Instructor Handbook

Math in the City

University of Nebraska-Lincoln

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Petronela Radu
Stephen Hartke
GTA: Michael Uhrig

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Contents

1 Introduction

This Instructor Handbook is designed as a guide to an instructor who would like to teach the Math in the City course at their institution. Math in the City was conceived and initially designed by Petronela Radu, who taught three pilot offerings during 2006–2008 at the University of Nebraska–Lincoln (UNL). Petronela Radu was awarded an Initiative for Teaching and Learning Excellence Award in 2006 by UNL based on Math in the City.

Petronela Radu and Stephen Hartke received a National Science Foundation Course, Curriculum, and Laboratory Instruction (CCLI) grant DUE-0941132) in 2010 to further develop the course and disseminate it to other schools. This handbook is part of the materials that we hope will be useful for other instructors as they prepare to offer Math in the City at their own institutions. It is based on Radu's experience teaching Math in the City from 2006–2008 and Radu and Hartke's co-taught course in fall 2010.

In the following sections, we describe the goals of Math in the City, how we structured the course, suggestions for projects, and guidelines about how we ran the course. Though we describe the specific offerings at UNL, we believe that this information is useful for anyone teaching the course. Comments indicating tips or special issues to think about are marked with a preceding ★.

2 General description

Math in the City is an interdisciplinary course in which students engage in a hands-on learning experience using mathematical modeling to understand current major societal issues of local and national interest. The course is run in collaboration with local businesses, research centers, and government organizations that provide data and act as consultants throughout the course thus creating strong connections between academia and industry, while engaging students in a learning and discovery process. This one-semester upper-level course is open to mathematics and non-mathematics majors at the sophomore level and above. Math in the City qualifies for students as a capstone course under the newly adopted UNL general education requirements ACE.

In many mathematics courses students have the most difficulty with the modeling part of the material, when trying to bridge the theoretical content with the applications. Students memorize and study formulas to solve given problems, but to many of them it is never clear how these concepts relate to applications. Math in the City gives students a hands-on experience that makes quantitative disciplines more approachable and that enhances their appreciation of the utility of mathematics. This motivates students to deepen and broaden their studies in STEM fields.

The main focus of the Math in the City course is on semester-long projects based on a real-world issue that attracts strong interest from both the community and the local collaborator. Teams of

3–5 students investigate the topics of the projects under the direction of the course instructor and guided by the business partners. The students use the data provided by the project collaborators to create a mathematical model, to analyze the model, and to interpret and communicate the results.

Learning outcomes for the students. Throughout the course students benefit from the experience in the following ways:

1. Students are able to address current issues through mathematical modeling; to gather and transform real quantitative information for use in the model; and to effectively use computer software to analyze the model and interpret the results.

2. Students deepen their understanding of how mathematics is used to understand current major societal issues and to inform policy decisions. The course provides a bridge between the "textbook" information learned in other courses with real life problems of national interest. The connection between mathematics and other disciplines is emphasized throughout the semester.

3. Students develop both oral and written communication skills, effectively communicating to mathematical and non-mathematical audiences. The students have opportunities to communicate orally and in written form at all levels: summaries, reports, presentations, and posters.

4. Students develop their ability to work with others in a team approach to effectively address a large project, to better prepare them for non-academic STEM work environments.

★ Math in the City is not a remedial class. Since many of the students who did not do well in other classes have an outstanding performance in this class, it may be perceived that this class does not incorporate mathematical difficulty. However, Math in the City gives students an opportunity to develop skills not normally employed in most traditional math classes, and the topics can often "turn on" students in ways that standard math topics do not. Students may continue the work in Math in the City by providing them with valuable research experiences.

2.1 Hands-on Learning and Other Instructional Strategies

I hear and I forget
I see and I remember
I do and I understand.
- Chinese Proverb

One of the main benefits that the Math in the City experience provides to the students is the active participation in tackling a real-world project by using their acquired academic knowledge.

Students in this hands-on program will understand the material better, feel a sense of accomplishment when the task is completed, and be able to transfer those skills to other learning situations.

During pilot offerings of the course it became apparent that the one-to-one interaction between students and the instructor was a key benefit, and in particular served those students that have been struggling in other mathematics courses. For many students this is a unique time when they do not feel threatened or intimidated by the mathematical tools because they are aware that they are working on an open ended problem that has many approaches. Drawing on the students' interdisciplinary knowledge and interests empowers them and motivates them to bring to the project valuable information that gives them a unique role within their group.

The course instructional strategies are developed around some central themes: students need support, respect, and someone to take an interest. Supporting these goals are the group work that is closely supervised by the instructors during weekly meetings, intense email correspondence, and the collaborators' involvement. Providing the students with appealing choices consistently during the project work gives them the desired freedom typical of their age, departing from (but complementing) the standard homework assignments method of acquiring new mathematical skills. This course exploits the students' natural curiosity and spirit of inquisition to seek out answers to fundamental real-world questions while getting deeper insights into mathematical modeling.

In order to better prepare students for a future career in a rapidly changing world an emphasis should be placed in the learning process "on skills—skills in handling, in seeing, and imaging, and in symbolic operations" [3]. Indeed, the focus in Math in the City is on developing such skills, not on assimilating new material, or learning new mathematical techniques. The main instructional strategy used to this end is a hands-on learning through collaborative work.

Statistical evidence supports hands-on learning instructional strategies showing dramatic differences in student performance measures in science process skills in activity-based programs. In [2] the students performed 20 percentile units higher than the comparison groups; see [5] and the references cited within for other relevant studies. The students in these programs scored higher than the control groups in the following measures (ranked from largest to smallest differences): creativity, attitude, perception, logic development, language development, science content, and mathematics. Students who were disadvantaged economically or academically gained the most from the activity-based programs ([5]).

In order to successfully complete the work on the project the students will be provided with the necessary mathematical content and modeling material, the ability to use a computer program, and just as importantly, with clear ways to improve their communication skills in mathematics and with their peers. The ability to work in teams equips students with an invaluable professional skill that they can use throughout their careers. "If we expect students to work together, we must teach them social skills just as purposefully and precisely as we teach them academic skills" (see [9] p.

32). Giving instruction in planning and communicating are indispensable for helping students work on open-ended investigations.

3 Choosing a Project

In contrast with other university-industry partnerships, the design of the projects and the choice of topics and problems is primarily *student-oriented*. The instructor for the course chooses a relevant and timely topic of national and local interest. Such topics frequently appear as "front page news" and generate strong interest on the part of the students. The relevance of the topic is important both for recruiting students to enroll in the course and to maintain high motivation levels throughout the semester. An example of a relevant topic used by Petronela Radu in the pilot course during Spring 2006 is the effect of the 2000–2006 Nebraska drought on the water levels of Lake McConaughy. Additional topics that have been used in the pilot course and proposed topics for future offerings are discussed in more detail below.

Once the project topic has been identified, the instructor then contacts a local business, government organization, or research center to find a partner willing to provide data and guidance to the students. Working with the collaborator, the instructor then refines the general topic into concrete and specific problems that can be addressed by the teams of students. It is critically important that the local collaborator be able to provide the necessary data in a usable form. Data that requires confidentiality (such as non-anonymized medical data or data relating to trade secrets) is in general not suitable for the purposes of the projects.

Each team of students has a different specific project to work on, though the projects may be closely related. For instance, during the pilot course in Fall 2008 two of the teams examined the cost benefits of green features for two different buildings. It is crucially important that each team has a different project to maximize each student's sense of ownership of their contribution to their project and to minimize the feeling that the project is "just another homework problem" in a traditional mathematics class.

The students work in teams of 3–5 students, meeting weekly with the instructor. The students also meet with the local business partner at his or her workplace and keep in regular contact by phone and email. Each team constructs a model that captures the salient features of the proposed problem; populate the model with the data provided by the local collaborator, transformed as necessary; analyze the model using appropriate computer software; and draw conclusions from the model that addresses the proposed problem.

Students keep journals that allow them to keep track of their progress on the project. The regular writing serves several important purposes: to help the students organize their time, to clarify the issues that they do not understand and to reinforce the issues they do understand, and to help with individual assessment at the end of the course. The students also practice formal writing by sending “executive summaries” to the local business collaborator to keep them updated on progress.

To conclude each project, the students communicate their results in both written and oral form. Each team prepares a detailed written report describing the problem, the team’s model and analysis, and the conclusions that they reached. At the end of the semester, each team also gives a public presentation describing their work in front of an audience formed by mathematics faculty members, undergraduate and graduate students, the local collaborator, and other members of the business community. Students have also presented posters explaining their model and conclusions at UNL’s Annual Research Fair held every spring. Students may also present posters at regional (such as the Nebraska Research and Innovation Conference) or national conferences (such as the annual Joint Mathematics Meetings) or submit their report to undergraduate research journals.

4 Tips for Choosing a Project

In this course the mathematical knowledge is equally important as the students’ interest in the project and this is why the projects have to appeal to the new generation and revolve around current issues of national and local interest.

Unlike many other academic-business partnerships, Math in the City is not a consulting service. The topics of the projects will be primarily of interest to the students and based on this fact the local business partner is chosen. Having clear expectations upfront for both the students and the business collaborator is crucial for the success of the course. Throughout the semester students visit the collaborator’s workplace to experience first-hand the non-academic work environment.

Identifying local collaborators for the courses has usually been followed by the company’s enthusiastic agreement to participate in the program. Being involved in a Math in the City project is one way for the local collaborators to advertise the company’s work as well as to promote their company as a career opportunity. Whereas with internships the company’s interaction is usually with one student, Math in the City provides the opportunity for an organization to work with a group of potential employees. Even if students do not accept a position at the organization, they still have an understanding and appreciation of the work that the organization does.

★ Local government agencies are often good collaborators, as most data they have is already public information so there would be no confidentiality issues involved. Additionally, members of such agencies are often pleased by public interest in their work.

4.1 Project Portfolio

The following are a list of projects previously explored by the Math In The City class at UNL:

The projects that were investigated during the pilot course offerings were:

1. *Statistical analysis of risk factors in heart disease*, in collaboration with Nebraska Medical Center in Omaha. For this project students used data collected by a UCLA group of researchers which found the factors that predict heart attacks for a group of patients. First, statistical variables (age, smoking, history of heart attacks, heart irregularities) have undergone a basic analysis, followed by the creation of a logistic linear regression for **all** patients. The students obtained the same results as in the UCLA study for the **entire** group, but with different, simpler methods. The interesting insight that the students had by looking and analyzing the data was to consider men and women separately. Their statistical analysis found that *men and women have different variables that predict their risk of future heart events*; thus, the heart predictors for each gender are different from heart predictors from the entire group (UCLA study found the heart predictors for entire group).

2. *A differential equations model of water levels in Lake McConaughy*, with the Nebraska Department of Natural Resources. In Spring 2006 Nebraska was in a 7-year drought and lake levels were at one of the lowest points in recent history. Since the lake (the largest in Nebraska) is very important to agriculture (irrigation), entertainment, wildlife, hydroelectric power the project was chosen on a topic of high interest. Students used data that recorded water levels over the last 50 years, also evaporation rates, and precipitation and they set up a differential equations model for the water levels. They also performed numerical computations based on Euler's method and their model was able to predict the water levels in the lake with a small error for water volumes $< 5 - 10\%$ (considered very good by our collaborator) for September - June, but the error became large during the summer months June–September. The conjecture was that the large error came from the fact that the model did not account for the snow melt in the mountains which arrives in the water table by June, thus drastically increasing the water volume.

3. *Traffic flow in downtown Lincoln*, with The Schemmer Associates. The students performed an analysis of traffic in downtown Lincoln. First they analyzed how traffic is affected if a one-way street or a two-way street is blocked. Using the data provided they solved a nonlinear conservation law to determine traffic times on a downtown road at all times by using the continuum model for traffic flow. Under the same assumption of continuum flow students also found a nonlinear relationship between speed and traffic density that maximizes the capacity of a road.

4. *The rise of the housing market in Lincoln*, with the Lincoln County Assessor; During the fall semester of 2006 students tried to answer the question: Was there a bubble in the Lincoln real estate market? The project was based on data on residential property sales during 1995-2005. During this period a nationwide increases in home-sale prices was noticed with double digit percent increase/year in some metropolitan areas. Students showed showed that over the past decade only the high-priced real-estate in Lincoln followed the national trend by increasing at a 5% rate per year. Students also established a linear regression equation between the price of a house and its features(square footage, lot, bedrooms, amenities, etc).

5. *Benefits of sustainable design in LEED certified buildings* with the Architectural Partnership (three different projects on this theme). Three groups of students analyzed costs vs. savings in sustainable design at two LEED certified buildings: the Nature Center at Pioneers Park in Lincoln, NE, and the Prairie Hill Learning Center in Roca, NE. These buildings feature green, energy and water saving features such as: strawbale walls, geothermal HVAC system, a wind turbine, 16 solar panels, energy efficient windows and appliances, low VOC emitting paints, cool metal roofs, low flush toilets, sink aerators etc. During the construction phase local contractors and suppliers were used, thus keeping down carbon dioxide and other toxic gases emissions. The third group of students looked at the impact that these buildings have on the environment by optimizing costs while minimizing carbon dioxide and other pollutants emissions. All three projects used linear programming as the mathematical tool. Students set up in each project cost savings functions which included as variables the items or the units corresponding to a green feature and the coefficients were taken to be the savings generated by the particular green feature per unit over a fixed period of time. For example, $3x_1$ would denote the dollar savings given by x_1 sink aerators over a year with one aerator saving \$3 per year. The linear constraint was the total premium cost of the green features included in the model. Thus, the students looked at the best green features in which to invest so that the total premium cost paid by the builder would be less than a given amount. For longer periods of time (30 years) students also incorporated financial factors such as inflation, increase in energy and water prices, and rate of return for the money, and then analyzed the model under different scenarios for these factors.

Most of these projects can be redone in the future using data from a different time period or a different location, which makes the course sustainable and easily exportable to other institutions. For example, it would be interesting to see if the increase in housing prices during 1998–2004 has been followed by a comparable decrease during recent years. Below is a brief description of three projects on sustainable design offered during Fall 2008. Note that, again, the topic is currently of much interest to our society and this increased the students' attention and involvement during the semester.

4.2 Future Project Ideas

The projects proposed below are sustainable since they can be conducted for large enrollments by an instructor assisted by a second person (another instructor or GTA); they are recyclable, in that the issue will be relevant in the future and will continue to appeal to students. During a future offering the work will be redone by different students, using different data and possibly a different model. As an added feature for the sustainability of the course, the pervasiveness of the below mathematical models in different areas of life sciences, physics, business, or engineering will reduce the amount of mathematical material to be prepared.

Green Energy. It is becoming more critical that the United States use more renewable energy in the future in order to minimize the impact of society on the environment and reduce foreign oil dependence. Nebraska ranks sixth in the nation for potential in generating wind energy, yet it ranks 24th in actual wind energy production according to the American Wind Energy Association [4]. The students will investigate possible solutions to this issue in collaboration with the Nebraska Wind Working Group and Nebraska Energy Office. They will set up a model to optimize production and distribution of wind energy, and in which factors such as choice of site, costs, materials used, distance to the manufacturer will be taken into consideration.

Investing strategies. Financial mathematics always generates student interest, but particularly now during the current economic recession. The credit crisis and drop in the stock market has significantly reduced many families' investment and retirement accounts. How can an investor allocate his or her capital to minimize risk while guaranteeing a minimal rate of return? The students will start with the Markowitz model for investment allocation, and then add extra factors like non-quadratic utility functions and higher-order moments. Analysis of the model involves probability and nonlinear optimization. Students will work with a local bank such as First National Bank of Omaha or a local investment company such as Berkshire Hathaway.

Placement of cell phone towers and Wi-Fi access points. The ubiquity of cell phones and wireless-enabled devices such as laptops and PDAs have created a demand for universal connectivity. A service provider wants to have sufficient coverage to meet customer demand at the minimum cost. This project will analyze the number and placement of transceivers needed to provide access at all locations in a region, provide sufficient capacity for the demand at each location, and to reduce interference. Analysis of the model will involve graph theory, statistics, and basic linear optimization. Students will work with a local cell phone provider such as Sprint and with UNL Information Services that oversees the campus Wi-Fi network.

Nebraska native insect populations. The importance of native insect populations has come into the national attention recently as more biologists research the critical role that they play in our ecosystems, even more critical than the role played by large mammals like polar bears [1]. The numbers drastically dropping is a warning signal for biologists and draws interest in studying better population models that incorporate these new declining trends. Students will start with a simplified predator-prey model, to which they add factors like climate, spreading of human communities, etc. Professors G. Ledder and D. Logan, whose area of interest is in Mathematical Biology, have agreed to offer further guidance to those students interested in this project.

★ Start thinking about possible projects and potential collaborators as early as possible—even as much as a semester before. Be prepared to contact several potential collaborators before finding one that is willing and suitable.

5 Running of the course

5.1 How it's done. Outline of the semester

The course is run during a semester when students work in group of 3-5 students on a project in collaboration with outside business or research center.

Below is a high-level timeline of teaching Math in the City during a 16-week semester and the key activities performed in each phase. See the outline in the Mathematical Background on linear and integer programming and the traveling salesman problem for a timeline of the mathematical background in fall 2010.

- Project Phase I (weeks 1–5)
  - collect data provided by local businesses or reseach centers at the beginning of the semester. students understand data and extract data necessary to populate models.
  - students gather additional data from other sources.
  - students research and write about a topic related to the project.
  - discussion of mathematical modeling and background material.
- Project Phase II (weeks 6–12)
  - the mathematical content has already been covered, students are ready to use the tools on the data provided
  - the work in groups begins; whole class discussions are limited only to topics that concern all groups

  - mathematical models created: set up of variables, equations, find restrictions for the variables and the parameters; discuss existence of solutions
  - models implemented as computer programs
  - Repeat process:

    model solved ⇒ results interpreted ⇒ refine model

    until satisfactory result achieved
  - preliminary results are obtained; students may give poster presentations
  - students start writing their results.

- Project Conclusion (weeks 13–16)
  - students reconsider the assumptions, create more realistic model
  - during this final period there is a lot of brainstorming going on: students fully understand the problem and try different ways to come up with an optimal solution; they need guidance to channel their ideas, otherwise they start feeling overwhelmed by the scope of the problem
  - compile results, give conclusions, and offer recommendations
  - write final report as an iterative process of students sending drafts and instructors providing comments.
  - prepare slides, give mock presentations in front of the classmates; give final hour-long presentation for each group in front of a large audience

★ The later parts of the project (such as running calculations with several sets of data, interpretation, writing the report, and preparing the final presentation) always take longer than one would expect. Make sure to leave adequate time for them. Some of the finished parts can be started earlier in the semester. For instance, the introduction and background parts of the report can be written before calculations and conclusions are completely finished.

5.2 Background Material and Concepts

At UNL, Math in the City is a one-semester upper-level course open to mathematics and non-mathematics majors at the sophomore level and above. The recommended prerequisites for students taking the course are having a background in Differential Equations, Matrix Theory, and Statistics. It is not expected that all students in the class will have taken these three courses; a careful distribution of students into groups will ensure that the needed material is covered by at least some of the group members.

The course instructors use several class periods at the beginning of the semester to develop the students' mathematical modeling skills, as well as to present additional mathematical concepts needed by the students to address the project topic. The goal of these lectures is to provide the students with the "tools of the trade" (as called by John Harte in the excellent modeling books [6, 7]) needed for a specific project. Short worksheets and homeworks solidify the students' understanding of these concepts by giving them the opportunity to practice their skills before needing to use them on the project.

A midsemester assignment is assigned to all students in the class. The purpose of this work is twofold. The instructor assesses at this time if the students have assimilated and are ready to use the necessary mathematical and modeling background, and also the students will have to exercise their proficiency at mathematical writing. For example, during the semester when sustainable design was the topic of investigation the students had to show their ability to use the given data for one green feature aspect (e.g. water savings) to set up a model with linear programming whose results will identify what water saving features should be used so that the total premium cost is less than $100. During the semester when recycling operations were studied, an "ideal day" was investigated that employed a simple linear programming model that did not involve routing.

★ Students take the homeworks in stride because homework assignments are familiar to them. Resist the temptation to assign too many homeworks for the students to really work with the mathematical concepts in depth. Instead, make sure that all of the assignments work towards the ultimate goal of completing the project.

5.3 Working with real data

A particularly important aspect of the Math in the City course is that students start working with real data which often is not well organized or incomplete; it is *real* data. Thus, it is of particular importance that the instructor sees a sample of the data before the semester starts (a couple of weeks in advance). During the first week of classes the data is presented to the students, followed by a discussion of how the data will be needed, so the students start thinking about organizing it and gathering additional data. Finding information and data relevant to the process continues throughout the semester, so it is a good idea to ask students to choose a topic in which they become experts (for example during a recycling project, students choose different commodities or topics related to recycling to write a report on; the student that researched plastic or transportation costs will be able to provide data and references to the groups when they need it).

★ It may be easy to underestimate the amount of time or the importance of organizing the data and students getting accustomed to it. This is a process that has taken place over the first 4-6 weeks of classes; a few times even longer when the collaborator did not have all the data available at the beginning of the semester. The instructor should allow the needed time since during this period students start to make connections between the different pieces of information, formulate conjectures, and finally, propose ideas for solving the problem.

5.4 Working in groups

During the first week of classes groups are organized. In the past the topics to be researched were presented and students were asked to choose a topic of their interest. Once the spots in a group were filled, students could be assigned to a different group (although, if this is done in class, students see themselves when a group is full and they choose a different group). Other approaches, based on students' schedules could be experimented with, although it is preferable that students work on a project of their interest since this will be their work for an entire semester.

Some ground rules should be stated and the instructor needs to stress the importance of keeping up with the work, otherwise an entire group may have to wait for an individual to finish a section or obtain some results. By using student journals or meeting with individual students regularly an instructor will be able to detect if the dynamic in a group is not conducive to the success of the project and propose different ways for the group members to handle the tasks.

5.5 Communication skills

Math in the City gives students an incredible opportunity to exercise and improve their communication skills. They learn how to efficiently and precisely report at the weekly meetings on the work they have done. Also, they have to learn to use their communication skills in the interaction with their peers in the group. During the final weeks of the course the students have a most rewarding experience by presenting their results after completing the work on the project. They will communicate these results individually and in group: in the written form of a report which will be a product of the entire team, and through oral and poster presentations. For many students this will be the first time that they have to present mathematical content to an audience formed by their peers, other undergraduate and graduate students, faculty members in the Department, and business partners. The experience and intensity they feel while giving the talks will serve them well in the future especially during job interviews and other career presentations. This teaches them about the value of achievements obtained after long and intense work while having a goal and a deadline in mind. Attracting interest in their work on the project during UNL's Research Fair is another highlight which they greatly appreciate for the boost in self confidence that it gives them.

This is an ideal way to start a successful career by getting to know how accomplishments feel like during the college years.

★ The best way for students to learn communication skills is to practice: many drafts of written work with feedback and practice talks for presentations.

5.6 Computer skills and computer software

An important part of the project is being able to manipulate and transform real-life data. This requires the use of computer software, and the students need to be shown how to use appropriate mathematical software, such as the computer algebra systems Maple or Sage, the numerical toolkit Matlab, the spreadsheet programs Microsoft Excel or OpenOffice, or the statistical software SPSS.

In several previous semesters, Maple was used as the primary computing tool. The advantages of using Maple include extensive documentation and examples, including those found online; availability of the software on classroom computers and in campus computer labs, via UNL's campus-wide software license; robustness and capability of the software, particularly for symbolic computations; graphical interface, including sophisticated graphical output; and some students had prior exposure to Maple in another mathematics course, particularly calculus, differential equations, or linear algebra. The drawbacks of using Maple include having a difficult to use programming language, and the unavailability of the software to use on the students' own computers without purchasing a license for the software.

In Fall 2010, Sage was used as the primary computing tool. Sage is a free open-source mathematics software system that combines the power of many existing open-source packages into a common Python-based interface. Though not as polished as Maple, Sage is a powerful mathematical environment that is fully capable of handling all levels of undergraduate mathematics. Once a server is setup, Sage can be used through a graphical interface run in a web browser, so students have access to Sage using their own computers and from wherever they have Internet access. As a general-purpose programming language, Python is well-suited to dealing easily with data in different formats. Python is also easy to program in, and students benefit from learning a programming language that is widely used outside of academia.

★ Some students pick up mathematical software and programming extremely easily. For others, it can be an extremely frustrating experience. Be prepared to help students find missing semicolons and other aggravations, or have a GTA or a student in each group that can.

5.7 Assessment

Math in the City gives students an opportunity to use and develop many different skills. Frequently, students that have difficulty in one aspect of the class excel in another. In most traditional math classes, it usually straightforward to linearly rank students according to their mathematical ability. In Math in the City, however, all the different student learning outcomes must be assessed.

Several tools will be used in assessing the most important part of the Math in the City course: the student learning outcomes. The instructors will use the student journals, the midsemester assignment, and the final individual student presentations to assess student progress and final outcomes on an individual basis. The final report will offer valuable feedback about how combined efforts contributed to the success of the course.

The assessment will focus on the ability of the students to construct models for real-life situations, to gather and transform real quantitative information for use in the model, and to effectively use computer software to analyze the model and interpret the results. The achievement of these goals will be assessed by using the following rubric ([8]):

Points	Characteristics
0	Fails to reach a conclusion.
1	Draws a conclusion that is not supported by data.
2	Draws a conclusion that is supported by data, but fails to show any evidence for the conclusion.
3	Draws a conclusion that is supported by data and gives supporting evidence for the conclusion.

For the Fall semester 2010 the students' grades will be computed based on the following scheme:

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)

6 Graduate Teaching Assistant

Duties for a GTA may vary greatly from semester to semester, depending on how the instructor chooses to run the course. This section is meant to give ideas about how a GTA can be used to improve the experience of Math in the City for both the instructor and students.

- Assisting groups with their projects.

  Having a GTA available to assist students is useful for many reasons. First and foremost, having more people available to help will increase the amount of one-on-one time the students get to talk about their individual ideas. Depending on the size of the class, it may be difficult for only one person to make it around and give a significant amount of help to every group within the time constraints of one class period. There are several ways in which a GTA can fill the role:

  - A very large amount of time in class is spent in group meetings, brainstorming ideas for the model and then attempting to execute these ideas analytically or in a computer model. The GTA should attend all of these classes and be available to answer questions or give guidance.
  - The GTA may hold office hours, which are given out to students in the syllabus at the beginning of the semester.
  - Students may be required at certain points throughout the semester to give an update on their progress.

- Preparing materials

  - For the Fall 2010 semester at UNL, a large part of the assignment was spent preparing materials to disseminate MitC to other institutions. Although the dissemination aspect may not be relevant to other instructors, it may be useful to help create a course which is sustainable at your institution, as it will give future professors ideas for material which may be relevant to their project(s).

- Grading

  - A GTA can be useful to grade the homework assignments throughout the semester.
  - It may be useful to have the GTA give feedback to the students on the projects, though it is less likely that she or he will be completely assigning the grades for this assignment, as it will almost certainly be such a significant part of the final grade.

7 References

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