

FIVE POINTED STARS AND ESCHER'S REPTILE DRAWINGS THROUGH COURSE MANAGEMENT SYSTEM WITH SKETCHPAD

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Introduction

Over the course of several years, I have developed a college geometry course for pre-service teachers, comprised of two components: exploration of geometry concepts with the dynamic geometry software Sketchpad [Jackiw, 2006] and a students' group project that has both a written and oral requirement. Recently I began using the online course management system, Oncourse [Oncourse, 2009], to post syllabus, announcements, solutions to problems and exams, sketches, and updated students' grades. Students found the Tool Box, one of the collaborative instruments in Oncourse, of particular value for storing and sharing versions and parts of their projects with me and each other.

It is well supported in literature that the use of Sketchpad helps students focus on the relevant aspects of a problem, distinguish between drawings and constructions, and develop and reason about conjectures on the basis of generalization of patterns [Sher, 2002]. Sketchpad facilitates the making and testing of conjectures and impacts students' awareness of the intuitive, visual aspects of geometric situations. Users continually show appreciation for experiencing "the satisfaction of building, animating, and investigating geometric objects" [Devaney, 1992] on their computer screens.

The group project component of the course is central to the course. It allows students to gain new skills not only through exposure to new proofs and constructions, but also through presenting it to new audiences. The group of students that worked on Escher's reptile drawing, in addition to presenting their project to the peers, also presented it at the 16th ICTCM and at the Indiana MAA meeting. Projects are student-driven and have the potential for solving relevant real-life problems (defining characteristics for project-based learning, as pointed out by Thomas, 2000 and Cranel, et al., 2004).

Five Pointed Stars

The first project that illustrates several features of project-based learning was done by a group of four students. Golden ratio and regular pentagons are often a source of fascination for students and indeed they were motivation for this group. One of the students wrote, "I had watched my father, as he put the finishing touches (always five-pointed stars) on carved wooden banners he made for boats. ... There is something anthropomorphic about a five pointed star, however, that makes people notice any flaw

or irregularity. ... We lived with a guilt of knowing we were advertising something precious (boat names) with stars that never looked quite right."

Such a strong motivation leads to students' willingness to struggle through proofs and constructions. Students used Microsoft Word Equation Editor to type portions of proofs. They explained how the construction of the golden ratio connects to different constructions of a regular pentagon and the golden spiral. All constructions were done with Sketchpad, and effectively used the multiple tabs format to show the progression of constructions. Figure 1 represents parts of students work related to the golden spiral and regular pentagon.

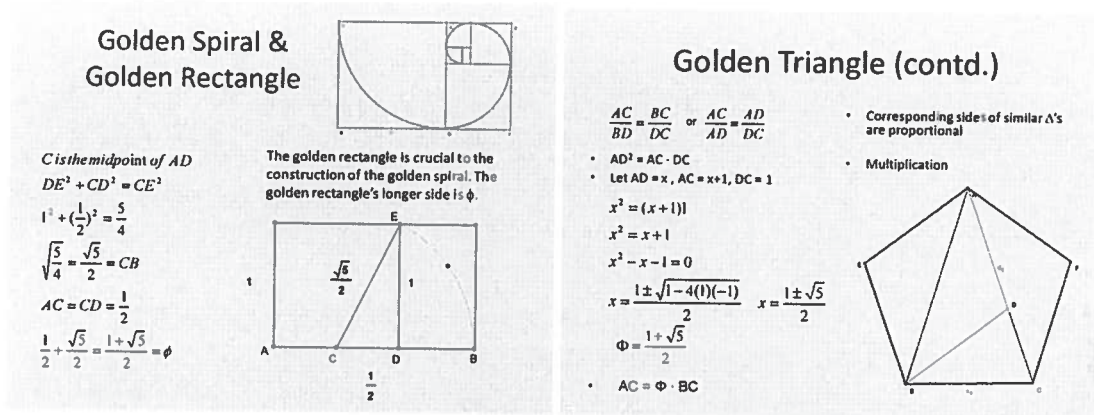


Figure 1: Key steps in constructions of a pentagon and golden spiral

Throughout the semester, the instructor used several features of Oncourse. The syllabus was posted, followed by regular announcements, and updated homework. Hints for the proofs that student needed help with were posted in Resources. Take-home parts of exams, all Sketchpad, PDF, and Microsoft Word files intended to share with the whole class were also kept in the Resources folder (see Figure 2). All clarifications needed for topics in the six chapters that we covered in the textbook [Reynolds, B. and Fenton, W. , 2006] were also included there. Files that students wanted to keep private (for example their exams files and chapter homework) were kept in their respective Drop Boxes (see Figure 3). Students could also give each other access to parts of their Drop Boxes or could make files available to the whole class in Resources. Thus, this feature further promoted collaborative learning, which was one of the goals of the class and the group project.

Escher's Reptile Drawing

The project about the use of regular tessellations of the plane in recreating one of Escher's drawings was done by a group of students in the same class several years ago. The project was successful because the group worked together seamlessly, integrating their mathematical, computer, and artistic skills. They explained why only three types of regular polygons tessellate the plane and which types of tessellations and transformations can be found in Escher's works. They recreated Escher's drawing (Figure 4)

appropriately using necessary transformations. They also created a very effective Microsoft Word Power Point presentation that animated Sketchpad constructions. They presented their project, not only to their peers, but to a wider audience at the Indiana MAA meeting and at the 16th ICTCM.

A PDF version of the student Indiana MAA Meeting presentation can be found at <http://www.iun.edu/~mathvk/Chicago04.htm>

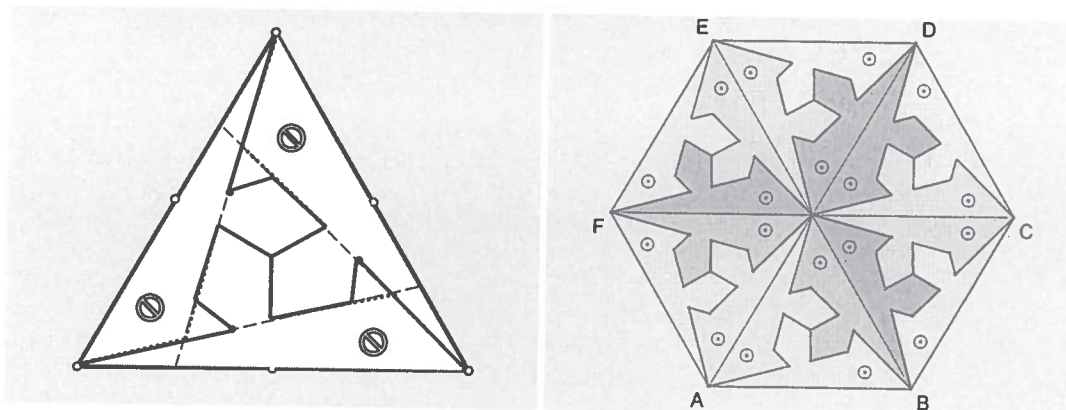


Figure 4: Reconstruction of Escher's reptile drawing

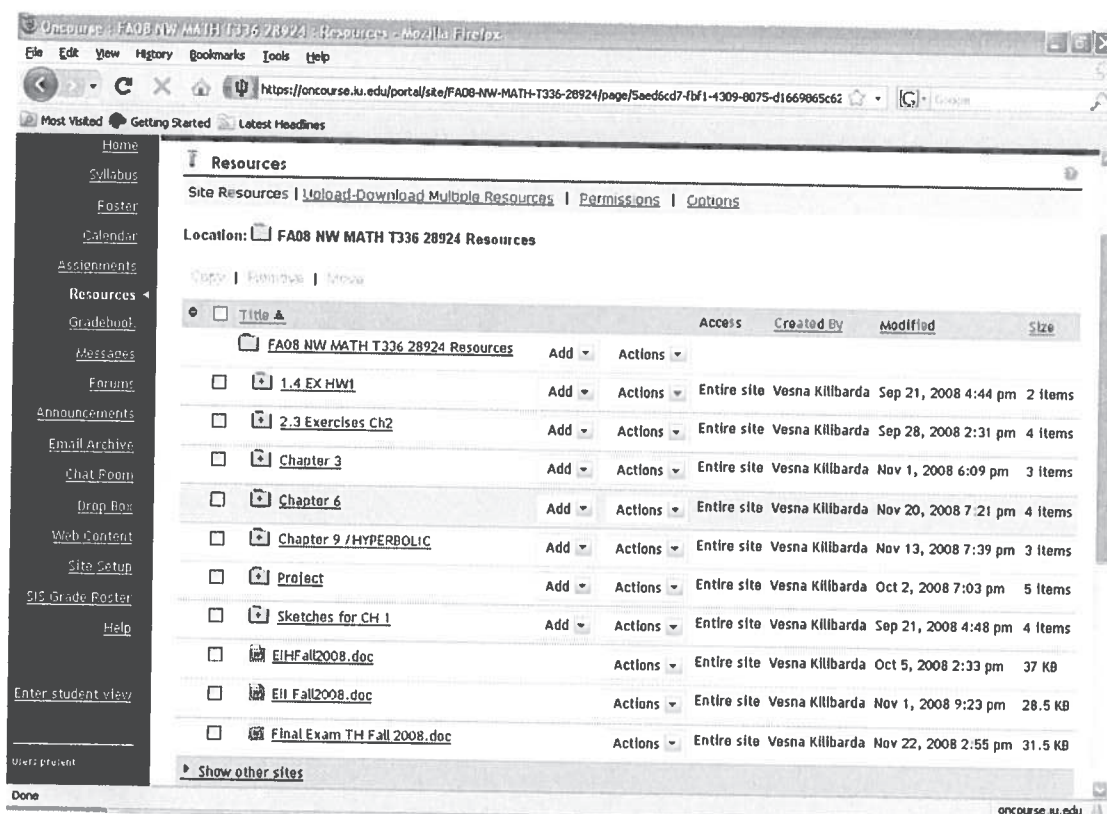


Figure 2: Picture of Resources in Oncourse

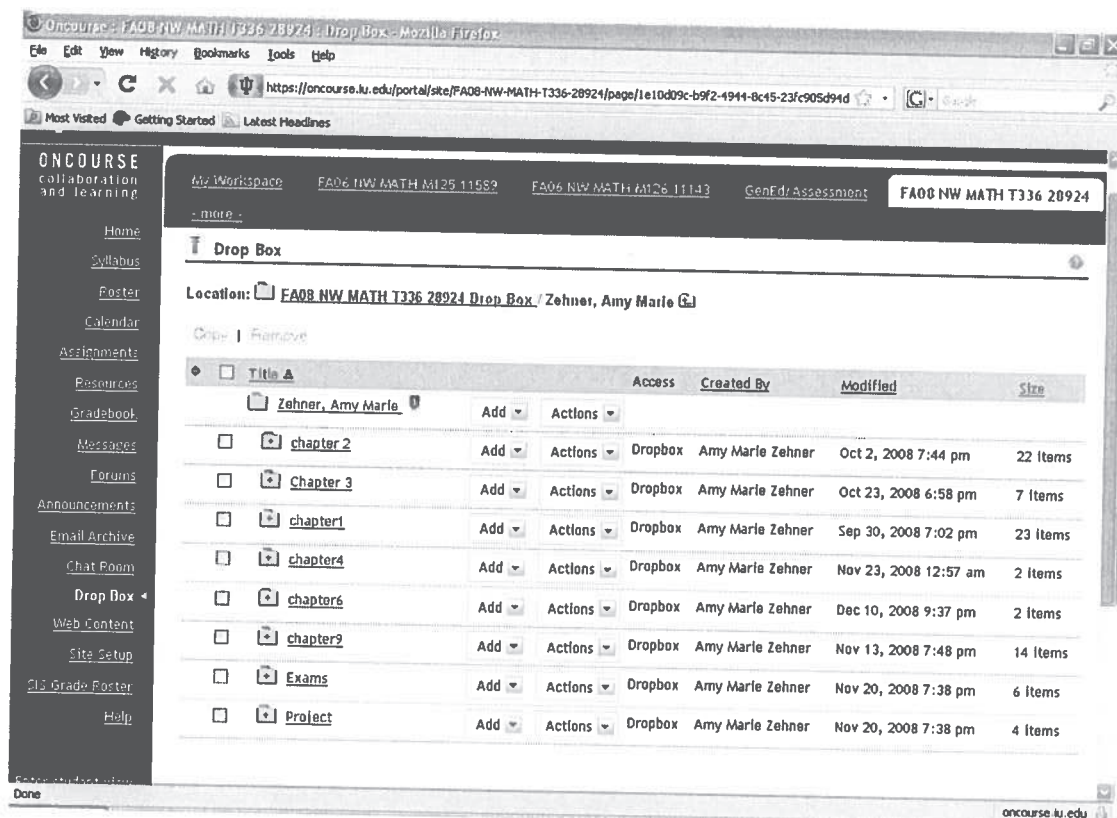


Figure 3: Picture of a student's Drop Box in Oncourse

Conclusion

The presented projects provide further evidence that Sketchpad investigations promote the use of inductive reasoning and cooperative learning, and make it easier to connect geometry to art, architecture, and other disciplines. Students take pride in their work and value the experience. Their projects become opportunities to showcase their work and are parts of their student and professional portfolios. Course management system allows students and instructors to be better organized and collaborate easier.

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