Research in the ActiveMath Project

Pedagogy, Mathematics, Web!

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Projects’ History

- VIL (BMBF) 2000-2001
- In2Mat (BMBF, partner UdS) 2001-2003
- MMISS (BMBF, partner UdS) 2001-2003
- MIPPA (DFG, 2002-2004)
- LeActiveMath (EU, coordinator) 2004-2006
- iClass (EU, partner) 2004-2008
- Mathe Führerschein (Arbeitgeberverband Gesamtmetall) 2004
- Kaleidoscope (EU, partner UdS)
- ProLearn (EU, partner DFKI)
Pedagogical goals
(first phase)

- Personalization and adaptation
  - content
  - presentation
  - feedback

- usability of content presentation

- some self-responsibility

- active exploratory learning

- target audience: University undergraduate
Technical goals
(first phase)

- web delivery
- separation of content and functions
- promote re-use of content
- several presentation formats
- standardized encodings
- open, distributed architecture
- platform independence
ActiveMath 2003

- personalized content and presentation
- interactive exercises with math-systems
- distributed architecture
- prototype suggestion
- OMDoc encoding, with pedagogical metadata

and many more!
ActiveMath architecture
OpenMath in action: presentation process

- Content is in OMDoc
- Items with text and formulae
- Formulae in OpenMath
- Metadata
- Is transformed to presentation
- Extensible XSLTs
- Velocity combination
- Global styling
A monoid is a structure in which is a semi-group with unit.
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OMDoc example: 4

A monoid is a \(<\text{structure}>, \text{times}, \text{unit}\) in which \((\text{structure}, \text{times})\) is a semi-group with unit.
How much semantic?

- Semantic-web... machine process-able?
- As much as authors like
  - from zero on
- Geared by features
- Offer them a feature...
- ...they will care for the data for it
OpenMath in action: Dynamic presentation

- can offer interactivity
  - symbol-name tool-tip
  - click to browse to definition
  - subterm-highlighting
- content is presentation independent
  - actually experienced
OpenMath in action: Copy and paste

- select sub-term in content
- paste in computer-algebra-systems interface
- works very restricted
- missing extension-capabilities of phrasebooks!
Authoring: Current Workflow

- Write OMDoc source in jEdit
- but not OpenMath
- use QMath syntax for formulae
- apply OQMath, reload and reference-check, test content presented
- test, check, and edit cycle
Authoring: Enjoyable?

kind-of...

XML-editing isn't so bad

OMDoc content isn't so wild

jEdit offers large support with DTD

cycling is enjoyable!

authoring semantic math is hard
Authoring Semantic Math

- finding the right symbol
- browse OM CDs and find the one
- may be not fully satisfactory
- need to define own symbol
- need to extend presentation engines and input
- lacking overall practice
- textbooks are rich...
- ... authors want this variety
Semantic Math Authoring: Lacking practice

- what's the semantic expression of:
- indexed sequences
  \((a_1 \ a_2 \ \ldots \ a_{k-1} \ a_{k+1} \ \ldots \ a_n)\)
- sub-term labelling
  - very hard to layout!
- authors make layout themselves
- structured rewrite
  - links between the parts being rewritten?
Currently available material

- some Abstract Algebra partly (CohenCuypers) en
- Analysis, (DahnWolter) plus new exercises  de
- Statistik, Grabowski (HTWSaar) de
- Optimization, Izhutkin (Russia) ru, en
- MathePrisma, combinatorics (Wuppertal) de
- some Topology (Cairns) en
- Matheführerschein (Hussmann, Leuders) de
- Software Security, Hutter et al (SB, Bremen, München), en, de
- School Math: fractions (Kessler) de

...IUB courses (Kohlhase)
...moderate constructivist Calculus de, en (LeAM)
LeActiveMath FP6 project

Language-enhanced, user-adapative, interactive e-Learning for Mathematics

DFKI, Eurice, University of Edinburgh, University of Northumbria, TU Eindhoven, Universidad Malaga, Universität Augsburg, Ernst Klett Verlag, Universität des Saarlandes
Some goals of LeActiveMath

- Generic OpenMath-aware input editor
- Tutorial dialogues
- Database of interactive exercises
- OpenMath-aware computer-algebra system
- Several learning-effective tools
- Improved knowledge representation
- Web services
- Motivational and emotional diagnosis and reaction
- Improved open student modeling and tools
- Moderate constructivist calculus courses, school/univ
- Classroom tests
ActiveMath Roadmap

- Applied research directions:
  - Extend to other domains
  - Flexible exercise architecture
  - Efficient for 100 students
  - Privacy Issues
  - Authoring tools
ActiveMath Roadmap

Basic research directions:

- learning from errors
- exercise generation
- meta-reasoning
- innovative course-generation
- intelligent-support in authoring
- knowledge representation and ontologies