Creating mathematics websites in middle school

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Introduction

During middle school years, students generally finalise their attitude towards mathematics and their perception of themselves as students of mathematics in terms of aptitude, motivation, interest, and competence (NCTM, 2000). Therefore, giving them varied opportunities to foster a positive and successful approach to the study of mathematics is critical, and can help them appreciate the relevance, usefulness, and creativity of the subject. Asking the students to create a website that focuses on mathematics can provide such an occasion; readily available, free internet tools that do not require any prior programming experience make this opportunity accessible to all students. In the school where I teach—an independent all-girls school in the suburbs of Washington DC—my Grade 8 Algebra 1 and Geometry classes have completed this activity successfully and with great interest. In our case, each student at the school is issued a laptop (and the school is internet-enabled), although all that is necessary is that students have access to a computer—whether in a lab, from a computer cart or in some other way.

Learning objectives

The main objective of this study is to introduce middle school students—usually 12-14 years old in the United States—to fascinating mathematical topics and ideas that are not generally covered in the regular classroom curricula in order to foster interest, spark excitement, and inspire enthusiasm. These topics are drawn from the history of mathematics, or allow a historical viewpoint. In fact, the history of mathematics can provide students with a richer and deeper understanding of mathematical concepts or provide a gentler introduction to more advanced ideas. It shows them how and why such concepts were developed through years and sometimes centuries of hard work, excitement, adversities and delight. It offers students the opportunity to enjoy first-hand some of its most stunning creations. Finally, with its wealth of elegant concepts and proofs, colorful characters and interesting stories, the history of mathematics may increase students' interest and enhance positive attitude towards mathematics.

This project also promotes mathematical literacy as the students have to research their topic extensively, analyse, organise and integrate the information and the resources they use, and think and communicate mathematically about higher-order mathematical concepts.

Project design

The directions for this project and the two lists of topics I created are shown in Figures 1 and 2. The students in each class chose a subject from the list and were given a set of mathematical websites that could be useful for their research, although they could also use books, textbooks and other resources. The students were directed to take notes on the most interesting points, best pictures, most fun aspects of their topic; to highlight the beauty of their subject; and to spend no more than two hours on their research.

The Wonderful World of Mathematics

This webquest will give you the opportunity to use the internet to learn more about some fascinating numerical topics that we will not be able to explore in our course and that can allow you to discover the extraordinary beauty of this subject. Choose one of the following topics:

1. Perfect, deficient and abundant numbers
2. Complex numbers
3. The number π and the irrationals
4. Transcendental numbers
5. Ramanujan's numbers and other curious numbers
6. The primes
7. Zero
8. The Fibonacci Sequence and nature
9. The "witch" of Agnesi
10. The Golden ratio
11. Pythagoras' Theorem
12. Eratosthenes and the determination of latitude
13. The numbers e and i
14. Euclid's fifth Postulate
15. Arrows' impossibility theorem
16. Pascal's triangle
17. The genius of Archimedes
18. The Stomachion
19. Germaine primes
20. The figurate numbers
21. Al-Khwarizmi and its solution of quadratic equations
22. Diophantus and the dawn of Algebra
23. Apollonio, Hypatia and the conic sections
24. The Hindu-Arabic number system
25. Zeno's paradoxes
26. The most beautiful equations (two or three).

If you choose another topic, please ask for my approval before starting to work on it. Use the Internet to research your topic and plan to share your findings with the class through a Wix webpage (http://www.wix.com/).

Figure 1. Project directions for The Wonderful World of Mathematics.

The Wonderful World of Geometry

Introduction
This webquest will give you the opportunity to use the internet to learn more about some fascinating geometry topics that we will not be able to explore in our course and that can allow you to discover the extraordinary beauty of this subject. Choose one of the following topics:

1. The Golden Rectangle and the Golden Ratio
2. Flatland
3. Eratosthenes
4. Euclid's elements
5. Escher: artist or mathematician?
6. Non-Euclidean geometries (Riemann, Lobachevsky et al)
7. The genius of Archimedes
8. Impossible objects (Mobius Strip, etc.)
9. Islamic geometric Art
10. Origami
11. Mazes
12. From Pythagoras' Theorem to Fermat's Last Theorem
13. Tessellations
14. Giotto, Brunelleschi, Piero della Francesca: Understanding perspective geometry
15. Geometry in art and architecture

If you choose another topic, please ask for my approval before starting to work on it. Use the Internet to research your topic and plan to share your findings with the class through a Wix webpage (http://www.wix.com/).

Figure 2. Project directions for The Wonderful World of Geometry.

To create their website, students could use Wix (www.wix.com) or other sites of their choosing they are already familiar with. Our school technology coordinator gave a short lecture on how to use these web creator sites and provided written instructions. My students found Wix rather self-explanatory and user-friendly; they appreciated the flexibility it gave them to showcase their creativity and took to it very quickly, learning as they went along. In their final product, the students were asked to list the resources they had consulted, and also to plan a brief class presentation on what they had learned.

This activity was conceived mainly as an independent project that would showcase the students' research skills, their critical and analytical thinking abilities, and their creativity. Therefore, the students did most of their research at home, although they were also given some time in class so that they could touch base with me, if they wished to do so, and I could monitor their progress.

Class activity and discussion

The project's culminating activity required the students to introduce their website to the rest of the class with a 5–10 minute presentation. Most of the presentations were engrossing—especially for the other students in the class,

who often for the first time were exposed to many fascinating, visually stunning or deeply thought-provoking concepts and ideas. For example, the conversation about Zeno's paradoxes (http://isabellekoff2018.wix.com/zenospradoxes) continued for almost 30 minutes as the children struggled to reconcile their everyday experience with the logic of those statements.

The students clearly had a great time with this project: some studied the connections between mathematics and their future career (http://oliviaparsons2018.wix.com/geometryinart); others enjoyed telling stories (http://thegeniusofarchimedes.webs.com/); some delighted in the visual beauty of mathematical objects (http://bonnieakhavan2018.wix.com/fibonaccisequence); and others simply had fun (http://jaymeslotkin2018.wix.com/zero-project; http://reaganleibovitz2018.wix.com/prime-numbers). And, while building their website and listening to their peers' presentations, they all learned a great deal of mathematics.

As the class could ask questions and share observations about the website presented, the presentations often went on for longer than the allotted time because of the interest raised by the mathematical topic or the technical flair of the site. It was clear that many students chose to spend much more time than required on their project as they enjoyed both the subject of their research and the tools they chose to show it off, and they were proud of their final creation.

At the end of her presentation, each student shared also her own observations and comments on the design, content and format of this project. For example, most students were thrilled by their experience with Wix because it allowed them to create a rich final product.

Evaluation and assessment

Each student's website was assessed with various tools against criteria for content: Is the information accurate, substantive, interesting to your classmates? Is your site clear and precise in presenting your information? Is it aesthetically pleasing? Did you include your sources? And criteria for presentation: Was your presentation effective in communicating to your classmates the material you wanted them to learn? Did you maintain good eye contact? Did you avoid verbal litter? Did you avoid fidgeting? Did you look as you had fun researching this project, putting it all together and presenting it to your classmates? The students were also asked to orally evaluate their work, their presentation, and their overall experience.

I used a simple, general rubric (Figure 3) that can be applied to different projects. I also provided the students with a simple rubric to help them review their own work and each of their classmates', and encouraged them to add notes and to be specific with their comments, so that their feedback could be clear and helpful. Figure 4 shows this rubric, built with RubiStar (http://rubistar.4teachers.org). I collected the evaluations—which were completed anonymously, so that students could feel free to express their thoughts—and if there was a recurrent observation or theme, I added it to my evaluation notes, stating the classmates as source. I also found these peer-evaluations very useful to gauge the class' interest and learning. This project also inspired some interesting conversations on side topics such as how to use and cite sources, what constitutes common knowledge, and how to avoid accidental (and not so accidental) plagiarism.

Math Project Evaluation

Name:
Project Title:

1. **Visual Presentation (1-50 points):**
   Originality (1-10 points):
   Creativity (1-10 points):
   Neatness (1-10 points):
   Organisation (1-10 points):
   Followed directions (1-10 points):

2. **Mathematical Content (1-50 points):**
   Followed directions (1-10 points):
   Understanding of problem/concept (1-10 points):
   Strategy and reasoning (1-10 points):
   Complexity of problem (1-10 points):
   Appropriate analysis and solution (1-10 points):

Notes:

Figure 3. Maths project evaluation rubric.

Website project — peer evaluation

Teacher's name:.....
Student's name:.....

Category	4	3	2	1
Mathematical Concepts	Explanation shows complete understanding of the mathematical concepts used to solve the problem(s).	Explanation shows substantial understanding of the mathematical concepts used to solve the problem(s).	Explanation shows some understanding of the mathematical concepts needed to solve the problem(s).	Explanation shows very limited understanding of the underlying concepts needed to solve the problem(s) OR is not written.
Explanations	Explanation is detailed and clear.	Explanation is clear.	Explanation is a little difficult to understand, but includes critical components.	Explanation is difficult to understand and is missing several components OR was not included.
Neatness and organisation	The work is presented in a neat, clear, organised fashion that is easy to read.	The work is presented in a neat and organised fashion that is usually easy to read.	The work is presented in an organised fashion but may be hard to read at times.	The work appears sloppy and disorganised. It is hard to know what information goes together.

Figure 4. Web site project peer evaluation rubric.

Conclusion

This activity was successful in both classes. Its emphasis on creativity, initiative, inquiry, exploration, independent work, extensive reading and research—all features of enriching tasks—can captivate students' interest. My students responded enthusiastically to this undertaking, and enjoyed making their website and looking at and evaluating those of their peers'. They relished sharing it with their families, which were very appreciative of the final products, and with the rest of the middle school community. The excited reception afforded to this project leads me to conclude that this is a strong activity that the students will remember and appreciate for years to come.

Acknowledgements

I cannot close without thanking our school technology coordinator, Mary Dobroth, for her expert advice, and my colleague, Ellen Case, who shared with me her experience with a similar activity she held in her English class. Finally, and most importantly, I need to thank my students whose enthusiasm for this project made it all worthwhile.

References

National Council of Teachers of Mathematics (NCTM). (2000). *Principles and Standards for School Mathematics*. Reston, VA: National Council of Teachers of Mathematics.

Rubistar. (n.d.) Retrieved 18 April 2015 from http://rubistar.4teachers.org/

Wix.com. (n.d.) Retrieved 18 April 2015 from www.wix.com

Details of Middle School student websites created during this mathematics project

Fibonacci sequence
<http://bonnieakhavan2018.wix.com/fibonaccisequence>

Zeno's paradoxes
<http://isabellekoff2018.wix.com/zenospradoxes>

Prime-numbers
<http://reaganleibovitz2018.wix.com/prime-numbers>

Geometry in art
<http://oliviaparsons2018.wix.com/geometryinart>

Zero-project
<http://jaymeslotkin2018.wix.com/zero-project>

The Genius of Archimedes
<http://thegeniusofarchimedes.webs.com/>