MATHEMATICS TEACHING RESEARCH JOURNAL
SPRING/SUMMER 2019
Vol 11 no 1-2



# Using Projects in a Quantitative Reasoning Course

Paula R. Stickels

Milikin University

*Abstract: Many students have trouble communicating about mathematics and connecting mathematics to the outside world. Using projects is a way to encourage them to make the connections. We describe the integration of projects with real-world connections into a quantitative reasoning course.*

At our small, private liberal arts institution in the Midwest the faculty have placed a value on quantitative reasoning (QR) for all students. As a result, all students are required to complete a QR course as part of their graduation requirements. There are a variety of courses on campus that meet the requirement, and many students meet the requirement simply by completing requirements for their major. However, there is a population of students who have no such requirement for their major, so they find themselves in the default QR course, Finite Mathematics.

The Finite Mathematics course typically covers four to five topics as determined by the instructor, and all instructors cover financial mathematics. Since students come from areas across campus the students in the course have majors ranging from theater to political science to sports management. With the wide of range of students, it is challenging to meet all of their interests. As a result, the authors decided to take the approach that what is done in class must be related back to the students' lives in some way. What better way to do that than have the students experience the mathematics? Thus, the idea of implementing projects as an assessment of the material was born.

## BACKGROUND

One of students' greatest complaints about general education courses is they do not see the relevance of the information to their lives. So, the integration of projects into Finite Mathematics seeks to demonstrate the relevance of the mathematical topics to them. With the creation of each project, great thought has occurred in the selection of the scenario or context for each of the mathematical topics. It is important that not only does the context need to be real and relevant, it is also important that the context is of interest to the students (Middleton & Jansen, 2011; Sanchal & Sharma, 2017). When the context of problems is culturally relevant and relate to personal experiences, students are more engaged (Campbell, Adams, & Davis, 2007; Ukpokodu, 2011; National Council of Teachers of Mathematics, 2014).

For students who have not previously had to do more than regurgitate mathematical procedures, completing a mathematical project can be challenging. Teachers who implement problem-based tasks often encounter initial frustration and difficulties in their classrooms, but they find that the student learning and change in students' mathematical disposition is worth the effort (Marcus & Fey, 2003). In particular, when teachers can connect the mathematics to real-life problems, this helps in the development of student interest (Arthur, Owusu, Asiedu-Addo, & Arhin, 2018; Karakoç& Alacaci, 2015).

## THE COURSE AND AN IDEA

In many traditional mathematics courses, a topic is presented and then students are given an examination to determine if the material was learned. While there are written assessments of varying length given throughout the semester in Finite Mathematics, after major assessments (exams) on the topics, a project is given as an alternative assessment form based on a portion of the most recent topic. Each project was assigned in the class meeting following the examination over the topic. Prior to distributing a project, the exams were returned so that students were able to identify any areas of weakness.

The purpose and requirements of each project was explained as well as the way in which the assignment would be assessed. Students were given the opportunity to ask questions to clarify the directions and requirements of the project. Students were then allowed to begin work on the project. There were multiple opportunities to meet with the instructor at designated times for further assistance or clarification of the project. The length and depth of the project dictated the amount of time students were allotted to complete the project. Times ranged from four days to a week.

In any given semester, the authors cover four to five subjects that always include financial mathematics. Additional topics may include statistics, geometry, sports statistics (introduction to data analytics), geometry, voting, probability, and sets. Although the students do not know what the project is until it is assigned, the instructor uses the project as a driving force in preparing materials for class and for motivation for the class to learn the information.

## PROJECT EXAMPLES

As the mathematics topics vary between semesters, so do the projects. Also, the details are varied from one semester to another in order to keep them fresh and to avoid the re-use of a previous project. Following are representative examples of some of the projects implemented in Finite Mathematics.

*Financial Mathematics*

After the financial mathematics unit, the students are assigned a project that focuses on home mortgages. The authors vary the details of the financial mathematics project each semester, but the goal is to have students bring the idea of purchasing a home to life. All students can decide where they would like to live and then select their dream home. Students peruse real estate websites to find a house that is suitable to their liking. Once students decide on a house, they then need to find mortgage rates for a bank around the location of the house. The project includes finding interest rates for a traditional 30-year fixed rate loan as well as a shorter-term loan (10, 15, or 20 years). Once students have gathered the information from the bank(s), they use it to determine the monthly payment, total cost of the house over the life of the loan (excluding inspection costs, closing fees, etc.), and the interest paid for each interest rate at each bank. They then repeat the process of finding the amounts based on a fixed-percentage down payment given by their instructors. In addition, the students determine the down payment amount, the amount to be financed, and the total cost of the house (including the down payment and interest). (See Appendix A.)

The students submit all their calculations as well as a written response. The write up is to include a short description of the house including the location and why the student selected it. Students are to be specific as to why they selected the location, layout/size of the house, etc., and discuss the features that caught their eye. Then, they identify what bank(s) they used for their loans and why they selected it (them). Their written response is to include the monthly payment amount found for the various interest rates and loan terms.

Approximately half the points for the project are based on correct calculations, 20% on a complete write up, 10% on correct and appropriate spelling/grammar in the write up, and the remaining approximately 20% is submitting the various required elements such as a printout of the house listing, bank interest rates, etc.

**Statistics**

After the completion of the statistics unit, the students are assigned a project where they collect data, organize it, and draw a conclusion. Students are tasked with the idea of being a business owner and opening a local eatery. (This class has a high population of business majors, so this is a popular idea.) Students create survey questions to sample the local population regarding their food preferences. They determine what sampling method to use as well as how they are going to present the survey (hard copy, digital, etc.). Once the students have collected their data, they must organize it to make sense of it to draw an informed conclusion. (See Appendix B.)

The students submit a write up in a proposal format to the local city council in an effort to obtain the required permits for opening the establishment. Within the write up they are to discuss their survey questions, how individuals were surveyed, question results, and a conclusion. They are to

include a discussion of the sampling method and a justification for the conclusion as well as at least two (total) graphs or tables displaying the statistical data.

Approximately 47% of the project is based on a complete write up with the required information and correct grammar/spelling, 20% on complete and correct graphs/tables, and the remaining is completing the required elements such as including at least three survey questions, surveying at least 30 individuals, etc.

**Geometry**

The geometric ideas covered in the course are not anything beyond what the students have seen before. Basic area, volume, and surface areas are reviewed with standard and nonstandard shapes. After the completion of the short unit, students revisit the idea of owning a home that might not be exactly what they want. As a result, the necessity of redoing the floors in the home arises. To reduce faculty workload and since not all home real estate listings include floor plans (or some rooms do not have dimensions), the students are given several different floor plans to choose from. (See Appendix C.)

Once students have selected their desired floor plan, they must determine how much flooring is necessary for each room. They then must decide what type of flooring to place in each room (carpet, tile, vinyl, hardwood, etc.). Once they have made these decisions, they must seek out cost information for the various types of flooring. They can do this from a variety of sources whether it be a big box do-it-yourself home store or a direct sell flooring company. Once they have gathered the information they use it to determine the cost of re-flooring each room as well as the total cost of re-flooring the house.

The students submit all their calculations as well as an itemized cost per room. The write up students submit must include a short description of which floor plan they chose and why they selected it. They must also identify where they got the pricing information for the flooring and include the total for redoing all the floors in the house. In the write up, they are also required to explain why they selected the type of flooring for each room (carpet versus hardwood, etc).

Approximately half the points for the project are based on correct calculations, 25% on a complete write up with correct spelling and grammar, and the remaining approximately 25% is submitting the various required elements such as printouts of the various flooring types.

## STUDENT REACTION TO ASSESSMENT

At the end of a recent semester, the authors administered a survey asking students for their feedback on the projects. Despite a small sample (n = 23), the students' reactions were positive. Students offered comments such as follows:

• *It's a fun way to end the lesson.*

• *It gives students more practice and real world examples.*

• *I felt like it was a nice, relaxing activity after the test.*

• *The help of doing projects can knock out at least one bad exam grade.*

• *I strongly believe these help me learn more than studying for a test.*

In addition, students were asked about the timing of the assignment of the projects as well as the project weight in their overall grade. (The projects collectively were equivalent to one exam grade.) Over half the class indicated they preferred having the projects after an exam as opposed to before the exam. Over 25% of the students indicated it made no difference. Approximately 44% of the class felt the projects were weighted appropriately in their final grade whereas about 35% felt the projects should be equivalent to two exams.

Collectively, the students performed better on the projects than on the exams. This is not surprising as the projects were more focused on a smaller portion of a topic, they had more time to work through the project, and students could get assistance while working on the project. There were three students out of the 26 students in the class who did not complete all the projects. They were removed from the data set for exam and project grade comparisons for an n of 23. The overall exam average was approximately 84.1% while the overall project average was 89.7%. This was a statistically significant difference $\left(z = 2.127, p < 0.05\right)$.

**CONSLUSION**

Despite some initial objections to having to write in a mathematics course, the projects have been well received in the Finite Mathematics course which is in line with Marcus and Fey's (2003) work. The projects continue to evolve from semester to semester as loopholes are identified in instructions or more emphasis or clarification is given to certain criteria. As students offer feedback as to what they find interesting or frustrating about the projects this information is reflected on and taken into consideration when creating a new version of the project. Additionally, the authors found that some students who struggled to assimilate large portions of information in preparation for exams were able to succeed with projects because of either a smaller amount of material or due to the real-life nature of the project.

It is hoped that other instructors of quantitative reasoning courses (and other courses) will incorporate projects in some form into their classes. Specifically, in a course that is considered a general education requirement, the real-life project give students the opportunity to view mathematics in context, and hopefully, come to appreciate the everyday use and need for mathematics.

**References**

Arthur, Y. D., Owusu, E. K., Asiedu-Addo, S. & A, A. K. (2018). Connecting mathematics to real life problems: A teaching quality that improves students' mathematics interest. *Journal of Research & Methods in Education, 8*(4), 65 – 71.

Campbell, A. E., Adams, V., & Davis, G. (2007). Cognitive demands and second- language learners: A framework for analyzing mathematical instructional contexts. *Mathematical Thinking and Learning*, *9*(1), 3 – 30.

Karakoç, G. & Alacaci, C. (2015). Real world connections in high school mathematics curriculum and teaching. *Turkish Journal of Computer and Mathematics Education, 6*(1), 31 – 46.

Marcus, R. & Fey, J. (2003). Selecting quality tasks for problem-based teaching. In H. L. Schoen & R. I. Charles (Eds.), *Teaching mathematics through problem solving* (pp. 55 – 68). Reston, VA: National Council of Teachers of Mathematics.

Middleton, J. & Jansen, A. (2011). Emphasizing sense making and personal investment: Using contexts judiciously. *In Motivation Matters, and Interest Counts: Fostering Engagement in Mathematics* (pp. 103 – 114). Reston, VA: National Council of Teachers of Mathematics.

National Council of Teachers of Mathematics. (2014). *Principles to Actions: Ensuring Mathematical Success for All.* Reston, VA: NCTM.

Sanchal, A. & Sharma, S. (2017). Students' attitudes towards learning mathematics: Impact of teaching in a sporting context. *Teachers and Curriculum, 17*(1), 89 – 99.

Ukpokodu, O. (2011). How do I teach mathematics in a culturally responsive way?: Identifying empower teaching practices. *Multicultural Education, 19*(3), 47 – 56.

Appendix A, Financial Project

**What is Your Dream?**

It is time to find your dream home! You have no limit on your budget or location. So, think of what you want and go for it. You will determine your monthly payment, total cost of the house over the life of the loan (excluding inspection costs, closing fees, etc.), and the interest paid.

*Nuts and Bolts*

• Find your dream house and print out one page that contains the listing (with the price).

Highlight the price.

• Locate a bank (located in the same area as the house) and determine the interest rate for a fixed rate loan for 30 years. Print out this page, and highlight the bank name and interest rate.

• Locate a bank (located in the same area as the house) and determine the interest rate for a fixed rate loan for 10, 15, or 20 years. Print out this page, and highlight the bank name and interest rate. *You may use the same bank for both interest rates.*

* Determine the monthly payment, total cost of the house over the life of the loan (excluding inspection costs, closing fees, etc.), and the interest paid for *each interest rate at each bank*.

* *For each interest rate at each bank*, assume you have the money to make an 18% down payment. Determine the down payment amount, the amount to be financed, the monthly payment, cost of the house over the life of the loan (excluding inspection costs, closing fees, etc., AND down payment), the interest paid, and the total cost of the house (excluding inspection costs, closing fees, etc., but including down payment).

Your write up will include a short description of your house including the location and why you selected it. Be specific as to why you selected the location, layout/size of the house, etc. Discuss the features that caught your eye. Then, identify what bank(s) you used for your loans and why you selected it (them). Include the amounts you found for the two * items above. The paper should be typed and double-spaced using a 12-point font and 1-inch margins although the mathematics may be handwritten and attached. Grammar and spelling count.

Appendix B, Statistics Project

**Sampling Satisfaction**

You want to open a local eatery but there has been an influx of food businesses of late so you as a business owner must justify to the local city council why you should be given the required permits to open your eating establishment.

You are not sure what kind of food eatery to open. To be an effective owner you need to find out the public's opinion. You decide to survey the local public to see what their favorite food is and how often they go out to eat. You elect to create a survey to administer to a sample of the local population to find out their food preferences. The questions are up to you.

Your write up should be in a proposal format to the local city council. Within the write up you should discuss your survey questions, how individuals were surveyed, question results, and a conclusion that includes a discussion of the sampling method and a justification for the conclusion, as well as *at least two* (total) graphs or tables displaying the statistical data. The write up should be typed and double-spaced using a 12-point font and 1-inch margins. (The write up should be 1 – 2 pages.)

*Nuts and Bolts*

- Determine your sampling method and survey at least 30 individuals. Attach the survey results from all individuals. (You are familiar with five sampling methods. The choice is yours.)
- Attach any questionnaires that you may have used during the survey. (For example, if you gave any form to participants or showed them anything.)
- The survey must contain *at least* three questions.
- The graphs or tables may be generated from a website or Excel.
- Make a decision as to the type of eatery to open based on the sample data. Be sure to justify this decision in your proposal based on the survey results.

Appendix C, Geometry Project

**Designing Your House**

You've found your home, but before you move in you want to do some work. In order to ensure the final product is what you want, you will handpick all the materials.

*Nuts and Bolts*

• Determine which of the floor plans you will use for "your house". Be sure to state this.

• For each room, determine how much flooring is needed for that room.

• For each room, determine whether you want hardwood flooring, tile, vinyl, or carpet.

• For each room, determine *specifically* what flooring you will use and identify the cost of the flooring. Compute the cost of flooring for the room.

**You must use at least three different (priced) floorings.

* Include the computation of the flooring needed for each room.

* Include an itemized list (typed) of the rooms with the cost for each room.

* Include a printout of *each* flooring used. Highlight the price and the name of the business. On the printout, identify what room the flooring is being used in.

Your write up should include a short description of which floor plan you chose and why you selected it. Identify where you got your pricing information for the flooring, and include the total for redoing all the floors in the house. In your write up, explain why you selected the type of flooring for each room. Do not forget the itemized cost list of the rooms. The paper should be typed and double-spaced using a 12-point font and 1-inch margins although the mathematics may be handwritten and attached. Grammar and spelling count.