# SAGE, Algebra, and UTMOST

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Sage Edu Days 5
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# Whitman College

Whitman College is a liberal arts school in Walla Walla with about 1500 students.

Our department teaches about 400 students per semester, with about 10 math majors per year (though this has spiked in the last few years)

## Math 385-6

Abstract Algebra is a year-long sequence, offered every other year.

Majors are required to take (among other courses) two of Algebra 1 & 2 and Analysis 1 & 2, though many students are encouraged to take at least three of these.

Students come into Algebra having had three semesters of Calculus, a Proofs course, and usually either DE or Linear Algebra.

## From the Catalog

*The first semester is an introduction to groups and rings, including subgroups and quotient groups, homomorphisms and isomorphisms, subrings and ideals. Topics for the second semester may include fields, simple groups, Sylow theorems, Galois theory, and modules. Prerequisite: Mathematics 260.*

## Algebra 2012-13

The Fall Class enrolled 26 students (10 seniors, 15 juniors, one sophomore). All but two are math majors.

The Spring Class enrolled 19 students (6/12/1).

## Fall 2012

In the first semester, we worked through Judson's online Algebra book (Chapters 1-6, 9-11, 13, 16-18).
We worked through approximately one chapter per week.
Student responsibilities were

- 7-9 homework exercises per week
- One SAGE assignment per chapter
- Biweekly quizzes (in class and take-home portions)
- Midterm (with oral component) and Comprehensive Final

Class met twice a week for 80 minutes (with copious office hours).

# Spring 2013

In the spring, we split our time between Galois Theory and advanced Group Theory Topics.

We did the first 14 chapters out of Ian Stewart's Galois Theory Text (before Spring Break)

We did Chapters 14 and 15 out of Judson (with SAGE assignments), as well as some topics on group classifications and simple groups.

We also spent a week on symmetry and art (with field trip) and a week of student project presentations.

## Class Atmosphere

Both semesters featured a highly collaborative atmosphere among the students. Students often worked on homework in groups and completed SAGE assignments in pairs.

Class time was largely interactive lecture, but with ample opportunity for student exploration and exercises (construction of $D_8$, explorations of roots of unity, using Sylow to classify simple groups, creations of frieze patterns, etc.)

# Reaction to the Open Source Book

Reaction to the text was generally very favorable. Whitman has a tradition of open-source books, and students have used these in their proofs course and, in many cases, in their calculus course.

The book nicely complemented the pace of the class, and was modular in nature to allow for selection of topics in the first semester and for projects in the second semester.

## Reaction to SAGE

Reaction to SAGE in the Fall was mixed to negative among students. Common complaints were about lack of help documentation, and feeling hamstrung within worksheets without a 'global' acumen to rely on.

Student 'frustration' such as it was was inversely proportional to past programming experience.

Some of the better students were able to blend LaTeX and SAGE with no issues.

At least a couple of students wrote off the 5% of their grade from SAGE.

## SAGE beyond

Though SAGE wasn't as explicitly integrated in the Spring semester, students still found it useful in terms of computing roots of polynomials and examining structures of larger groups.

One senior used SAGE in her Senior Project to investigate Pythagorean Triples and angle trisectability.

## Improving the Experience

Some of the 'global' acumen comes through the first two chapters, most of which were covered in their proofs course. I could do more work in terms of 'slowing down' these chapters.

The course could (should) meet for a full four hours per week, with at least half of one day each week devoted to SAGE.

# Further Integration of SAGE

There are many avenues for incorporating SAGE throughout our math curriculum.

- SAGE and WebWork in the Calculus Sequence
- Calculus Laboratory (replacing Maple with SAGE, and keeping LaTeX)
- Other upper level opportunities (Combinatorics and Graph Theory, Mathematical Modeling, Operations Research).