netGeometry: blending and modularizing two 400-level geometry courses for distance education. **Final Report**

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1 Introduction

The netGeometry effort is centered in the *Strategic Plan of the University of Illinois*[1], Goal V "Access to the Illinois Experience": Initiatives bullet to "increase and excel in distance learning." Goal V: Progress Indicators bullet, to increase the "number of distance learning IUs".

The two upper class college geometry courses [2] were restructured and adapted for online and distance education [3]. Both are mature courses in the curriculum of the Mathematics Department, and are taught each semester by up to 6 different faculty per year. They are designed for future teachers in high school and community colleges, but are popular with students across the campus, especially those taking a math minor. They may also be taken for graduate credit, in particular for a master's degree.

As the demand for qualified math and science teachers with advanced degrees and training increases, there is an increasing demand for opportunities to study advanced mathematics with an *extramural setting*: online and remote from the traditional college campus. At the same time, market forces and economic stringency at the University, make it imperative that these courses be offered in a blended format, so as to reduce the administrative burden on the research faculty asked to teach them.

For these two reasons the PI embarked on a multiyear effort to blend[4] and modularize[5] the courses first. Later, when methods and techniques have been experimentally

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[1] http://strategicplan.illinois.edu/planning_framework.html

[2] *Modern Euclidean Geometry* http://new.math.uiuc.edu/math403 and *Post-Euclidean Geometry* http://new.math.uiuc.edu/math402

[3] The original PITA proposal with post-project annotation is at http://new.math.uiuc.edu/netgeom.pdf

[4] The goal of *blending* is to put all course content online; the students interact with the instructor online and in class; homework, term papers, quizzes, tests and anonymous student polls are online; grading, computer labs and problems sessions are handled by TAs.

[5] The goal of *modularizing* is to enable the instructor to choose 3 from at least 6 modules, each equivalent to 1 of the 3 credit hours of the course.

confirmed or rejected in the blended course, the extramural course can be taught asynchronously[6] and in an economically sustainable level of support.

Geometry requires proofs and accurate figures. To teach these skills online, and devise ways for student graders to evaluate student progress, constitutes the challenge this PI has taken upon himself. He is grateful to the Chancellor's Office for supporting a 25% FTE graduate RA for the 2nd of the 3 years of this project has been underway. He is grateful to Debra Woods, director of Netmath program for suggesting the project in the first place and supporting another 25% of the same RA.

2   Results

During the PITA year, the blended courses differed from the extramural version only in the 3 weekly class meetings for the former. Their absence for the extramural students was compensated by 20/7 email contact with the instructor and (rarely) by real-time interactive electronic sessions.[7]

A blended section of MA403 was taught FA09 (33 students finishing) and FA10 (33). Extramural sections were taught FA09 (3 finishing), SP10 (1), SU10 (5), and FA10 (1). All course materials were online from the beginning, but continually revised and augmented as exprience required. Students wrote email or posted questions and answers were posted online and answered in class. Difficult passages were pre-emptively reviewed in the two weekly lectures.[8] Construction with the traditional geometry tool[9], quizzes and problem solutions occupied the Friday lab. Anonymous, 33 question student course evaluations were collected.[10]

Both blended (29 students) and extramural (2) editions of *Post-Euclidean Geometry* (MA402) were taught SP10. In contrast to FA09, the lessons and exercises were composed in "real time", that is, as part of the customary class preparation of the instructor. This was made possible a vastly more efficient authoring system[11] than the *AsciiDoc* tools we used previously. In addition, the author of the geometry construction software that the students purchase with their textbooks, custom modified it for my purposes.[12]

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[6]The remote student completes one module at a time until 3 or 4 credits accumulate.

[7]The six scheduled and recorded *Elluminate* sessions (SU 2010) were technically unsatisfactory and poorly attended.

[8]The F09 blended section was observed weekly by a member of the Curriculum and Instruction faculty, and Prof. Gonzalez's careful description and evaluation is attached as an appendix.

[9]Ilya Baran's freeware drawing tool, KSEG, has proved invaluable in my geometry courses for nearly two decades. Unfortunately, licensed proprietary components prevented us from integrating KSEG properly into the website.

[10]On the class websites, `/answers403.pdf` and `/answers402.pdf` respectively.

[11]Jared Schaber and Brent Nelson adapted their *Pudding* system (as "the proof is in the ...") for for composing MathML/HTML files in LaTeX code.

[12]Prof. Michael Hvidsten of Gustavus Adolphus College implemented 6 additional models for Euclidean and non-Euclidean geometries into his *Geometry Explorer* (GEX2.0) package.

A total of 143 webpages were published for the two courses (ca 70 pp each), ranging from 1-6 pages each, depending on context: lessons, homework, labs, tests, solutions, and indices. The online tools developed *de novo* by the RA, Michael Sommers, and others,use JavaScript, PHP, and HTML/CSS and are extensively used in both blended and extramural settings. Students in other of the PI's courses also used them extensively. A variety of other, only modestly successful experiments with *Camtasia, Elluminate, MySQL*, videotape, etc were conducted, evaluated and reviewed elsewhere. [13]

- **texWins** is a WYSIWYG browser GUI for students to create illustrated LaTeX documents on a genuine MiKTeX typesetter located on a remote server.

- **texPad** is a JavaScript/MathML application[14] students use to practice LaTeX offline.

- **QAint** is a "Question and Answer Interactive" Apache access controlled web tool for the instructor to write and responds to inline questions in lessons, quizzes, and progress assessment questionnaires written in *the Pudding.*

3 The Future

While the goals of the blended version of the 2 courses were largely achieved, we have some way to go to reach the appropriate clientele on the extramural side. While student attrition in the blended versions was less than the non-blended (10 vs. 20%), the extramural sections lost half of the initially registered. This was for lack of student time and mismatched expectations on the work required. The "yield" of inquiries to enrollment was also disappointing and suggests the need for better advertising and screening. The time and effort overrun (over 100% FA09) should have been expected. Obviously, future grant proposals by netGeometry will include specialists in recruiting and screening the extramural cohort.

Begun in the last month of the PITA grant, and now privately supported, QAint is the beginning of an integrated webbased system, modeled after the classical PLATO concept, which combines all the features needed for netGeometry: accurate constructions, proper mathematical notation, pedagogy conducive to writing and testing proofs, all under one roof.[15]

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[13]`http://new.math.uiuc.edu/netgeometry` in preparation.

[14]Coauthored by my former REU Abdulmajed Dakkak, now at Wolfram Research.

[15]We considered, pre-tested and rejected several extant *Class Management Systems*, none of which were even remotely satisfactory. We used some features of the Netmath CMS, *Classcomm*, such as the announcements, message board and online homework submission system.