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D5.3 Online tutorial on mathematical markup

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Abstract
This tutorial addresses the topic of "mathematical markup", namely the formats that are currently in use for representing mathematics online, e.g. in interactive course material.
The tutorial explains the pros and cons of using a markup format, lists some of the software which can help in producing, converting and using it and gives simple examples.

Choosing a mathematical markup

If you have decided to create your educational material using a markup language designed to support mathematics, then you face the question of which language you should use. It is clear that the richer the language, the more manipulation and processing one can expect to be able to do to adapt the material to arising requirements of presentation media, user preferences and learning resources. However, the authoring task is still quite involved, especially when the document is able to support multiple views and functionality.

Here below we try to make a comparison chart to identify some of the characteristics of each markup format, that might help you take a more informed decision.

Server: where and how it can be served
Interactivity: if it can be used to represent interactive educational material like an exercise
Notation support: if it allows users to set notation preferences (this is more an aspect of the serving platform)

Formulae: format in which the actual mathematics is encoded
Authoring GUI: editing software
Converters: formats which can be readily obtained from the sources

Format	Server	Interactivity	Notation support	Formulae	Authoring GUI	Converters
OMDoc	SWiM, pantha-rei, ActiveMath	Y	Y	OpenMath/C-MathML	STeX, OQMath, jEditOQMath	XHTML+MathML
MathDox	mathdox-player	Y	limited, via xslt	OpenMath/LaTeX/MathML	-	XHTML+MathML, PDF, LaTeX (beamer, article)
CNXML	cnx.org	N	Y	C-MathML	Word	XHTML+MathML
OOXML	N	N	N	OMML	MS Office	PDF, PPTX?, DOCX, DOC

Pointers to eContent Management Systems for Mathematics

ActiveMath Platform

ActiveMath is a web-based, user-adaptive platform for mathematics that has been used in schools, universities, and in life-long learning. ActiveMath offers an interactive, learner-centered platform that can be customized with look & feel, specific content and with tailored interactivity. Learners can choose among several learning scenarios, receive tailored learning material and assemble individual courses. Active participation is required during interactive exercises, and in using tools such as the semantic lexicon, the concept map tool, and the assessment tool. Each activity is tracked in a learner's model which captures the system's beliefs about the user's capabilities and preferences.

- OQMathJEdit Plugin User's Guide [1] is the documentation of the editor for OMDoc documents meant for the ActiveMath platform
- Book of tasks [2] offers step-by-step guides that are ordered by typical tasks occurring while authoring
- Authoring handbook [3] is an ever growing documentation written by users of ActiveMath
- Blogs [4] expresses personal views, often related to markup technologies, of users of ActiveMath

Connexions Platform

Connexions is an online environment for collaboratively developing, sharing, and publishing educational content for everyone — from children to college students to professionals — organized in small modules that are easily connected into larger collections or courses. All content is free to use and reuse under the Creative Commons "attribution" license. Content is stored in XML, in particular MathML Content is used to encode the meaning of a mathematical expression disjoint from its presentation. This allows authors to reuse modules while maintaining notational consistency. For instance, vectors may be denoted by a bold letter, an over bar, an over arrow, or a hat. As an author, you can specify how you want vectors to be presented in your course, regardless of the source of each module.

- Connexions Tutorial and Reference [5] as a connexions course, it also provides a sample module that authors can use as a template
- Introduction to Connexions [6] is a course outlining the basics
- Documentation, tutorials, and reference material [7] created by the developers

MathDox Platform

MathDox is an XML based format for interactive mathematical documents. MathDox documents can be

transformed to interactive mathematical web pages using the Mathox Player. Although MathDox can be used as an interactive information source for any topic, it is tailored for material containing interactive mathematics. But even if the interactivity that the MathDox Player offers is ignored, the MathDox tools still allow for easy publishing of scientific documents or papers on the web. Any MathDox document will benefit from the ease with which mathematical formulae can be rendered in web browsers, but MathDox really shows its potential where it concerns demonstrating the workings of an algorithm, testing readers' skills with exercises or explaining new concepts with dynamic, on-screen, calculations. Interactivity offers the reader of the MathDox document the possibility to test and experience the document.

MathDox uses OpenMath for semantic representation of mathematics and allows the use of programming constructs and web-services to their interactive potential.

The MathDox Player is freely available under the LGPL license. The software packages that are used by the MathDox Player are also available under an open source license. The MathDox Player can be downloaded at mathdox.org [8].

- Manual and tutorial [8] in MathDox itself.
- JEM page on MathDox [9]

Pointers to editing software

Editing tools and conversion tools from legacy formats can make all the difference when one decides to move over to a markup format for mathematical documents. The JEM portal devotes an entire section of the wiki to editing sofwtare, http://www.jem-thematic.net/en/node/232 [10], and also a few software description pages, http://www.jem-thematic.net/view/software [11]. Here below we just make a selection that concentrates on tools specifically geared towards markup.

The **MathDox formula editor** is a web-based editor for mathematical formulas that produces an OpenMath representation of the formula and can be easily integrated into existing HTML pages since it is written in javascript. It is intended for usage in interactive pages where users are required to answer. See more on JEM pages [12] and on distribution page [13].

Another OpenMath/MathML editor intended for web applications, and developed as a java applet, is available from Maths for More, it is called **WIRIS OpenMath tools [14]**. For OpenMath advanced users, the applet can be configured to create new symbols, associate one or several graphical representations to it and, finally, use the new symbols through a toolbar in the editor. WIRIS Editor can be tested at http://www.wiris.com/demo/omeditor [15].

The java editor **jEditOQMath** is also available for supporting the creation, editing and to some extent, the management of collections of OMDoc documents for use in the ActiveMath learning environment by XML-editing, validation, and template-supported creation of OQMath documents. Built-in scripts simplify the publication on the ActiveMath server and the input of mathematical formulae by on-the-fly by using the QMath converter from a common and easy to read syntax to OpenMath. Entering mathematics is as simple as writing expressions such as `$3a+5b$` or `$Hn = set(x | x ∈ Rn ∧ π(n,x) > 0)$` that are converted during the build-scripts-run to OpenMath. See the developer snapshot from jEditOQMath's home page [16].

LaTeXML would be the choice for those authors already familiar with LaTeX, the widely used typesetting system for mathematics. The goals of LaTeXML are a faithful emulation of TeX's behaviou, extensibility by packages, preservation of both semantic and presentation cues, abstract LaTeX-like, extensible, document type and possibility to support the semantics of mathematical content by good Presentation MathML, and eventually Content MathML and OpenMath. See more on the JEM page [17] and in the presentation Why TeX and LaTeXML? [18].
Similarly, **sTeX: Semantically Enhanced TeX** provides specialized macro packages, to authors wishing to add semantic information to the document without changing the visual appearance. The information in the semantically pre-loaded sTeX source allows automatic conversion to content-oriented, XML-based formats, like CNX, C-MathML, OMDoc, Dublin-Core, and PhysML via the LaTeXML Transformer, de facto creating an XML production workflow. Using this process on own legacy documents will involve to some extent the creation of new “LaTeXML bindings”, i.e. directives to the LaTeXML emitter that specify the target representation in XML. See more on the JEM page [19] and the case study [20] in which the learning material was generated using sTeX.

Conclusion

During the last few JEM meeting, few partners have presented eLearning solutions which are possible only by the choice of a rich formalism for storing and expressing the mathematics used in the materials. They have shown how the choice of semantic markup can support accessibility, aural rendering, customized notation, flexible elisions, and run-time interactivity.

Producing this type of eContent is not yet as easy as one would like it to be however steps forward have been made and few success stories are described in this online tutorial. As the adoption of the technology grows, we can expect that the tools will also improve and that more and more benefits will become apparent in time.

deliverable

Links:
[1] http://www.activemath.org/projects/OQMathJEditPlugin/manual.html
[2] http://eds.activemath.org/?q=en/tasks
[3] http://eds.activemath.org/en/handbook/intro
[4] http://eds.activemath.org/?q=en/blog
[5] http://cnx.org/content/col10151/1.17
[6] http://cnx.org/content/m10884/latest/
[7] http://cnx.org/lenses/cnxorg/documentation/
[8] http://mathdox.org/player/
[9] http://www.jem-thematic.net/en/node/204
[10] http://www.jem-thematic.net/en/node/232
[11] http://www.jem-thematic.net/view/software
[12] http://www.jem-thematic.net/en/node/331
[13] http://mathdox.org/formulaeditor/
[14] http://www.jem-thematic.net/en/node/829
[15] http://www.wiris.com/demo/omeditor
[16] http://www.activemath.org/projects/jEditOQMath/
[17] http://www.jem-thematic.net/en/node/244
[18] http://www.jem-thematic.net/en/node/192
[19] http://www.jem-thematic.net/en/node/233
[20] http://www.jem-thematic.net/