

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

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1 Executive Summary

NetGeometry is a project to prepare two upper level college geometry courses to be offered in *NetMath*. As such it 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”.

NetMath² is a distance learning program that offers online math courses for college credit. The Mathematics Department of the University of Illinois at Urbana has a fifteen-year history of offering high quality but popular online courses. With the support of the NSF the online pedagogy for these courses was developed and is sustained within extant campus tuition models.

As public education becomes more and more desperate for highly qualified teachers, there is an increasing demand for online degree programs, certification programs, and CPDU³ courses in mathematics. The courses are also taken to obtain a math minor by students in many areas. For in-service teachers, an online format of these course will be suitable for credit toward an MA.

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

²<http://netmath.uiuc.edu>

³Continuing Professional Development Units

2 Introduction

Currently, one section of MA403⁴ and two sections of MA402⁵ are taught each semester. Either course satisfies a requirement for the BA in Secondary Mathematics Education, and the majority of students taking these courses are math majors in this LAS program. The program is very tight and students, especially those transferring from community colleges, have difficulty fitting all course work into 4 years. They must spend a semester off-campus student-teaching. They also hold summer jobs in their home communities. During this time it makes sense for them to take courses on the internet.

Initially, they will be taught synchronously with a *blended*⁶ version of the standard 3 credit hour course using LON-CAPA, an open source *Learning Management System* (LMS) from MSU. Illinois is part of the governing nodes. The ultimate goal is to *modularize*⁷ the courses to permit a variety of approaches to the standard topics. This will permit us to create courses composed of modules uniquely available at Illinois, to be offered in the emerging CIC *CourseShare*⁸ program. Once in this form, we expect netGeometry to be of interest to students at other institutions, stateside and across the English speaking world.

Although both traditional courses have standard syllabi, the instructors are members of the regular faculty (not TAs) who have considerable leeway in developing approaches to the prescribed topics. The modularization will permit instructors to individualize their net-based courses as well as their blended in-house courses.

In order to compete with peer research math departments, we have reduced the number of courses per year for the most productive faculty. Blending will shorten the number of lectures per week, and modularizing will make it easier to staff these demanding courses in the future, as the pool of available faculty able to teach them decreases.

⁴“Advanced Topics in Euclidean Geometry”, <http://new.math.uiuc.edu/math403>

⁵“NonEuclidean Geometry”, <http://new.math.uiuc.edu/math402>

⁶All course content is available online. Students study this and submit questions in advance of tutorial or lab sessions. Homework is submitted, graded and returned on line.

⁷Encapsulate each course into 3 modules equivalent to 5-weeks of instruction, and offered for 1 credit hour each.

⁸<http://www.cic.net/Home/Projects/SharedCourses.aspx>

In trial year (FA09,SP10,SU10) of netGeometry this target population was not effectively reached.

LON-CAPA was rejected in favor of Classcomm before trial year started.

Modularization was achieved, but was disallowed by Banner for extramural courses.

No contact with CIC was attempted during trial year.

Course webpages were made available to other instructors for MA403 and MA402 in trial year.

In trial blended sections, Fridays were used for quizzes, labs, problem sessions. But student preferred 3 meetings per week.

Annotation continued 19nov10.

3 Schedule and Progress

3.1 netMA403: Transformational Geometry

The catalog name differs and is misleading.

- This course consists of 3 parts:(1) Affine geometry treating the theorems of Ceva, Menelaus, Desargues, Pappus, Euler and Feuerbach, (2) the theory and practice (by hand and computer) of linear perspective as an introduction to projective geometry, and (3) a complete treatment, for the 2-dimensional Euclidean plane, of Felix Klein's *Erlangen Programm* to develop geometries in terms of their isometry groups.
- Will continue to use the traditional textbook.⁹ However, Prof. Tondeur has given me permission to revise and update his textbook, and in due time publish a new edition with him.
- Will continue to use the open source interactive geometry drawing package KSEG¹⁰ from MIT.
- KSEG will be integrated with the online courseware, which is written in the text based (TeX) document generation software, *asciidoc*¹¹
- A first draft of 67% of the lecture notes¹² was prepared by my assistant, Michael Sommers, and is ready for proofreading and revisions.
- To be written this summer is the module on drawing in linear perspective based on projective geometry. I have used perspective drawing by hand (ruler and compass) and machine (KSEG) as bridge between Euclidean and projective geometry. This section will be particularly challenging to implement in NetMath. As far as I know, MA403 is the only standard college geometry course in the US¹³ that teaches linear perspective. Hence this is another module suitable for the CIC CourseShare program.
- As in the regular MA403, students in netMA403 will submit homework in a grammatically complete long form, with diagrams and illustrations. Selected expositions will be corrected and returned for revision.
- The substantial semester project, with fully literate, term-paper quality documentation and composed in LaTeX, will be required in the blended as well as in the NetMath version.

Book project not begun yet. Should become an e-book project.

Inability to recompile this open source app precludes its integration into extant class management system.

All class materials are now complete and continually revised as needed.

Delayed but completed fall 09 and used successfully also in extramural sections.

Online submissions could not be efficiently corrected in Acrobat 9. Reverted to printed submissions and hand corrections.

This was required only for the 4 credit option available for all 400 level math courses. But no students opted for the 4th credit.

The texWins client-server app was finished by Aug09, server issues resolved by SP10, available to all with UI netid since SU10.

⁹Ph. Tondeur "Vectors and Transformations", Publish or Perish, 1993.

¹⁰<http://www.mit.edu/~ibaran/kseg.html>

¹¹<http://methods.co.nz/asciidoc>

¹²<http://new.math.uiuc.edu/illmath/dbrisson9/403/web/>

¹³On the web, there is such a course taught in the Czech Republic.

- This writing component will eventually become a module on writing mathematical documentation in LaTeX. It is hoped that it will eventually qualify for an Advanced Composition credit¹⁴
- With support this summer, we can have netMA403 ready this fall, when I am scheduled to teach a regular section of MA403. This will enable us to synchronize the online with the oncampus courses this fall.

Done on time.

3.2 netMA402: Post-Euclidean Geometry

- The course treats non-Euclidean plane geometry from an axiomatic, analytic and experimental viewpoint. It also has 3 parts: (1) the history of geometry from Euclid's elements to Gauss, Lobachevsky and Bolyai, leading to the proof of the consistency of Euclidean and non-Euclidean geometry, (2) using the complex number system to show that the isometries are groups of Möbius transformations, and (3) investigating these very strange and counter-intuitive geometrical ideas with the help of an excellent computer based construction tool.
- The current Hvidsten text¹⁵ will continue to be used.
- The text comes with the software package, GEX. I am in contact with Hvidsten (its author) about adding some new geometrical features to GEX which I want to use.
- With these new features, developed last year by John Pacey (a student in my REU program), netMA402 becomes unique, and thus suitable for the CIC CourseShare program.
- The earliest netMA402 could be ready is Spring 2010, if I have assistance for steady development during the fall semester.

Done!

Done! Prof. Hvidsten kindly implemented the requested new features in his GEX 2.0. Class use SP10 successful.

Not attempted yet.

4 Qualifications of Project Staff

- George Francis has a long career of teaching and research, with degrees from Notre Dame (BS 1958), Harvard (AM 1960), Michigan (PhD 1967). He pi-

¹⁴Currently, there is only one math course, MA348, which carries the Advanced Composition credit. I have taught this course several years now, and see no reason the geometry courses should not be similarly structured. LaTeX tutorials and templates have been used successfully for several years.

¹⁵M. Hvidsten, Geometry with Geometry Explorer, McGraw Hill, 2005

oneered mathematical visualization in immersive virtual environments¹⁶ and was awarded an AMOCO campus award (1994) for excellence in undergraduate teaching, chiefly for integrating computer graphics into math courses. Most relevant to the netGeometry project, he introduced fully integrated and fully interactive computer labs in almost all course he has taught since the advent of personal computers. His students create real-time interactive computer animations¹⁷ elaborated with literate documentation¹⁸ in the LaTeX mathematics typesetting system.

- Debra Woods has been director of the NetMath program at Illinois since 1994. She took the NetMath program from a grant-funded program to a self-supporting program. Prior to coming to Illinois, she received degrees from UCLA (AB 1980) and USC (MS 1984). Her work experience includes 25 years of teaching and six years in the aerospace industry as a systems analyst.
- Michael Sommers is a graduate student in the Mathematics Department. He has graded the homework assignments for Francis's MA403 and MA402 for many years. He assisted Francis in designing and grading the examinations. He has extensive experience with networking, C/C++, Mathematica, and TeX.

Sommers is no longer a graduate student in math.

Now also with PHP, Javascript, CSS, and MySQL

5 Evaluation and Evolutionary Revision

- Tests will be the same for MA403 and netMA403
- Will enlist Prof. Sharon Tettegah, Dept. Curr.and Instr., EdSchool, UIUC to develop a rigorous schema for evaluation.

While the homework, quizzes and test were identical, grading standards had to be adjusted for the extramural students who do not have the discipline or preparation of the UI students. Instead, Prof. Gloriana Gonzalez, C&I, visited the class weekly and submitted a written evaluation.

6 Budget

- 25% TA for 2 semesters (\$8910)
- 200 hours of undergraduate tech support (\$10/hour)
- Travel of 1 faculty and 1 TA to conference about the course management system LON-CAPA (\$910).
- Total \$11,820

The budget had to be significantly changed. The actual cost, not counting faculty time and effort, was double the budget.

¹⁶<http://www.beckman.illinois.edu/news/features/112807>

¹⁷The tools range from open-source geometry construction packages to C/C++ programs with OpenGL.

¹⁸Extended homework, reports, essays, and term papers

7 Specific Explanation of how the PITA will be leveraged to secure or compete for external support

Once established, further funding for maintenance and growth of the program is anticipated from tuition income from the online courses. This is expected to increase as these courses are incorporated with others to create online degree and certificate programs. The current NetMath courses have already established that this model works for self-supporting online programs.

Tuition income had to be applied already, even before the end of the developmental period and experimentation. Private funds (UIF) had to be obtained and invested in the project.

8 Recap

We conclude by reiterating specific contributions of the netGeometry project to the Strategic Plan of the University of Illinois. It ...

- Brings us one step closer to offering an online Masters Program in Teaching Math (this is specifically mentioned in Goal II of the Strategic Plan).
- Gives on-campus and off-campus students better access to these courses, thus allowing for a more diverse student group (mentioned in Goal IV).
- Successful completion of these courses will make an online minor in math possible, and will allow for the creation of other online degree programs (Goal V).
- Increases online course offerings for the department, thereby increasing access to the Illinois experience (Goal V).
- Increases undergraduate student engagement with faculty through learning assessment and feedback systems, leading to academic excellence (Goal II).
- Puts a framework in place for other instructors to teach these courses using the current set up (Goal IV).
- Helps faculty learn to teach with technology (Goal IV).