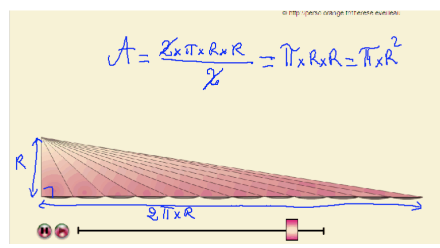
$A = \pi \times 3^2 = \pi \times 9 = 9\pi$

L'aire exacte de ce disque est 9π cm².

On peut obtenir une valeur approchée de l'aire du disque :

- en utilisant la touche π de la calculatrice, on obtient 28,274… . Une valeur approchée au centième près de l'aire du disque est 28,27 cm².
- en prenant 3,14 comme valeur approchée au centième près de π, on obtient 28,26 cm² comme valeur approchée de l'aire du disque.

2. Teacher's resources and documents



Resources: a word processing software to write the course, the digital textbook, a personal website with an historical presentation and a dynamic illustration with the circle unfolding and transforming into a triangle.

Marie-Pierre selects pieces of these resources, recombines them, sets up the course in class, writes on the IWB and records a paperboard for her students.

2. Teacher's resources and documents

Teachers' *documentation work,* in and out-of-class:

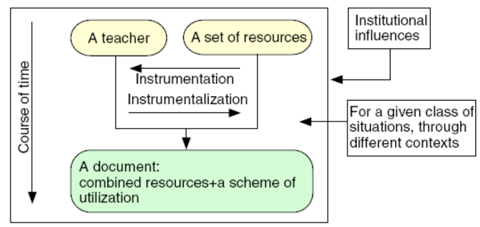
- ✓ looking for resources, selecting them;
- ✓ designing mathematical tasks;
- ✓ planning their succession;
- ✓ carrying them out in class;
- ✓ managing the available material, etc.

Teachers draw on sets of various *resources*

« Our conception of a *resourced teacher* then becomes a teacher acting with material and socio-cultural resources » (Adler 2000)

A dialectical relationship between available *resources* and *documents* developed by the teacher (a point of view inspired by the *instrumental approach* Guin *et al.* 2005).

2. Teacher's resources and documents



Documentational genesis:

✓ a teacher develops a document from a set of resources;

✓ the document associates resources, and a cognitive structure, professional knowledge;

✓ a double *instrumentalization/instrumentation* movement: the teacher shapes the resources, and the resources frame the teacher's choices and craft knowledge

2. Teacher's resources and documents

Marie-Pierre, introducing the circle's area, develops a document associating resources, and professional knowledge and beliefs:

- ✓ a new area formula must be justified by a cutting and recombining of the pieces to form a figure whose area is known;
- ✓ the circle's area must be linked with a previously known area (the triangle), and with the circle's perimeter.

Marie-Pierre's documentation work has been framed by these beliefs, and contributed to reinforce them.

Geneses are ongoing processes: *design continues in usage* (Rabardel & Bourmaud 2003), teachers are both users and designers of resources.

3. Documentation and teachers' communities

Emerging teachers' collective documentation work, linked with digitizing

✓ Observed in our interviews: two teachers have a "mathematics laboratory" in their school, with shared resources on a common computer; others participate to online forums; exchange courses with colleagues via e-mail;

✓ In France, development of teachers' online associations (Sesamath in mathematics);

✓ Projects grounded in online sharing of resources, of teaching experiments, in many countries: Enlaces in Chile, Enciclomedia in Mexico, A Geogebra institute in Norway.

3. Documentation and teachers’ communities

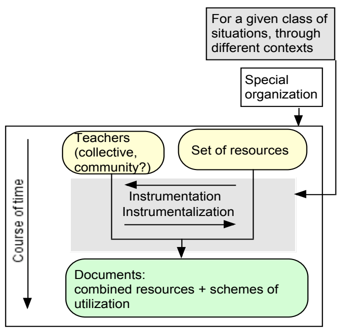
In *communities of practice* (Wenger 1998),

shared *repertoires* (objects, symbols, language etc.)

Collective lessons design: a promising mode of teachers’ training (Jaworski 2006, lesson studies in Japan, Myiakawa & Winsløw to appear)

Professional development programs supporting *collective documentation work* involving digital resources?

A research, and a teachers’ training project in France: Pairform@nce.

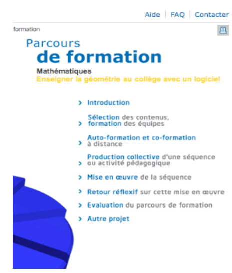


3. Documentation and teachers’ communities

Pairform@nce, a French national project set up by the Ministry of Education

- ✓ All disciplinary fields, primary and secondary school ;
- ✓ *Integration of ICT* ; following the German project “Intel Lehren”;
- ✓ Design of *training paths*, providing the structure of training device to be carried out across the country;
- ✓ These training device are *blended*, using a distant platform; they are grounded on *collective lessons design*.

pairFORM@NCE



3. Documentation and teachers’ communities

A research and development project (INRP, CREAD, IREM of Montpellier and Rennes, IUFM Bretagne, Ministry of Education support)
Production and simultaneous experimentation of 3 training paths.
Example in mathematics: **Individualization with e-exercises.**

- ✓Aim : expand the trainees pedagogical practice by integrating e-exercises as a means for individualization;
- ✓A training over 3 months, with a distant platform, 3 days in presence;
- ✓Each trainees team designs a session using e-exercises and organizing individualization;
- ✓Cross-observations within the team, the initial session is modified and tested if possible a second time.

3. Documentation and teachers’ communities

OBSERVATION OF A SESSION			
Date		Class	School
Session type		EEB used	
Objective			
Pedagogical organization			
Noted during the session			
		Description	Remarks
Mathematical content			
Students’ activity			
Teacher’s activity			
Individualization mode			
Role of the EEB			
Other			
Identification of ICT skills			
Students (B2i)			
Teacher (C2i)			
Session’s Advantages/Disadavantages			
Individualization mode	Advantages		
	Disadvantages		
Use of the EEB	Advantages		
	Disadvantages		
Other			
Suggested modifications			

Example of a resource proposed in the path: observation grid

3. Documentation and teachers' communities

Individualization with e-exercises: outcomes of the experimental training.

✓ the experimental training fostered collective work in the trainees schools, emergence of trainees communities, with their repertoires;

✓ the cross-observation was appreciated by all trainees, who drew on the grid provided (appropriation, genesis);

✓ the grid for session description was appreciated as a means of communication during the final report; but it was not used to prepare the session;

✓ the trainees did not use the distant platform during their preparation.

A modification of the training path on the national platform, a *design in use* movement.

4. Conclusion

Digital resources in mathematics: design, use and training issues

New articulations between design and use: design in use, users are also designers.

A new perspective on teachers' professional activity: the documentation work is crucial; documentational geneses are central in the teachers' professional development.

New forms of collective teachers' work.

Consequences for teachers' training: organizing collective lesson design, and supporting it (meta-design, Fischer & Ostwald 2005).

CERME 6, January 28th to February 1rst 2009, Lyon, France

WG7 "Technologies and Resources in Mathematical Education"

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Digital resources
and
mathematics teachers' documents

Ghislaine Gueudet
(IUFM de Bretagne-UBO, CREAD)
with the contribution of Luc Trouche, INRP

5th JEM Workshop

12 J. Saludes: Reviewing Exercises on an e-ink Reader

By exploiting synergies between available multi-purpose office machines and electronic document readers (with annotation capabilities), we can provide teachers with a mobile platform for exam reviewing. I will tell my experience on developing and using a system at my school for exams of about ninety students. As a bonus, we obtain automatic collection of grades and the possibility for the students to view their corrected exercises online.

I like to review exercises while commuting but until recently, I found it cumbersome since one has to carry a heap of sheets and manage to write on them in the narrow space of a train seat. Then, I bought an e-ink reader to carry my papers and I began to wonder if I could use the device to review my students exams too.

The procedure I'm currently using is:

1. On a pile of blank sheets I print a header displaying the name of the student, a datamatrix image encoding the same information, and a frame for the student grade.

2. At the examination room, I distribute these sheets to the corresponding students to be filled with the exercise solution.

3. After the exam, I use an office machine (which is provided with a batch sheet feeder) to scan the pile of exercises to a big PDF file that I load into my reader.

4. I review the exercises on the e-ink reader adding comments with the provided stylus and writing the awarded grade into the aforementioned frame.

5. A computer application reads the annotated exercises, identifies the student from the datamatrix code and recognises the handwritten grade from each digital page and finally collects this information in comma-separated file.

Reviewing Exams using an E-ink Reader

Jordi Saludes
Universitat Politècnica de Catalunya

Why?

* It's worth a try
* Exams can be legal documents
* Anytime / Anywhere

... and with a bit of coding:

* Faster delivering of grades and feedback
* Better storage

What is needed?

* Multi-purpose office machine
* E-ink reader
* Hand-written digit recognition
* Datamatrix library

What is needed?

* Multi-purpose office machine
  * Scanner
  * Printer

What is needed?

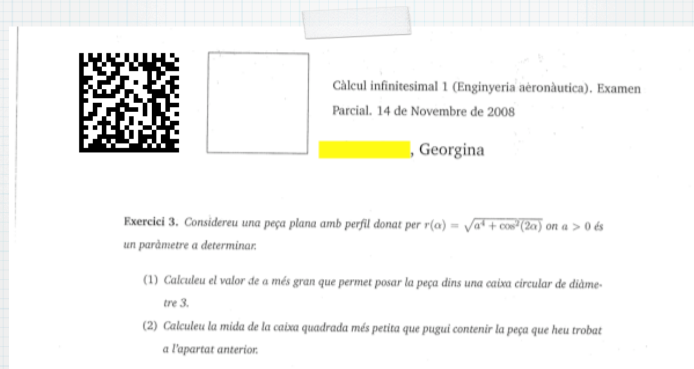
* E-ink reader
  * Reading
  * Annotating

How?

1. Making copies
2. Scanning answers
3. Reviewing
4. Collecting & displaying

1. Making copies

* Personalized copy
* Use dmtxwrite to print a datamatrix
  * LaTeX / LyX
  * Pdf


Càlcul infinitesimal 1 (Enginyeria aeronàutica). Examen Parcial. 14 de Novembre de 2008

, Georgina

Exercici 3. *Considereu una peça plana amb perfil donat per* $r(\alpha) = \sqrt{a^4 + \cos^2(2\alpha)}$ *on* $a > 0$ *és un paràmetre a determinar.*

(1) *Calculeu el valor de* a *més gran que permet posar la peça dins una caixa circular de diàmetre 3.*

(2) *Calculeu la mida de la caixa quadrada més petita que pugui contenir la peça que heu trobat a l'apartat anterior.*

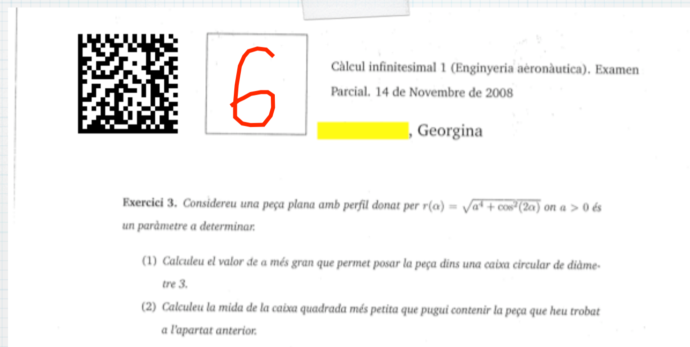
1. Making copies

2. Scanning answers

* Batch sheet feeder (2-sided)
* Copy to reader.

3. Reviewing

* On the reader:
  * Make annotations;
  * Write grade on box.



6

Càlcul infinitesimal 1 (Enginyeria aeronàutica). Examen Parcial. 14 de Novembre de 2008

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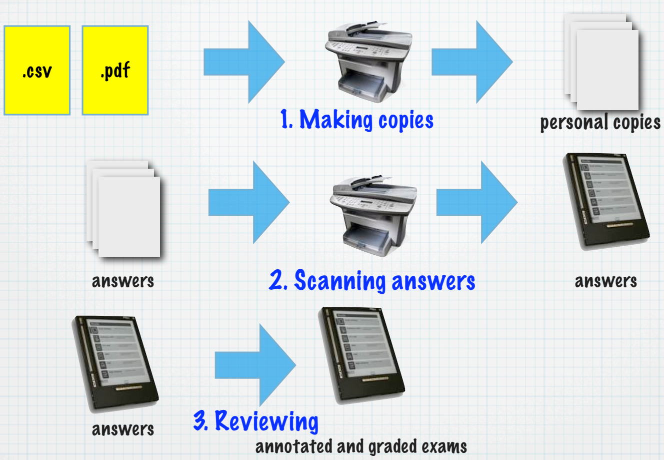
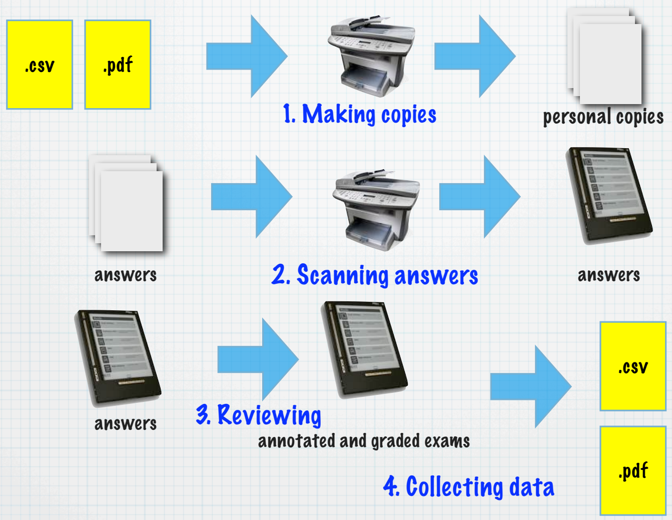
3. Reviewing



4. Collecting & displaying

* Collect grades on a CSV file
  * (Excel,...)
* Send/Serve annotated pages to student.



4. Collecting data

* Use dmtxread to get student identity.
* Use Lipi Toolkit to recognize hand-written digits.

Show annotations

* to student (online?)
* or send annotated exercise.

To conclude...

* Wait for bigger devices.
* Datamatrix reading is accurate enough.
* Improve digit recognition.

13 J Keller: Engaging learners and instructors in innovative mathematics technology-based applications

Applications such as GeoGebra and TERC together with other technology-based innovations for instructional delivery, such as mobile delivery systems, provide exciting new ways of supporting the teaching and learning of mathematics. However, as with any dramatic new innovation that stimulates people who are 'early adopters', there can be challenges in the process of integrating the innovation systemically into the mainstream of established ways of doing things. The new approaches that can be integrated into mathematics instruction might awaken interest and feelings of competence among some students who were not previously excited by the study of mathematics, but I believe it safe to assume that there remain vast numbers of students who still struggle with math and these struggles are due in part to motivational obstacles that they face, especially when the novelty effect of the innovation wears off. Furthermore, many instructors resist the implementation of new technologies because of conservative attitudes, fear, and lack of perceived value. Thus, it is important to consider a variety of change management, motivational, and instructional strategy issues when trying to creatively integrate these innovations into the mathematics curriculum and into ways of designing lessons. This presentation will address these issues and describe a validated theory and model that can be applied to designing the motivational aspects of learner attitudes and to the process of technology integration. Known by its acronym, the ARCS model refers to four categories (attention, relevance, confidence, and satisfaction) resulting from a synthesis of motivational literature. It provides a rational basis for a holistic understanding of motivation, for analyzing learners to determine what kind of motivational obstacles exist in a given situation, and for designing motivational strategies that are targeted to the needs of the learners. In addition, the issue of persistence is addressed by means of concepts of volition and self-regulation. These concepts help explain what is necessary for learners to maintain their goal-oriented behavior when faced with distractions and goal conflicts. Similarly, the successful adoption and integration of new technologies requires that certain motivational issues be addressed, such as the relative advantage and feasibility of the new technology. In summary, there are specific motivational and volitional factors to consider when implementing the exciting new technological innovations that are available and on the horizon with respect to the mathematics curriculum and methods of instruction.

Engaging Learners and Instructors in Innovative Mathematics Technology–Based Applications

John Keller

Regarding This Document:

This is a pdf version of a presentation to the JEM Workshop 5, Paris, France, on Wednesday, 26 November 2008

Before converting this presentation to a pdf file, internal hyperlinks were removed and it was reorganized into a linear sequence. Also, the masks were removed.

: IntroductionIssues

- Teacher's perspective: how can I teach mathematics? What methods and techniques are current and innovative?
- Student's perspective: Why should I have to learn mathematics? Why can't they make it more interesting?
- Novelty effect versus systemic change

Solution

To integrate technology meaningfully and effectively into the mathematics curriculum,

- combine effective and efficient instructional design with
- motivational & volitional design, which is the focus of this presentation

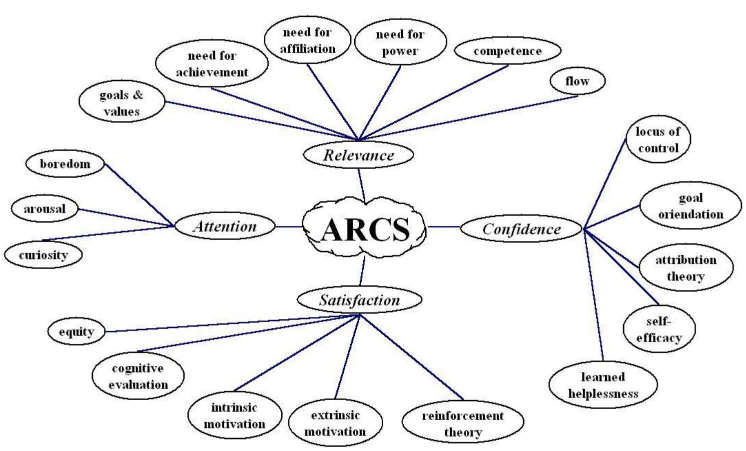
Topics

- Motivational & volitional problems
- Introduction to the ARCS model
- First principles of motivation and volition

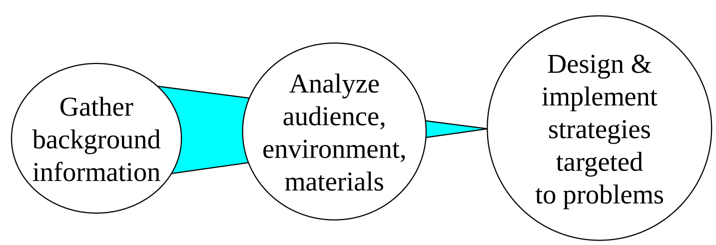
Motivation/Volitional Problems

- Materials and implementation
  - Boredom & irrelevance
  - Confusion and low expectations
  - Lack of positive outcomes
- Social support
  - Isolation: lack of social network and collaboration
  - Motivational support not available when and where it is needed

ARCS Model Concept Map



Systematic Design for Motivation & Volition

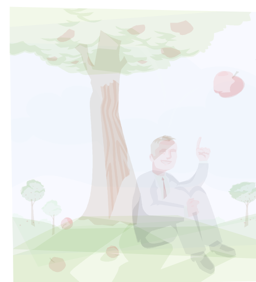


1st Principles: Motivation/Volition

Motivation to learn is promoted when:

1. Curiosity is aroused due to a perceived gap in knowledge

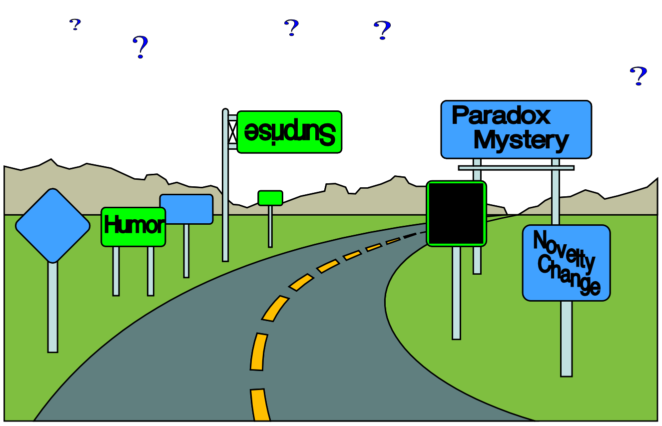
ARCS-V: Attention



How do I get and keep the attention of the students?

- Curiosity
- Newton's apple: his curiosity, not mine!

Attention: Curiosity



Newton, Apple, Gravity

- Lesson outline:
  - The myth of Newton under the apple tree
  - http://csep10.phys.utk.edu/astr161/lect/history/newtonapple.gif
  - What really happened
  - The lesson content
  - http://csep10.phys.utk.edu/astr161/lect/history/newtongrav.html
- An alternative opening
  - [I did the belt trick here, to illustrate gravity.]

1st Principles: Motivation/Volition

Motivation to learn is promoted when:

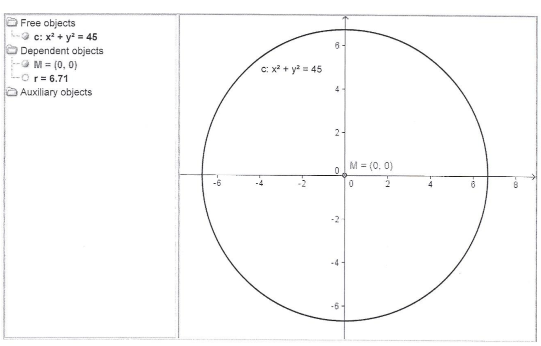
1. Curiosity is aroused due to a perceived gap in knowledge
2. The knowledge to be learned is perceived to be meaningfully related to one's goals

ARCS-V: Relevance

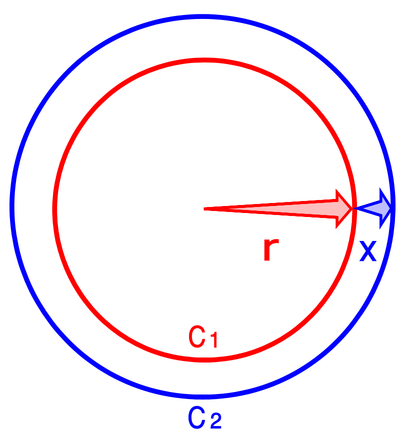
How do I connect my instruction to something meaningful and important in their lives?

- Teaching properties of circles
  - http://www.geogebra.org/en/examples/circle_equation/circle_equation.html
- How loose is my belt?
- What's the cheapest pie for Pi day?

Properties of Circles - Geogebra



CURIOSITY: Example



$C_2 - C_1 = 10'$

$C_2 = 2\pi(r+x)$

$C_1 = 2\pi r$

$2\pi(r+x) - 2\pi r = 10'$

$2\pi r + 2\pi x - 2\pi r = 10'$

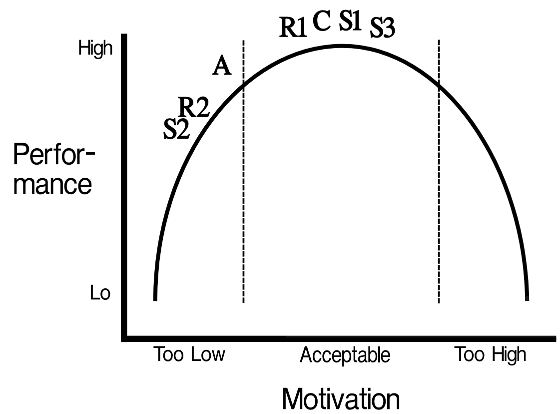
$2\pi x = 10'$

$x = 1.6'$

Motivational Analysis Example

- Subject and audience: The concept of pi with elementary school children
- Audience analysis:
  - Attention (curiosity) – not inherently interesting (A)
  - Relevance – must learn it because it is required and students are dutiful (R1), but no perceived relevance to their lives (R2)
  - Confidence – satisfactory (C)
  - Satisfaction potential – okay in regard to extrinsic outcomes (S1), but low in regard to intrinsic feelings (S2) except for kids who really like math (S3)

Analysis: Example



Make It Relevant

- Plan a celebration for Pi Day
  - Prepare a guest list
  - Plan & prepare demonstrations
  - Plan refreshments
- Ask: How can we determine which is the cheapest pizza to order?
- Prepare for and host the party

1^{st} Principles: Motivation/Volition

Motivation to learn is promoted when:

1. Curiosity is aroused due to a perceived gap in knowledge
2. The knowledge to be learned is perceived to be meaningfully related to one's goals
3. Learners believe they can succeed

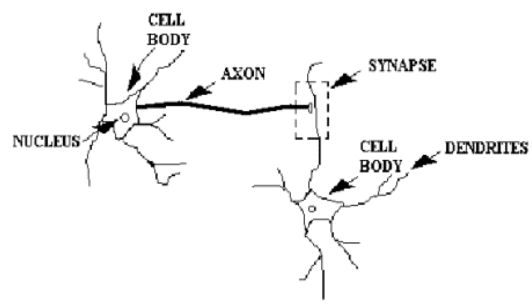
ARCS-V: Confidence

How do I build positive expectancies for success among my students?

- Attributions for success
- "My brain is growing!"

http://www.youtube.com/watch?v=FZ3401XVYww&feature=related

Synapse Expansion



1st Principles: Motivation/Volition

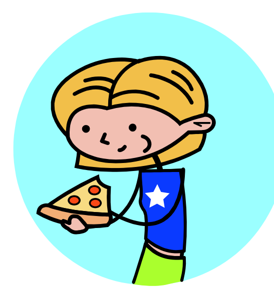
Motivation to learn is promoted when:

1. Curiosity is aroused due to a perceived gap in knowledge
2. The knowledge to be learned is perceived to be meaningfully related to one's goals
3. Learners believe they can succeed
4. Learners anticipate and experience satisfying outcomes

ARCS-V: Satisfaction

How do I ensure that they will feel good about their experiences and accomplishments?

- "Hey, I'm really learning this stuff!"
- "Oh boy! I get to eat the pie!"



1st Principles: Motivation/Volition

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1. Curiosity is aroused due to a perceived gap in knowledge
2. The knowledge to be learned is perceived to be meaningfully related to one's goals
3. Learners believe they can succeed
4. Learners anticipate and experience satisfying outcomes
5. Learners employ volitional strategies

ARCS-V: Volition

How can I help students persist when they encounter distractions and obstacles?

Do they need help?

- "Lost in hyperspace."
- Serendipity
- Procrastination/avoidance
- Action control strategies (self-regulation scaffolding/learner support)

Design & Deliver Strategies

- Two types of motivational & volitional strategies
  - Embedded strategies
    - instructional materials
    - motivationally adaptive CAI
    - reusable motivational objects (RMO)
  - Auxiliary strategies (student support)
    - instructor facilitated online learning
    - blended learning environments
- Can be used in combination

Motivationally Adaptive CBI

- Continuing analysis of learner motivation and performance
- Computer evaluates and adjusts motivational tactics
- Three groups:
  - Motivationally-minimized
  - Motivationally-maximized
  - Motivationally- adaptive
- M-Adp more effective, motivating, and interesting

Reusable Motivational Objects

- RLO design does not include motivational design
- Keller & Oh introduced concept of RMOs
- Metadata index categories:
  - Motivational category
  - Sequence
  - Fixed versus adjustable
- Prototype development and test focused on usability and had successful results.

Learner Motivation in Blended Learning

- Integrated motivational and volitional student support by using the online support system
- Based on the concept of "Motivational Messages"
  - Predictable problems
  - Spontaneous problems
  - Individual problems
- Found positive results for personal but not group messages

Summary

- Modern electronic technologies offer wonderful opportunities to improve capacity by building supportive learning environments,
- After building capacity, it is crucial to build meaningful and engaging content that stimulates and sustains students' quests for learning!

End!

For additional information about the contents of this presentation, contact jkeller@fsu.edu

14 Chris Sangwin & Simon Hammond: Enhancing traditional teaching through the STACK CAA system

A hallmark of the traditional approach to teaching is the importance of practice. Computer aided assessment provides one mechanism to automate this, providing immediate feedback to students and relieving teachers from repetitive marking. This paper is a follow-up to the JEM presentation given in Lisbon in Feb 2007 in which we asked 'what is a mathematical question?'. In this talk we will provide our answer. In particular we shall demonstrate the concept of mathematical question which has been implemented as part of the STACK computer aided assessment system. This include multiple 'parts' which may involve interactions of a number of kinds. These may be independent or linked, and may implement 'follow through marking', where appropriate. STACK questions are used by students through the Moodle content management system.

The Higher Education Academy Maths, Stats & OR Network

Enhance traditional teaching through the STACK CAA system

Chris Sangwin & Simon Hammond

Last Revision Date: December 1, 2008

STACK 2.0

GeoGebra, A personal journey...

Starting in 2006:

- diagrams for *How Round is Your Circle?* in LaTeX;
- applets for the website;
- dynamic diagrams in lectures.

... and interesting personal insights ...

- students upload proofs to Moodle.

15 J. Lagrange: Developing and experimenting a Dynamic Geometry and Computer Algebra environment

Developing and experimenting a Dynamic Geometry and Computer Algebra environment for the upper-secondary algebra and calculus curriculum.

In France, at at upper secondary level, students have to consolidate their algebraic proficiencies in order to tackle pre-calculus. The curriculum recommends non formal approaches of calculus concepts, but also that students should be introduced to abstraction and demonstration. It is then not easy to think of the role of algebraic techniques with regard to conceptualization. Rehearsing 'rote' techniques certainly does not help, but it is important that students understand the equivalence of expressions and the benefit of algebraic transformations. They should also be able to perform basic transformations without too much difficulty in order to handle problems with inventiveness, intelligence and rigour.

My research group is developing and experimenting a Dynamic Geometry and Computer Algebra tool (Casyopée). This tool can be described as a symbolic calculator of functions and it is also designed to help students deal mathematically with problems of geometrical dependencies (for instance the area of a figure against a length of a segment). We experimented on a series of lessons with at 11th grade and gained some knowledge on how students can take advantage of Casyope use.We are currently experimenting a transfer of this knowledge to a group of teachers.

Developing and experimenting a Dynamic Geometry and Computer Algebra environment

J.B. Lagrange
Did. Math U. Paris VII

Goal and Outline

"discuss the extent to which technology should change the actual content of the various mathematics curricula…

…this includes the use and the further development of various assistive technologies"

- Functions in the French upper secondary curriculum
- Casyopée
- The european project ReMath
  - An experiment

The French upper secondary curriculum

- Under-standing functions
  - *… to identify the independent variable and its set of values for a function defined by a curve, a table of data or a formula,*
  - *…to establish the value of the function for a given value of the variable in each register,*
  - *…to describe the behaviour of a function given by a curve, using a relevant vocabulary or a sketch.*
- Using algebraic notation
  - *The notation f(x), already introduced before, and f will be systematically used.*
  - *… to recognize various forms of an expression and to choose the most relevant form for a given work*

The French curriculum

- *It is possible to study geometrical situations, the independent variable being a length and the dependant variable an area.*

The problem is then often to look for a maximum, a minimum or simply a value.

The new exam at the baccalaureate

Towards integration

- in order to perform a real integration, the final evaluation should include the use of computers

Math exercises whose solution significantly involves technology

- Calculators, computers
- Dynamic geometry, spreadsheet, CAS
- Specific applications (preferably free)"

Rationales

- Technology use remains marginal
  - Because of evaluation
- Exam with calculator more and more problematic
  - Download whole math textbook
  - Cheating via wireless communication
- Important Math proficiencies not evaluated
  - Conjecturing
  - Self-inventiveness
  - Technology use

Practically

- Exam in school
- One hour
- 1/5 of the mark
- Teachers choose in a "bank of exercises"
- Teachers attend to 4 students during the exam
- They fill in an evaluation sheet

- Each item in the bank
  - A description
    - topic,
    - TICE proficiencies
    - Math proficiencies
  - The student document
  - The teacher document
    - Intentions
    - Possible use of technology
    - Comments about evaluation
  - The evaluation document

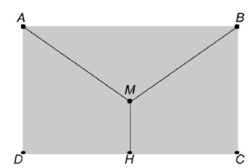
A description document

- Optimizing pipes

We want to put pipes on the wall of a house to collect rain water.

This wall is rectangular. A vertical pipe has to reach the bottom at the middle of the wall. Two other pipes have to collect water from the sides of the roof.

We want to use the shortest total length of pipe. Find the position of point M that gives this minimum length.

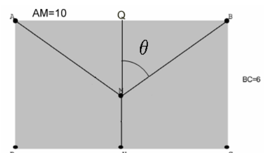


- Proficiencies at stake
  - In the use of technology
    - Building a figure using dynamic geometry
    - Using software to transpose a geometrical situation into a graphic.
  - In mathematics
    - Emitting a conjecture from various information:
    - Elaborating a strategy to find the extremum of a function.

Student text: conjecturing

On note Q le projeté orthogonal de M sur (BC) et on prend comme variable la mesure en radian de l'angle aigu $\widehat{BMQ} = \theta$.

1. (a) Utiliser un logiciel de géométrie pour simuler la situation décrite précédemment
   (b) En déduire une valeur approchée au centième de la valeur de θ qui rend minimale la longueur des tuyaux. Déterminer, grâce au logiciel, une valeur approchée au centième de la longueur minimale totale des tuyaux.



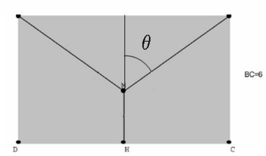
Appeler l'examinateur pour une vérification de la construction et des réponses trouvées.

Student text: proving

2. On définit la fonction $g : \theta \to g(\theta) = 2MA + MH$ sur l'intervalle $]0; \frac{\pi}{2}[$.

(a) On note g' la fonction dérivée de g. Démontrer que $g'(\theta) = 5 \times \frac{2\sin\theta - 1}{(cos\theta)^2}$.

(b) Déterminer la valeur exacte de θ qui minimise la longueur des tuyaux.



A critical view

- Big differences between
  - Description
    - Open problem
    - “Generic” problem
  - Student text
    - Particular problem
    - No choice of variable
    - Separation between
      - Conjecture
      - Proof
    - Use of software
      - only for conjecture
      - numerical approach
- Why ?
  - Acceptance by teachers
  - Constraints of the evaluation
  - **No adapted tool**

-> some disappointment

Casyopée

- ***CA**lcul **SY**mbolique **O**ffrant des **P**ossibilités pour l'**É**lève et l'**E**nseignant*

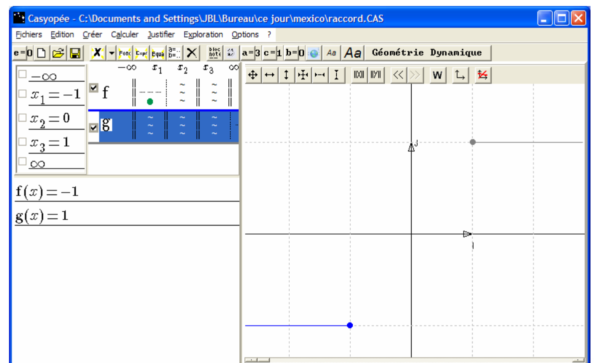
  (Computer Algebra System Offering Possibilities for the Teacher and the Student)
- A software environment
  - in development
  - … free for use
- http://www.irem.univ-rennes1.fr/recherches/groupes/groupe_aide_logiciel/cas/cas.htm

General Design

- Building a learning environment embedding a computer algebra kernel (*Maxima*)
- First version 2003-2005
  - a symbolic environment
  - typical problem: Smooth connection
- Second version (Remath)
  - Extension to a geometrical environment
  - deeply linked to the symbolic environment
  - typical problem: Studying Geometrical aspects of curves

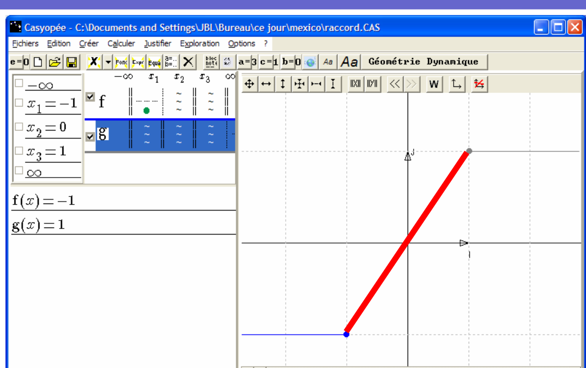
ReMath INRP DIDIREM IREM

Smooth connection



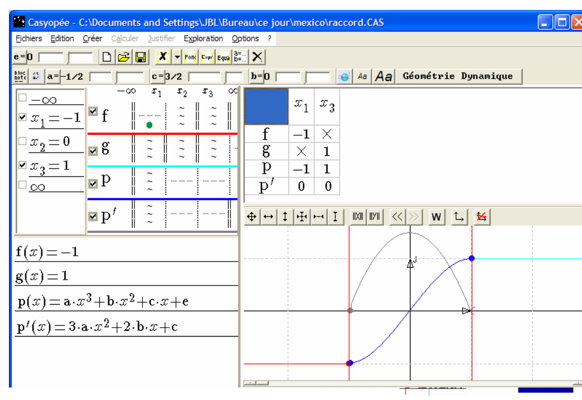
ReMath INRP DIDIREM IREM

Smooth connection



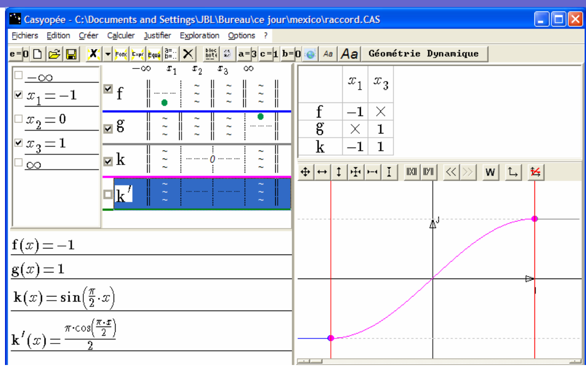
ReMath INRP DIDIREM IREM

Smooth connection

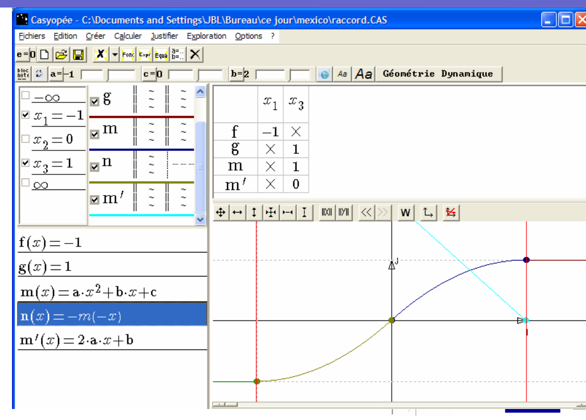


IREM

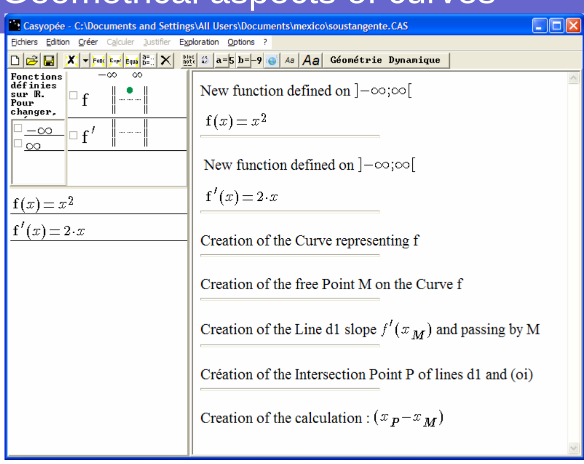
Smooth connection …



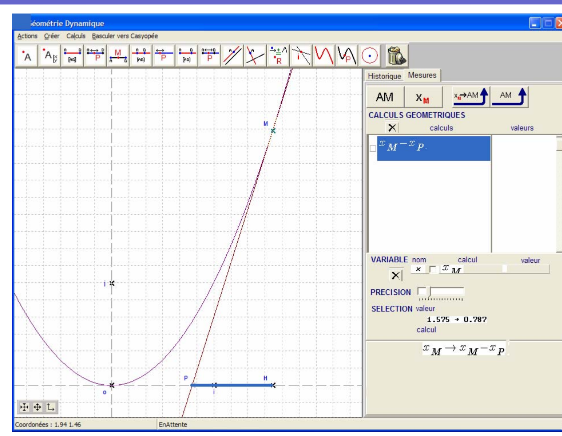
Smooth connection …



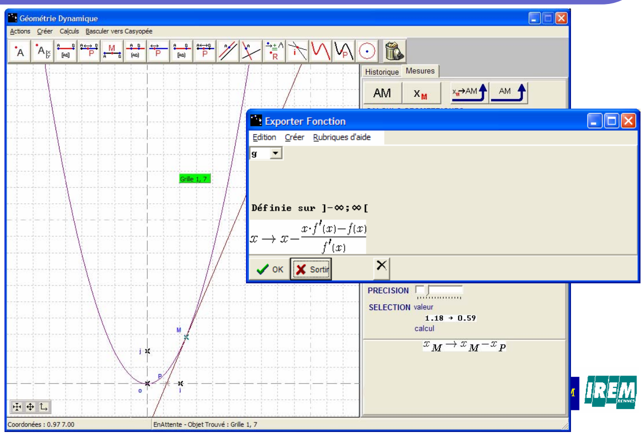
Geometrical aspects of curves



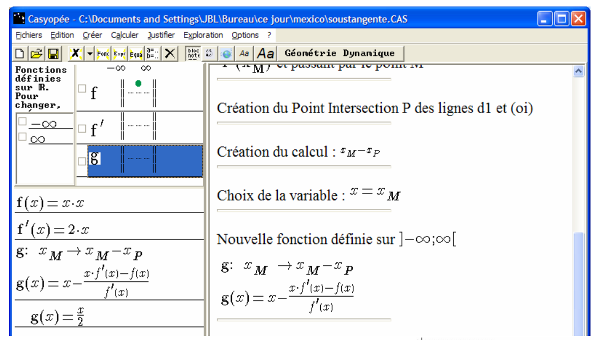
Geometrical aspects of curves



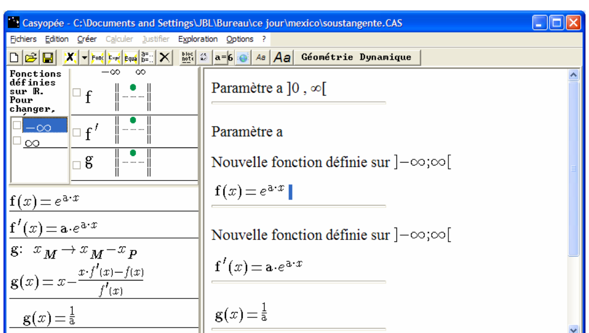
Geometrical aspects of curves



Geometrical aspects of curves



Geometrical aspects of curves

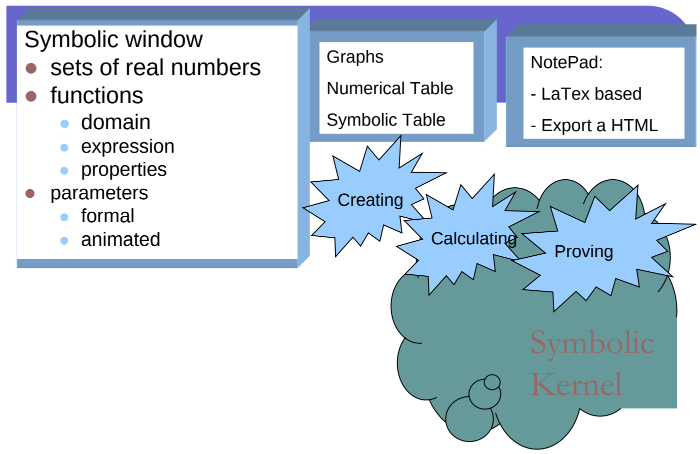


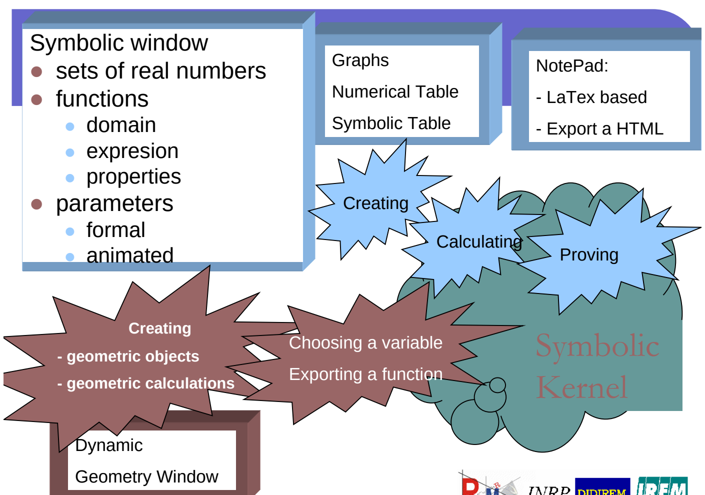
The Remath project
http://remath.cti.gr/

- *Objectives* :
  - integrating approaches to mathematical teaching and learning with digital technologies at the European level,
  - taking a 'learning through representing' approach
  - and focusing on the didactical functionality of 'digital artefact'.
- *Teams* : England (1), Greece (2), Italy (2), France (2).
- *Methodology*:
  - developing "artefacts" (6),
  - designing and (cross) experimenting classroom scenarios,
  - developing an integrated digital learning space for math education
  - Developing an *Integrating theoretical framework:* before and after experimenting

Remath Extension of Casyopée

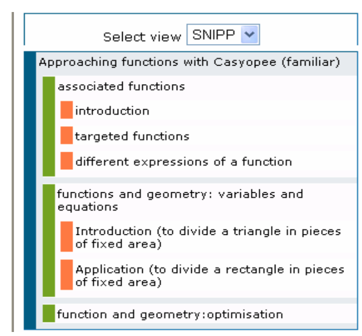
- Evaluation of Casyopée uses
  - Mainly restricted to algebraic representations
  - New objectives
    - To give a meaning to calculus and algebraic concepts by modeling phenomena
    - To study functional dependencies between variables
- Choosing Dynamic Geometry (GD) as a domain for modeling to help students
  - to understand a function as a model of dependency between measures
  - to process and coordinate representations in varied settings and registers,





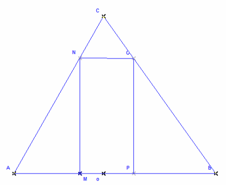
Cross Experiment Didirem Scenario

- 11th grade
- Goals
  - meaning of functions as algebraic objects,
  - meaning of functions as means to model a co variation in geometric and algebraic settings
  - Problematizing the variations (to prepare for derivation)



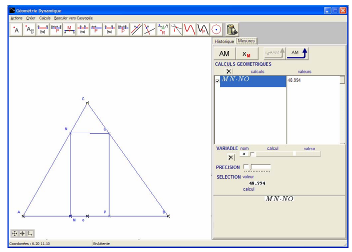
Part 3: Optimization Pb

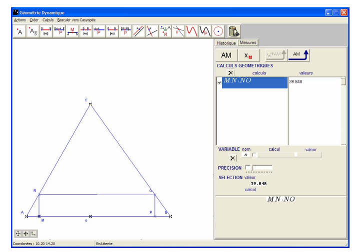
- a, b, c, 3 parameters >0
- A(-a,0); B(0,b); C(c,0)
- Find a rectangle MNPQ of maximal area
- (with M on [OA] ; Q on [OC] ; N on [AB] and P on [BC])



a priori resolution

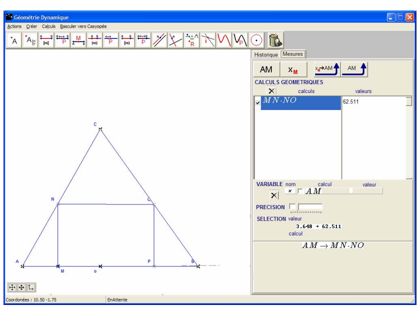
- Dynamic Geometry
  - Create a free point M and draw the rectangle MNPQ
  - Create a 'calculation' representing the area
  - Explore to conjecture the optimal position

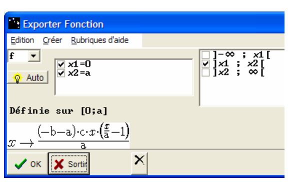




a priori resolution

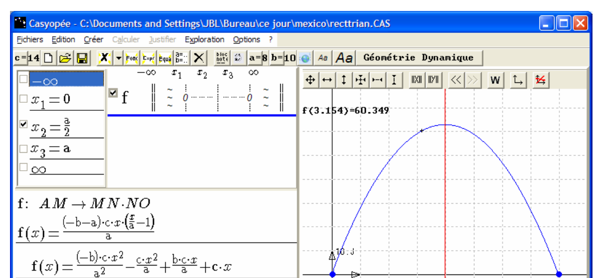
- Change of settings
  - Choosing a variable
  - Exporting a function





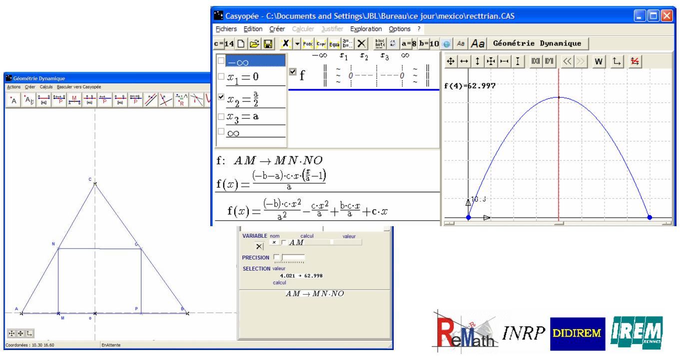
a priori resolution

- Algebraic settings
  - Graphic – Symbolic – Numerical

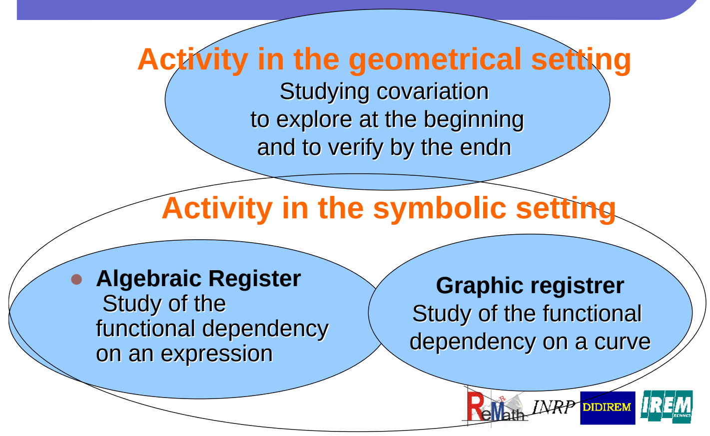


a priori resolution

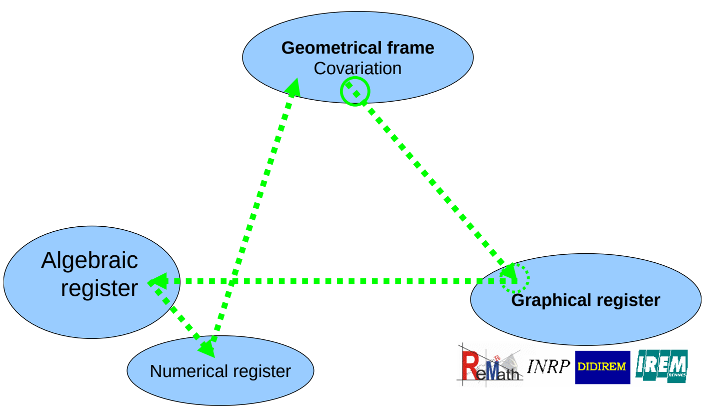
- Returning to geometry



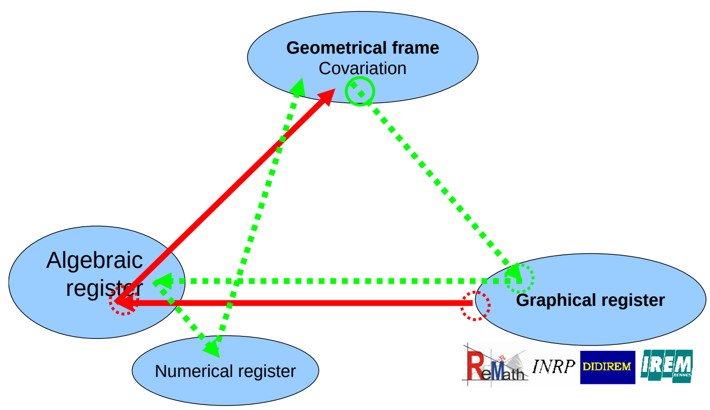
A posteriori analysis: 3 poles



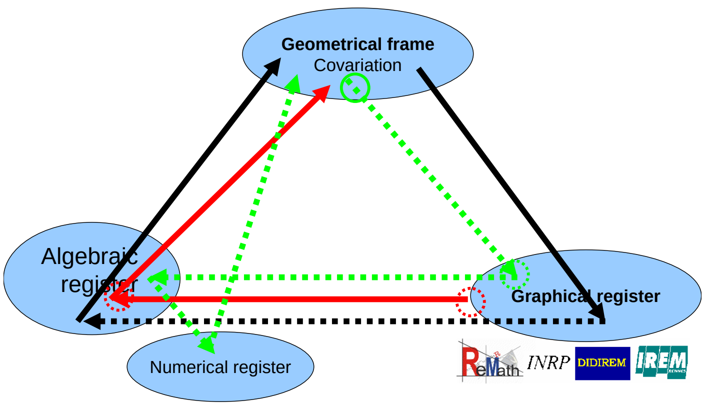
Green : team 1



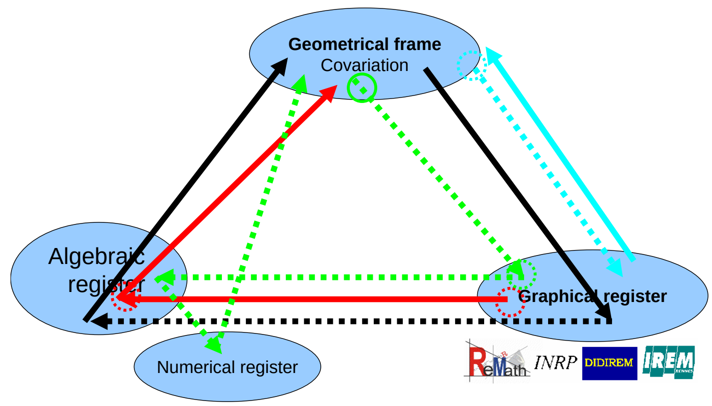
Green : team 1 ; Red : team 2



Green : team 1 ; Red : team 2
Black : team 3



Green : team 1 ; Red : team 2
Black : team 3 ; Blue : team 4



A first evaluation

- task allows varied way of solving and diversity of students' activity.
- students relatively autonomous,
- good instrumentation of Casyopée, thanks to the previous sessions,
- but...
  - even with Casyopée's help, changing settings is difficult
  - the teacher's role is important

Perspectives

- Software developpement :
  - Achieving the *Maxima* version
  - English version
  - On line help
- Studying and developping uses
  - Teacher scenarios
  - 'Breton' project
  - 'tutorial' environment
- Everybody can join …

Merci !

jb.lagrange.free.fr/site

16 Christian Schöne, Nils deBuhr, Julika Mimkes: New features in 'physik multimedial'

First, this is LiLi 2.0, a totally new version of LiLi, our catalogue and search engine of physic's learning material. LiLi provides links with descriptions, comments and ratings of learning material on the web. Everyone may search, comment, insert or rate the links. We have checked and updated every link and description in our database and enhanced the handling of our service.

Second, we start our authoring tools, a service for authors of elearning objects. We invite every author to join and share her or his experience with tools and programs, didactics and more.

17 Marco Burkschat: EMILeA-stat 2.0– A web-based learning environment in applied statistics

In the time period from April 2001 to December 2004, the development of the web-based learning and teaching environment EMILeA-stat has been funded by the German Federal Ministry of Education and Research (bmb+f). During this period, a consortium of several German universities was involved in the design and programming of the environment as well as the creation of its contents. EMILeA-stat contains a wide variety of introductory texts, examples, exercises and interactive visualizations for different topics in statistics and probability. Since 2005, EMILeA-stat is maintained and extended at RWTH Aachen University. The talk will focus on the concepts underlying EMILeA-stat and the new features of version 2.0 (http://emilea-stat.stochastik.rwth-aachen.de) which is released this year.

EMILeA-stat 2.0

A web-based learning environment in applied statistics

Marco Burkschat

RWTH Aachen University

Statistical education has become fundamental in ...

- many courses of studies (e.g., bio or life sciences, computer sciences, economics, engineering, mathematics, psychology, etc.)
- schools
- teacher-training courses
- in-service training courses and further vocational training

Main idea:

Development of one

learning and teaching environment

suitable for the statistical

education in all branches

http://emilea-stat.rwth-aachen.de

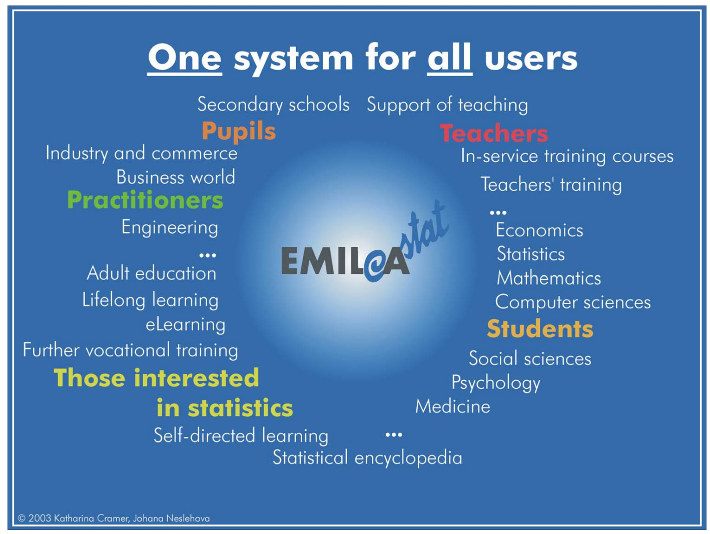
http://emilea-stat.stochastik.rwth-aachen.de

e-stat

- supported by the German Federal Ministry of Education and Research (bmb+f)
- "New Media in Education Funding Programme"
- project period: 04/2001 – 12/2004
- grant: 2.9 Mio. €
- set up by 13 partners at 7 German universities
- about 70 people were involved
- sustained at RWTH AACHEN University

EMILeA-stat

- developed within the e-stat project
- online since **04/2004**
- Version 1.0 accessible via
  http://emilea-stat.rwth-aachen.de
- Version 2.0 accessible via
  http://emilea-stat.stochastik.rwth-aachen.de
- accessible anywhere, anytime, and for anyone
- non-commercial education is free of charge!



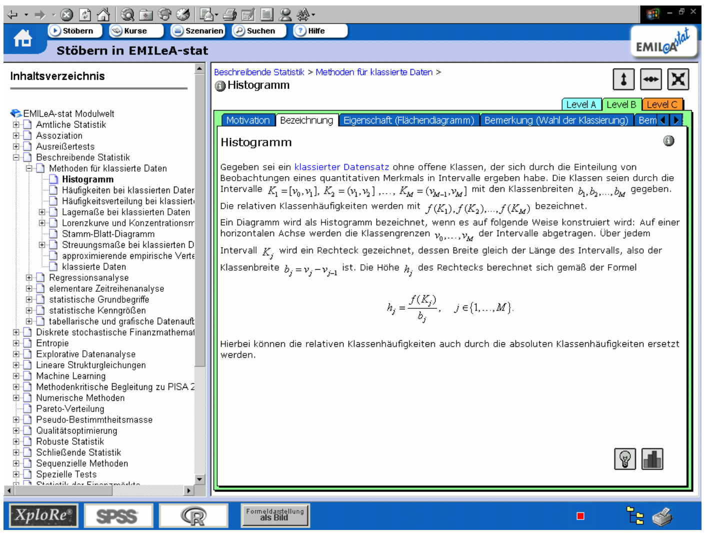
Characteristics

- user-oriented product: “different users have different needs”
  - e.g., three levels of abstraction:
    A: elementary
    B: basic
    C: advanced
- focus on graphical representations
- includes theory, examples, and exercises

Characteristics

- Content is strictly modular
  - module: smallest element
  - e.g., definition, remark, theorem, proof, example, exercise
  - a module should not exceed the size of the screen such that scrolling is not necessary
- Modules may be combined to form course units or courses

Important: free navigation remains possible!

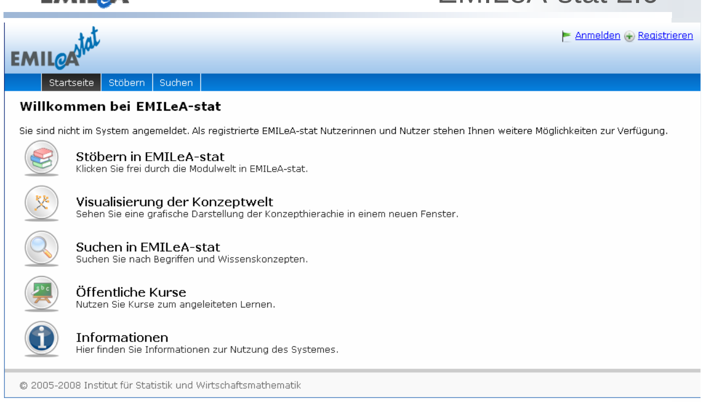


Version 2.0

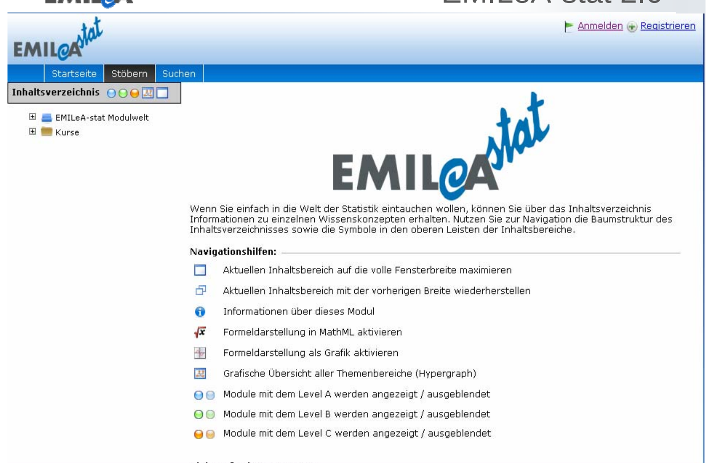
Changes:

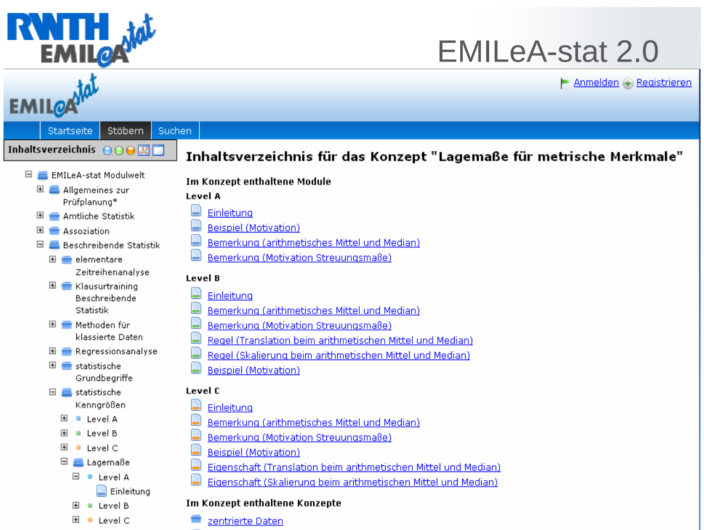
- improved usability
- integrated authoring tools for modules
- XHTML compliant output generation
- new database structure
- contents can be indexed by search engines
- ...

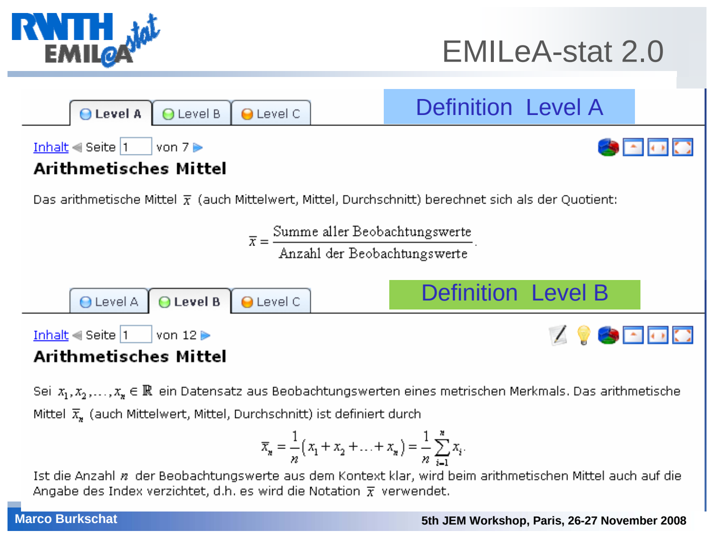
EMILeA-stat 2.0

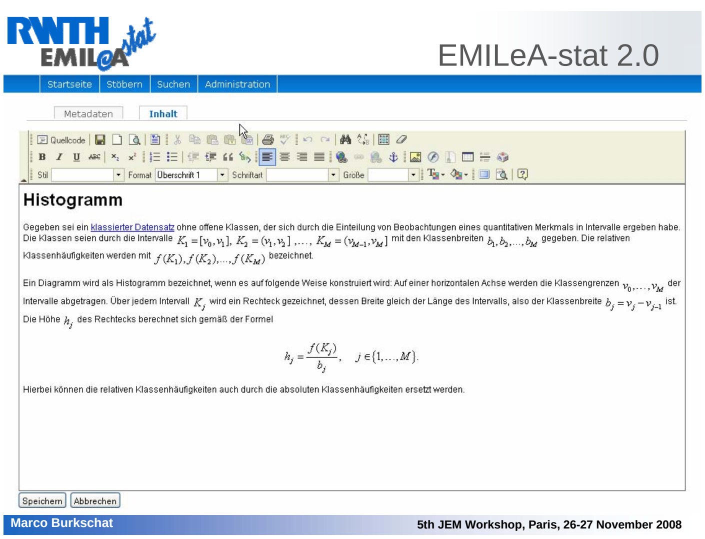


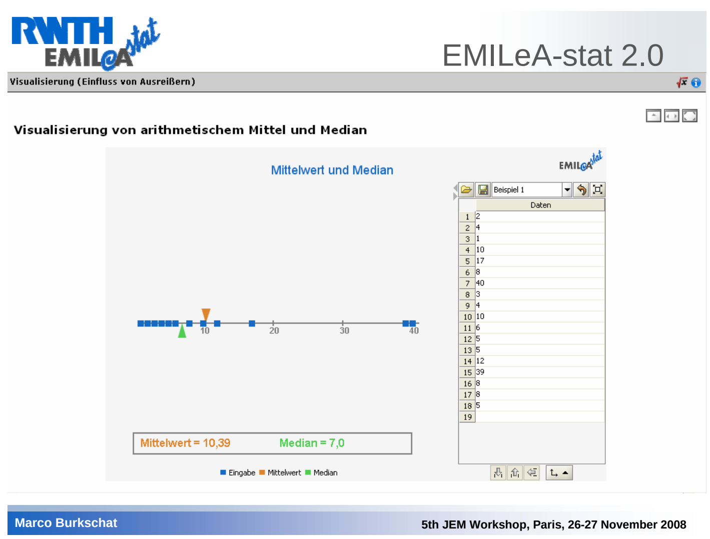
EMILeA-stat 2.0



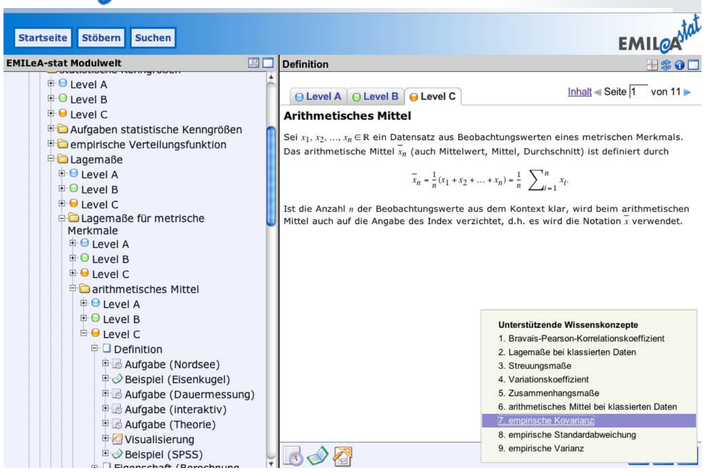

EMILeA-stat 2.0
Anmelden Registrieren
Startseite Stöbern Suchen
Inhaltsverzeichnis
EMILeA-stat Modulwelt
Allgemeines zur Prüfplanung*
Amtliche Statistik
Assoziation
Beschreibende Statistik
elementare Zeitreihenanalyse
Klausurtraining Beschreibende Statistik
Methoden für klassierte Daten
Regressionsanalyse
statistische Grundbegriffe
statistische Kenngrößen
Level A
Level B
Level C
Lagemaße
Level A
Einleitung
Level B
Level C
Inhaltsverzeichnis für das Konzept "Lagemaße für metrische Merkmale"
Im Konzept enthaltene Module
Level A
Einleitung
Beispiel (Motivation)
Bemerkung (arithmetisches Mittel und Median)
Bemerkung (Motivation Streuungsmaße)
Level B
Einleitung
Bemerkung (arithmetisches Mittel und Median)
Bemerkung (Motivation Streuungsmaße)
Regel (Translation beim arithmetischen Mittel und Median)
Regel (Skalierung beim arithmetischen Mittel und Median)
Beispiel (Motivation)
Level C
Einleitung
Bemerkung (arithmetisches Mittel und Median)
Bemerkung (Motivation Streuungsmaße)
Beispiel (Motivation)
Eigenschaft (Translation beim arithmetischen Mittel und Median)
Eigenschaft (Skalierung beim arithmetischen Mittel und Median)
Im Konzept enthaltene Konzepte
zentrierte Daten


EMILeA-stat 2.0
Level A Level B Level C
Definition Level A
Inhalt Seite 1 von 7
Arithmetisches Mittel
Das arithmetische Mittel $\bar{x}$ (auch Mittelwert, Mittel, Durchschnitt) berechnet sich als der Quotient:
$\bar{x} = \frac{\text{Summe aller Beobachtungswerte}}{\text{Anzahl der Beobachtungswerte}}$.
Level A Level B Level C
Definition Level B
Inhalt Seite 1 von 12
Arithmetisches Mittel
Sei $x_1, x_2, \ldots, x_n \in \mathbb{R}$ ein Datensatz aus Beobachtungswerten eines metrischen Merkmals. Das arithmetische Mittel $\bar{x}_n$ (auch Mittelwert, Mittel, Durchschnitt) ist definiert durch
$\bar{x}_n = \frac{1}{n}(x_1 + x_2 + \ldots + x_n) = \frac{1}{n}\sum_{i=1}^{n} x_i$.
Ist die Anzahl n der Beobachtungswerte aus dem Kontext klar, wird beim arithmetischen Mittel auch auf die Angabe des Index verzichtet, d.h. es wird die Notation $\bar{x}$ verwendet.
Marco Burkschat
5th JEM Workshop, Paris, 26-27 November 2008

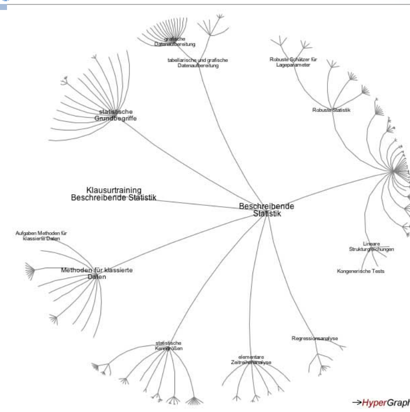

EMILeA-stat 2.0
Startseite Stöbern Suchen Administration
Metadaten Inhalt
Quellcode
Stil Format Überschrift 1 Schriftart Größe
Histogramm
Gegeben sei ein klassierter Datensatz ohne offene Klassen, der sich durch die Einteilung von Beobachtungen eines quantitativen Merkmals in Intervalle ergeben habe. Die Klassen seien durch die Intervalle $K_1 = [v_0, v_1]$, $K_2 = (v_1, v_2]$, …, $K_M = (v_{M-1}, v_M]$ mit den Klassenbreiten $b_1, b_2, \ldots, b_M$ gegeben. Die relativen Klassenhäufigkeiten werden mit $f(K_1), f(K_2), \ldots, f(K_M)$ bezeichnet.
Ein Diagramm wird als Histogramm bezeichnet, wenn es auf folgende Weise konstruiert wird: Auf einer horizontalen Achse werden die Klassengrenzen $v_0, \ldots, v_M$ der Intervalle abgetragen. Über jedem Intervall K_j wird ein Rechteck gezeichnet, dessen Breite gleich der Länge des Intervalls, also der Klassenbreite $b_j = v_j - v_{j-1}$ ist. Die Höhe h_j des Rechtecks berechnet sich gemäß der Formel
$h_j = \frac{f(K_j)}{b_j}, \quad j \in \{1, \ldots, M\}$.
Hierbei können die relativen Klassenhäufigkeiten auch durch die absoluten Klassenhäufigkeiten ersetzt werden.
Speichern Abbrechen
Marco Burkschat
5th JEM Workshop, Paris, 26-27 November 2008


EMILeA-stat 2.0
Visualisierung (Einfluss von Ausreißern)
Visualisierung von arithmetischem Mittel und Median
Mittelwert und Median
Beispiel 1
Daten
10 20 30 40
Mittelwert = 10,39
Median = 7,0
Eingabe Mittelwert Median
Marco Burkschat
5th JEM Workshop, Paris, 26-27 November 2008

EMILeA-stat 2.0



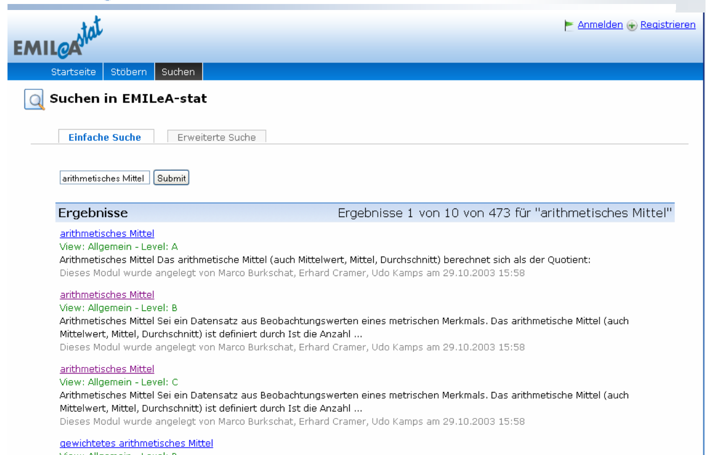
EMILeA-stat 2.0



EMILeA-stat 2.0

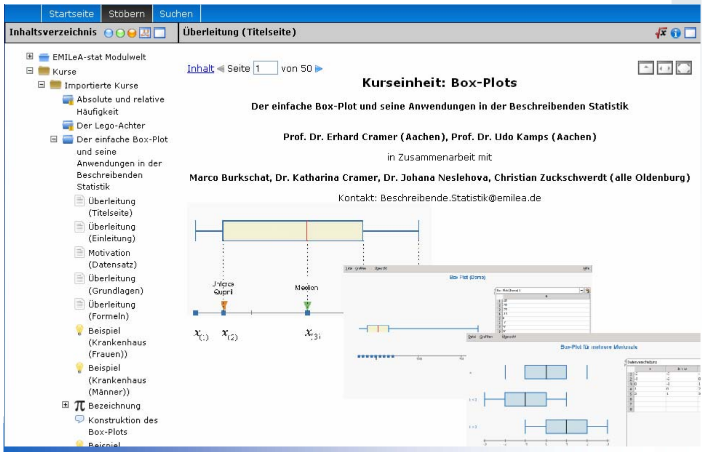
Marco Burkschat 5th JEM Workshop, Paris, 26-27 November 2008

EMILeA-stat 2.0



Courses

Course Unit



Use of EMILeA-stat

- Teaching, selective support of teaching (examples, visualizations,…)
- (online) collection of slides
- Self-directed learning before/after lectures
- Self-directed learning (eLearning)
- Supervised learning (blended eLearning)
- Online script with add-on´s (visualizations, self-assessments, …)

Use of EMILeA-stat

Further aims by using a learning and teaching environment:

- Contribution to point out the practical relevance of statistical methods (see toy examples)
- Visual learning – understanding as the learning target
- Critical reading of illustrations and interpretations
- Obtaining media-competence
- Learning the use of eLearning (eLearning as tool for LLL)
- Motivation to do further self-directed learning

Thank you for your attention!

18 Teresa Sancho-Vinuesa, César Córcoles, M. Antnia Huertas, Antoni Prez-Navarro, Daniel Marqus, Joana Villalonga: Automatic Verbalization of Mathematical Formulae for Web-based Learning Resources

Engineering students have traditionally had a lot of difficulty in reaching the objectives they have to cover, laid out in the different Mathematics courses. In a distance learning environment, both the learning methodology and the students profile (adults with family and professional responsibilities and with usually insufficient previous knowledge levels) are elements which aggravate these difficulties. In particular, it is mathematical notation which is necessary and ubiquitous in this kind of learning that presents a problem for the expression of content: verbalization is not a simple task and it is not easy to write using common digital resources. This second factor is especially significant in distance learning.

Mathematical expression verbalization tools have been developed with the goal of improving teaching quality in courses requiring scientific and technical notation unknown to many students. These tools have been integrated in web-based learning material, written in MathML, pertaining to a basic mathematics course for engineering at the UOC (Universitat Oberta de Catalunya). A first test with a group of students has been carried out with very satisfactory results.

Because of this initial success, we believe that this application improves the communication competences of students in courses with high mathematical content, reducing semantic confusion and so easing communication between students and teachers. From a technological point of view, it means including a new functionality to a formulae editor based on the MathML standard.

A demo can be seen in: http://www.jem-thematic.net/en/node/1221

Verbalitzation of mathematic formulae

Teresa Sancho-Vinuesa, M.A. Huertas, César Córcoles, Antoni Pérez-Navarro, Daniel Marquès, Joana Vilallonga

UOC www.uoc.edu

5th JEM Workshop
26-27 N, Paris

Contents

- Context
- Problem
- Solution
- Test & Results
- Conclusions and Future

Contents

- **Context**
- Problem
- Solution
- Test & Results
- Conclusions and Future

Reading other languages

人 木

How to read these symbols?

Reading other languages

rén
(Person)

人 木

mù
(Tree)

How to read these symbols?

Distance language learning

Distance learning of ANY language include “how-to-read” devices

Distance language learning

Distance learning of ANY?? language include “how-to-read” devices

Cinderella

Mathematics NOT !

Contents

- Context
- **Problem**
- Solution
- Test & Results
- Conclusions and Future

“Classical” learning

Teacher
SAYS
formulae

Distance learning

Nobody
SAYS
formulae

Distance learning

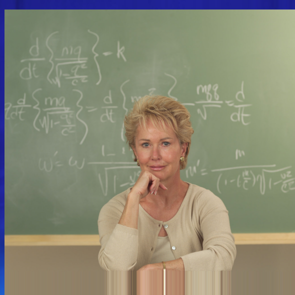
$$\int x^2\,dx$$

“What is the snake?”

$$a \in A$$

“What is the euro symbol?”

Distance learning



How to substitute the teacher?

First try

$$\int x^2 dx$$

First try

But...

$$\ln\frac{3+e^x}{2}$$?

Contents

- Context
- Problem
- **Solution**
- Test & Results
- Conclusions and Future

What we need?

- To generate automatically the transcription of formulae
- To associate every transcription to the formula indeed
- To visualize it only when needed
- To choose language

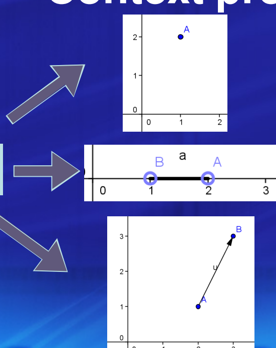
Linguistic Problem

$$3+\frac{5}{4}$$ 3, plus 5 over 4

$$\frac{3+5}{4}$$ 3 plus 5, over 4

Context problem

$(1,2)$



"Point 1,2"

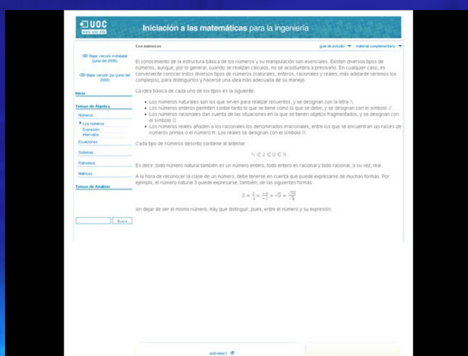
"Interval 1,2"

"Vector 1,2"

Goal

The tool is a goal by itself

The tool



Contents

- Context
- Problem
- Solution
- **Test & Results**
- Conclusions and Future

Testing the tool

Who?

- Introductory course
- New at UOC

What?

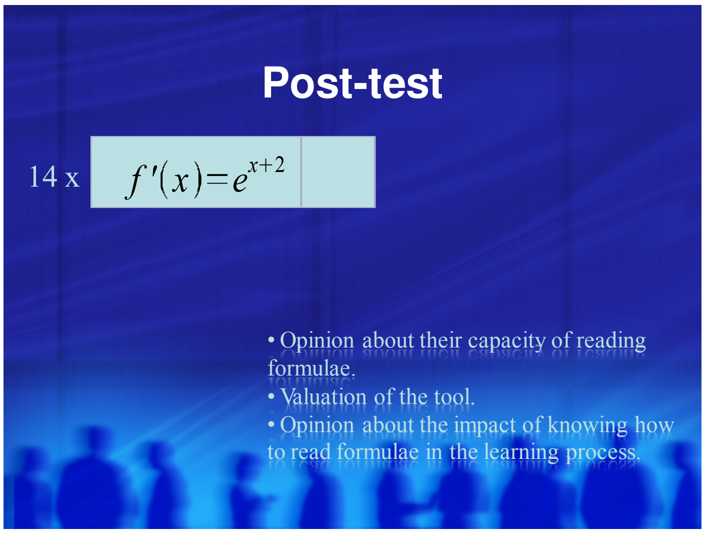
1. Pre-test with questions
2. The tool is used
3. Post-test with questions

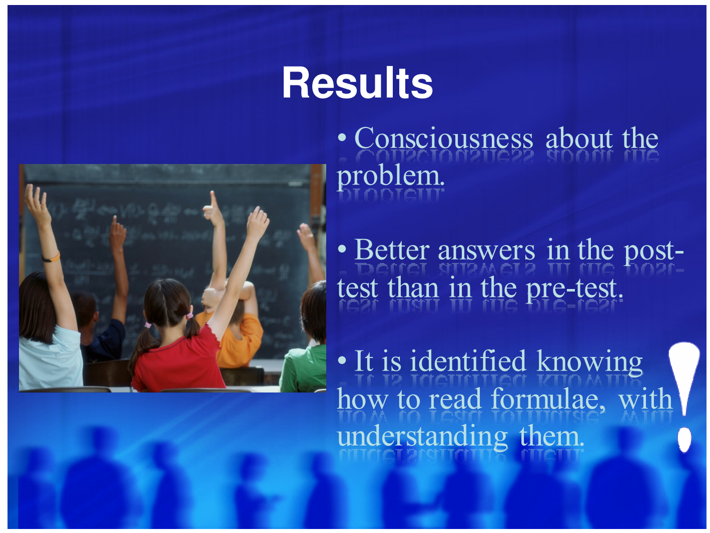
Pre-test

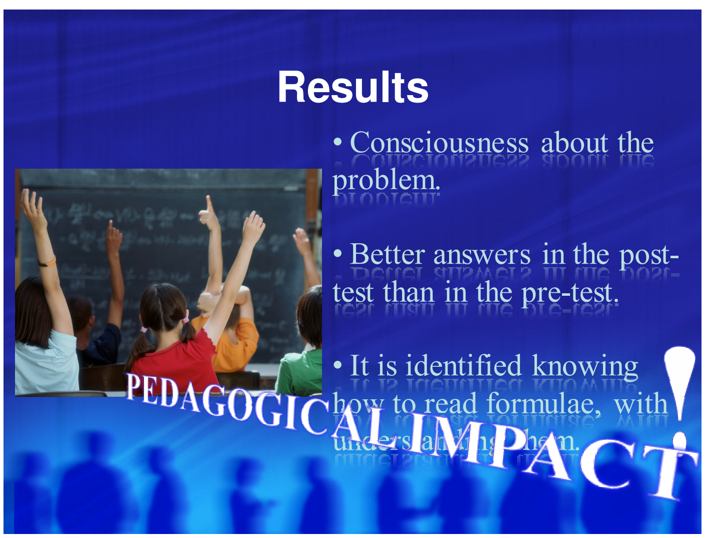
14 x $f'(x)=e^{x+2}$

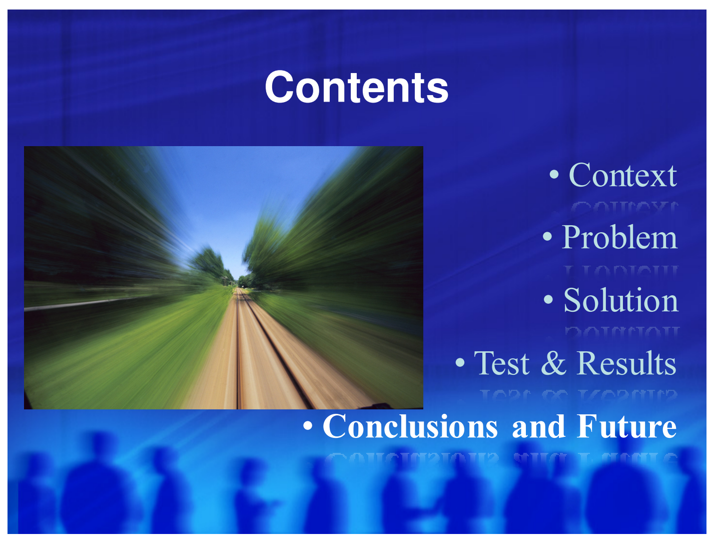
14 x Integral of x square differential x

- Difficulties with the exercise.
- Opinion about the importance of knowing how to read formulae.
- Improvement proposals.


Post-test
14 x
$f'(x)=e^{x+2}$
• Opinion about their capacity of reading formulae.
• Valuation of the tool.
• Opinion about the impact of knowing how to read formulae in the learning process.


Results
• Consciousness about the problem.
• Better answers in the post-test than in the pre-test.
• It is identified knowing how to read formulae, with understanding them.
!


Results
• Consciousness about the problem.
• Better answers in the post-test than in the pre-test.
• It is identified knowing how to read formulae, with understanding them.
!
PEDAGOGICAL IMPACT


Contents
• Context
• Problem
• Solution
• Test & Results
• Conclusions and Future

Conclusions

- A tool that automatically transcript a formula has been developed
- The tool allow on line students to learn how to read formulae
- Students identify knowing how to read formulae with comprehend them
- The pedagogical impact exceed expectations

Future

- To do at least one more test
- To continue detecting and solving problems
- To add a voice synthesiser
- To test the tool in new environments.

Team

UOC www.uoc.edu

- **Teresa Sancho Vinuesa**
- César Córcoles Briongos
- Ma. Antònia Huertas
- Toni Pérez Navarro

maths for more

- Daniel Marquès
- Joana Villalonga

Thank you, very much!

19 Ramon Eixarch: WIRIS Quizzes, enhancing Moodle quizz system with mathematical capabilities

For some time WIRIS suite has offered tools to support education in mathematics and science topics in Moodle, the Open Source LMS. So far these solutions offered a formula editor based on icons and pallets, plus a powerful platform for mathematical calculation called WIRIS CAS. We want to present the new WIRIS family member, called Quizzes, that integrates the powerful WIRIS mathematical calculation engine of with Moodle quizzes system.

WIRIS Quizzes allows users to incorporate to all Moodle questions mathematical elements generated at random. In addition, the response can be assessed automatically by the engine of mathematical calculation no matter it has open answer or multiple-choice answers.

WIRIS Quizzes

Enhancing MoodlE quizzes
WITH WIRIS TECHNOLOGY

Ramon Eixarch
Maths for More

JEM 5th WorkShop – Paris

WIRIS and Moodle

- WIRIS Plug-in integrates in HTML editor
  - Formula editor WIRIS Editor
  - Online CAS WIRIS CAS

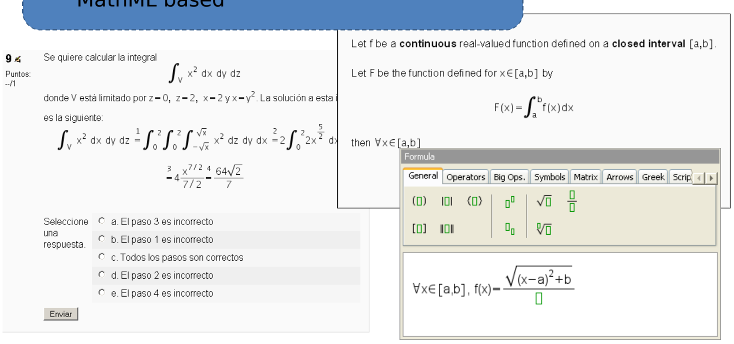
www.wiris.com/moodle/

- WIRIS Quizzes

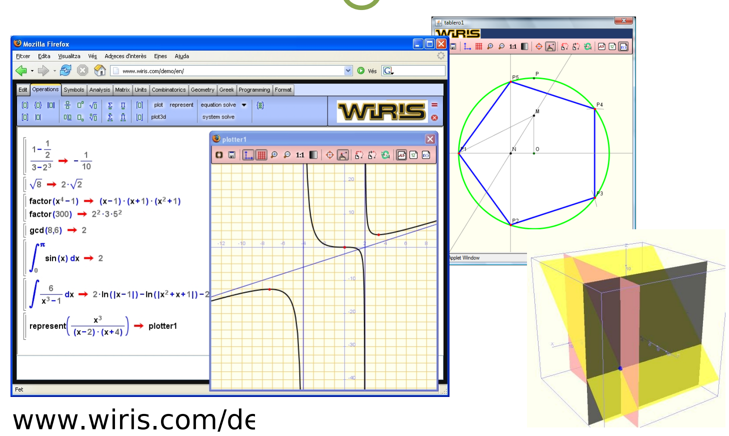
Improving Moodle quizzes system with WIRIS Technology

Formula editor

WIRIS Editor
WYSIWYG editor (icons, palettes)
MathML based



WIRIS CAS



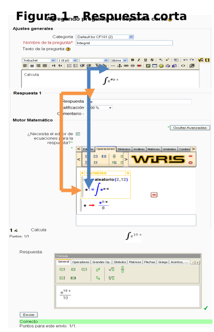
www.wiris.com/de

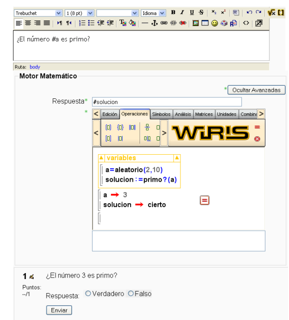
WIRIS Quizzes

- Improving Moodle quizzes system
  - Include randomly generated contents in the quiz.
  - Automatic evaluation of mathematical answers
  - Integrates WIRIS CAS, our online calculator, as evaluation engine, math calculations and random generation.
  - Integrates WIRIS Editor to write answer.

WIRIS Quizzes

- Some examples



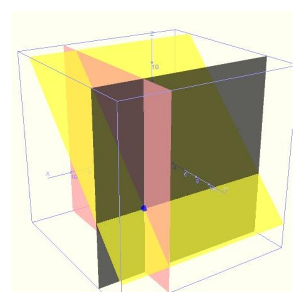


Technical details

- ¿What does it change in my Moodle?
  - All quizzes show an 'Advanced button' option
- ¿Does it have effects on teachers no using the system?
  - NO, quizzes not using WIRIS Quizzes power at stored as if WIRIS Quizzes was not installed.
  - NO, it doesn't have any effect on pre-existing contents.
- Requests
  - WIRIS Editor

Future steps

- Officially available
  - January 2009
- Image inclusion
  - Simple mechanism #plotter
- Improve evaluation
  - Answer comparison
    - x2=x·x?
    - x+2 =2+x ?
- Including WIRIS CAS interactivity



Merci beoaucoup

Eskerrik asko,

Moltes gràcies,

Moitas grazas,

Muchas gracias,

Thank you,

Ramon Eixarch

ramon@mathsformore.com

www.wiris.com

20 M. Antonia Huertas, César Córcoles, Mireia Pascual, Roger Griset, Lourdes Meler: Rodolf: open repository of formulae locutions

In a virtual learning environment with contents that follow textual and graphic (image) formats the correct reading of formulas and mathematical expressions is not feasible. The students of such non face-to-face simply do not 'hear' how the formulas are read and therefore they can not access that important competence. Making use of the technological possibilities to digitalize the human voice and later to enclose the files of sound to web texts, a team formed by professors and technicians of have designed and implemented a first prototype of an open, collaborative and multilingual repository of locutions of mathematical formulas. The repository and a study case of its use will be presented.

Rodolfo

Open Repository of Mathematical Formulae Locutions

M. Antonia Huertas

5th JEM Workshop, Paris, November 27, 2008

UOC Universitat Oberta de Catalunya

Motivation

- How does our student read this if it is the first time he/she read Set theory?
- Students in a non face-to-face learning situation simply do not “hear” how the formulas are read
- A solution comes from:
  - The technological possibilities to digitalize the human voice and store in files like MP3 format
  - The possibility of enclose the files of sound to web texts
- Rodolfo (Repositori Obert De Locucions de FOrmulas) is an open, collaborative and multilingual repository of locutions of mathematical formulas.

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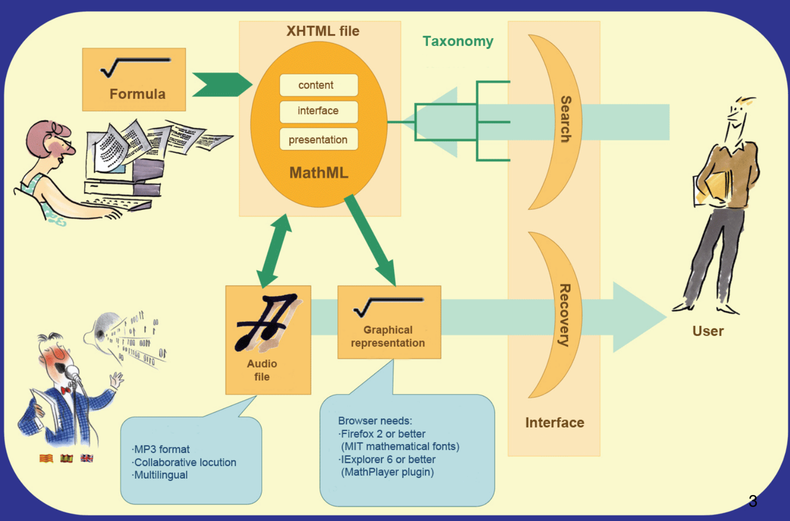

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Members of the working team

- A heterogeneous necessary team
  - Mathematicians
  - Audio-visual technicians
  - Computer scientists
  - Documentalists
  - Linguists

We wanted an open system…

…and also:

- Useful for face-to-face and virtual learning
- Multilingual
- Based in a collaborative environment
- Based in the math taxonomy used by JEM

UOC Universitat Oberta de Catalunya

A complex element…

- Mathematical formulae
- Graphic representation
- Different description languages (LaTeX, MathML)
- Different ways of reading a formula (multilingual transcriptions)
- Different locutions for each reading (stored in MP3 format)

Development of an own tool (catalan)

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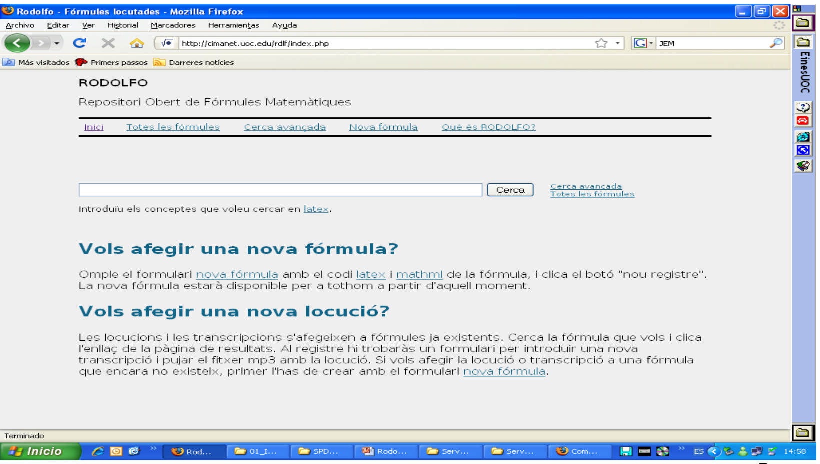

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In production…

- Different subjects
  - Set theory
  - Complex analysis
- Different languages
  - Spanish
  - Catalan
  - English

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To do

- More formulas, more languages, more locutions, more educational materials...
- Web of Rodolfo in Catalan, English, other languages
- Taxonomy implementation
- Improvements in the workflow and the tool
  - Users management
  - Adequacy to standards
  - New (and imaginative) forms of financing

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http://cimanet.uoc.edu/rdlf/

http://www.jem-thematic.net/en/node/1157

mhuertass@uoc.edu