

Course-based Undergraduate Research Experiences: Two Examples

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Mathematics at Illinois State University (ISU)

- Located in Normal, IL (2 hours south of Chicago)
- First public university in the state of Illinois (founded in 1857)
- Enrollment: 21,000 students. Largest freshman class in 33 years!
- 370 undergraduate Math Majors: Mathematics, Statistics, Math Education, Actuarial Science.
- 80 Masters students: Mathematics, Applied Statistics, Education, Actuarial Science, and BioMathematics.
- 16 Ph.D. students: Mathematics Education
- Integrated Masters Program
- [Visit our homepage](#)

Undergraduate Research in Mathematics

- Designed to give math majors an opportunity to do research.
- Journey: find patterns, make conjectures, examples, prove/disprove your conjectures, revise conjectures, generalize results.
- Be prepared to be stuck at every stage; that is our steady state!
- read the literature: papers published in journals!
- An exciting opportunity for students.
- Builds vertical integration in a department

Course structure

- MAT 268 - Introduction to Undergraduate Research in Mathematics
- 3-credit hour course
- Meets twice a week (75 minutes each)
- Prerequisite: MATH 146 (Calculus II)
- Can be used as a mathematics elective for math and education majors
- [My course webpage, Spring 2011](#)

History of MAT 268

- We have been offering this since 2007
- My colleague Saad El-Zanati started this course
- We offer it only in the Spring semester.
- Try to alternate between people in algebra and discrete mathematics groups who teach this course.
- I taught this twice (Spring 2011 and Spring 2018)

Registration for MAT 268

- Every year in the Fall semester (before registration) we advertise this course to our juniors.
- The instructor teaching this course will make a flyer which is distributed
- Undergraduate director, academic advisors and math instructors encourage our strong students to sign up for this class. (Our local Putnam toppers often end up taking this course)
- Registration is closed: Interested students talk to professor who will be teaching the course. Instructor will determine eligibility.
- Average enrollment: 12 students.

Organization of the class

- First few weeks (out of 16 weeks) are spent in bringing students up to speed: learning some background material.
- Instructor assigns problems to students that are designed for students in this class.
- Students work in small groups; typically about 3 groups of size 4 each.
- These students are urged to attend seminars in the department: algebra seminar, discrete mathematics seminar and undergraduate mathematics colloquium.

Sample research problems

1. Find all values of n for which 1's in the multiplication table of \mathbb{Z}_n occur only on the diagonal.
2. Ask the same question for any ring: What about $\mathbb{Z}_n[x]$? or $\mathbb{Z}_n[x_1, \dots, x_n]$? (joint with Michael Myers in Math Magazine)
3. What about the group ring $\mathbb{F}_p C_p$? where p is a prime.
4. When is a subgroup of the additive group of a ring $(R, +)$ also an ideal $(R, +, \times)$? (joint with Christina Henry in Involve)
5. Characterize all ordered pair (m, n) of integers for which there is a lattice polygon P with m points in its interior and n points on its boundary.

Resources for students

- Algebra: M. Artin, Dummit and Foote
- Roots to Research: A vertical development of Mathematical Problems (Judith D. Sally and Paul J. Sally, Jr.)
- LaTeX: all students in this class are expected to learn and use LaTeX for writing their final paper
- SageMath software for computations (some use Maple or Mathematica)
- Math ArXiv and Mathscinet
- Encyclopedia of integer sequences

Evaluation

This is up to the instructor. Final grade is based on

- Participation in class
- A final paper : each student will focus on his/her own contribution in their paper.
- Final presentation (This is announced in the department and interested people are welcome to attend)
- Presentation in the University undergraduate research symposium.

No exams! and hence no grading 😊

Final words

- This is a fun course for both students and teachers.
- Strongly recommend this course for your program if you don't have one already.
- Summer REU programs ([ISU's REU Page](#))
- Graduate schools
- I would like to maintain an archive of undergraduate research problems. (There may be some already?)

Undergraduate Research Symposium



Spring 2017



Undergraduate Research Symposium, Spring 2011

Thank you!

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