

Future of Math in the City

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Managing Groups

- having student buy-in from all students is key
- expectations need to be clearly set, and instructor needs to step in when necessary
- discussions with each group during each class meeting time
- possibility of having group leaders?
- some students get frustrated more easily and this can be contagious; watch for the group dynamic

Sample Journal

Mon Aug 30, 2010

Today Gene Hanlon (in charge of recycling for the city of Lincoln) came and talked to our class about recycling in the city. He clarified a lot of questions I had looming in my head about how the process of recycling works in the city.

- I learned a lot about recycling in Lincoln including a lot of monetary aspects I hadn't previously known. I feel that his powerpoint handouts will be very useful throughout this semester.
- I need to skim through the slides again to see what (if any) data is directly related to the green project.
- Once again, all of this data made me feel a bit overwhelmed and I really need to sit down and figure out what steps need to be taken, I feel like I am already behind and we haven't really even started much work on our projects. Is everyone else feeling this way?

Assessment of student work

- most of the work is done in groups, how should individuals be assessed?
- the grade is a linear measure to assess nonlinear performance; what is more important: mathematical analysis or interpretation/communication of results?
- most of the credit is assigned to work on the project, but the grade for the final report provides only a portion of the grade; other components: participation during the semester (weekly updates and student journals), individual presentations, homework assignments

Assessment

Example Grade Breakdown:

- 20% Homeworks
- 30% Project participation (documented through student journals, communication with team and instructors, participation in the poster session)
- 35% Project (memos, intermediate drafts, final report)
- 15% Performance during oral presentation (understanding of the work, communication skills, quality of the slides)

Math in the City at Your Institution

Groundwork for the first course offering:

- Talk to your colleagues about offering the course in your Department
- Talk to your Chair and Undergraduate Chair about the course filling a need in the curriculum; Discuss department resources, support for the instructor, benefits to the student and the department.
- Start thinking about **hot topic** projects; read the local newspaper or news column
- Keep in touch with us!

Future projects

- analyze financial investments considering different financial factors using ordinary differential equations, linear programming, mathematical finance
- the travel salesman problem for deliveries to a grocery store (routing, travel salesman problem, graph theory)
- model electrical circuits (ordinary differential equations)
- biology models (ordinary differential equations and partial differential equations)

Challenges

From the instructor's point of view:

- finding a good project: what type of math problems would be suitable? what businesses to approach? what data is available?
- instructor needs to be able to adjust (at any time) the course of the project in case the data is insufficient or incompatible with the mathematical tools available; handle the case when no optimal solution can be found
- motivate students and keep them focused when a roadblock appears, or when they feel overwhelmed (especially during initial and final stages)
- Set high (but realistic) expectations and students will meet them; give the students the room to excel, trust their abilities

Challenges

- different backgrounds for the students
- scheduling time for lectures and meetings; possible approaches: work with each group for 15-20 minutes every lecture, or meet with every group once a week for a full hour.
- management of group work; need involvement of all students
- assess individual work

Challenges

From the student's point of view:

- tackling an open-ended problem where the approach is not clear (even to the instructors!)
- learning non-mathematical background necessary for the project
- need to effectively communicate with peers, instructors, and collaborators, both quantitatively and qualitatively
- teamwork is necessary; students depend on each other to complete their work, so they have to trust their teammates with the work that is being done (and graded)
- conflicts in their schedules (they have to meet to do the work)
- need to research mathematical and non-mathematical issues without a textbook

Benefits to the Department

- potential for interdisciplinary collaboration and interaction with other departments or research centers
- establish connections with possible future employers for students, find internship opportunities
- increase visibility of the Department on and off campus

Benefits to the Instructor

- Teaching MitC is personally very rewarding
- Math in the City is a flexible course to teach; data is like clay in the hands of the instructor, so the instructor can choose the mathematical tools and methodology with *the given data*
- The instructor can adjust for the pace of the course, the depth of the material
- Great CV point for tenure and promotion, grabs the attention of potential employers, of the reviewers for grant proposals

Benefits to the Students

Educational:

- students understand how to translate a complex real-life situation into a mathematical model
- develop better communication skills in writing and for oral presentations
 - hour-long presentation to wide audience during the last week of classes
 - written report
 - possible poster presentations (Nebraska Research Expo, UNL Undergraduate Research Fair)
- learn mathematical software: SPSS, SAS, Maple, Sage
- exposure to workplaces outside academia (they can show off and improve their “employable skills”)

Benefits to the Students

Personal:

- learn how to deal with setbacks, meeting deadlines for their project, how to work in groups, learn to take initiative
- increased self confidence and sense of achievement
- connect with possible employers in the city; find job or internship opportunities
- the course provides a non-standard experience that students will remember and tell to others (interviews)

Educational benefits

Failure to establish relevance is one of the worst ten mistakes in teaching, since students learn best when they clearly perceive the relevance of course content to their interests and career goals. The trust me approach to education (...) doesn't inspire students with a burning desire to learn, and those who do learn tend to be motivated only by grades. (Felder & Brent, The ten worst mistakes)

A growing body of academic research supports the use of **project-based learning** in schools as a way to engage students, cut absenteeism, boost cooperative learning skills, and improve test scores; using open-ended projects versus the traditional, direct instruction is far more beneficial. Those benefits are enhanced when technology is used in a meaningful way in the projects (Edutopia)

The P21 initiative of the 21st century skills:

The Partnership for 21st Century Skills is a national organization that advocates for 21st century readiness for every student. The group has identified key elements of 21st century learning that are critical for every child's success as a worker and citizen in the 21st century (www.p21.org). One of the concepts is that of Learning Skills, which acknowledges the need for students to think critically, analyze information, comprehend new ideas, communicate, collaborate, solve problems, and make decisions.

P21 skills:

- Critical thinking and systems thinking. Exercising sound reasoning in understanding and making complex choices, understanding the interconnections among systems.
- Problem identification, formulation and solution. Ability to frame, analyze and solve problems.
- Creativity and intellectual curiosity. Developing, implementing and communicating new ideas to others, staying open and responsive to new and diverse perspectives.

- Interpersonal and collaborative skills. Demonstrating teamwork and leadership; adapting to varied roles and responsibilities; working productively with others; exercising empathy; respecting diverse perspectives.
- Self-direction. Monitoring ones own understanding and learning needs, locating appropriate resources, transferring learning from one domain to another.
- Accountability and adaptability. Exercising personal responsibility and flexibility in personal, workplace and community contexts; setting and meeting high standards and goals for ones self and others; tolerating ambiguity.
- Social responsibility. Acting responsibly with the interests of the larger community in mind; demonstrating ethical behavior in personal, workplace and community contexts.

Student Feedback

- “How to value different raw data is one of the most important skills I learned. I also gained some skills to pick and choose goals that are reachable from goals that cannot be finished.”
- “No specific answer to the problems. Instead of like a normal textbook, you just open up the back to see if you got it right, in this course you have to decide if you think it is right or not.”
- “Liked using raw data to find what was useful in it to solve the problem”
- “Experience working with a group on a much larger project than what could be done by an individual. ”
- “It made you think. A lot.”

The students were challenged to work on difficult problems, but they enjoyed testing and developing their abilities:

- “I also liked the fact that we didnt know what we were capable of doing until we did it.”
- “Enjoyed a trial and error approach to problem solving by trying a method see if it would work and then trying another method if it didnt.”

Students also commented that they felt more involved in the Mathematics Department than with other classes (especially through their participation in the poster session).