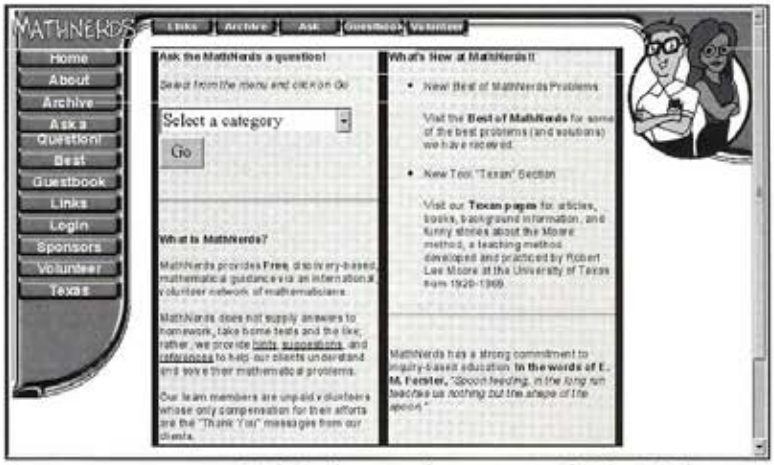
MathNerds Offers Discovery-Style Mathematics on the Web

By Valerio De Angelis, Paul Dawkins, W. Ted Mahavier, and Allen Stenger

This article is about the web site *MathNerds* (http://www.mathnerds.com), a discovery-style, volunteer-based, free service providing help in mathematics to students, teachers, parents and industry. The project grew out of two ideas, which we believe are both of interest to educators in mathematics. First, we hoped to develop a resource for teachers and students that made essential use of the potential provided by the spread of the Internet and the web. Second, we wanted to provide a setting to implement and promote the use of a discovery-style approach in the teaching of high school and college mathematics. Of course, we make no claim as to the originality of either idea. But we believe that the combination has resulted in an innovative project. That project is the *MathNerds* website.



MathNerds screenshot courtesy of CajunWorks.com.

In its simplest description, *MathNerds* is a web-based question-and-answer service. What distinguishes it from a host of other such websites is the commitment to a discovery-based style in the replies sent to its users. In general, no complete answers are provided by the team of volunteers. Instead, hints and suggestions are given, which often result in an exchange of several messages. This gradually enables the students to reach the solution by themselves.

This discovery-style method seems natural enough and easy to describe. But its practical implementation is more challenging than expected. As many of the *MathNerds* volunteers can testify, giving good and insightful hints and suggestions for the solution of a problem is often more difficult than working out the problem in its entirety.

However, the attractive feature of the approach is that "more difficult" in the previous paragraph almost never means "more time consuming," and always means "more rewarding." We believe that this aspect of the project has enabled us to attract and retain our current team of competent teachers and distinguished mathematicians.

The birth of *MathNerds*

MathNerds was born in 1999, but dates back to 1996, when Valerio De Angelis and W. Ted Mahavier began operating an e-mail-based mathematics service called *The Math Doctor* at Nicholls State University. In 1998 De Angelis moved to Xavier University where additional faculty began participating. The idea of using volunteers who would be assigned questions was born, and with a grant from Xavier's Center for Advancement of Teaching, we redesigned the site and developed an algorithm for distributing problems. Using a volunteer selection process, we quickly built a substantial team. In 2001, Mahavier moved to Lamar University, where Dawkins joined the team as the lead programmer for the project.

As of November 2001, about 100 volunteers have been accepted. They are faculty at places such as California, Chicago, Delaware, Dillard, Georgia Tech., Lamar, N. Texas, Rochester, SUNY, Temple, US Military Academy, Washington, Xavier, and Youngstown.

During the last year, an average of 600 questions per month were received with more than 75% answered. Average response time per question was less than 35 hours. Still, the need for an ever-expanding team is strong, because we receive a larger number of questions than the volunteers can handle.

Question and answer service

From the user side (students, parents, teachers, or industry), the service is straightforward. Users choose a category, complete a form, and submit a question, which is then assigned to a member of the team. From the volunteer side, potential team members complete applications choosing the categories they desire (currently K-5 through graduate level) and the maximum number of questions (per category) they are willing to receive each week (their *caps*). The applicant is then tested. If evidence of satisfactory ability is observed regarding knowledge of the subject, clarity of the exposition, and adherence to the discovery-style method, then the candidate is accepted.

Once on the team, volunteers receive questions, forming their *Personal Queue (PQ)*. They may then answer the question, move it to the *General Queue (GQ)* where it is available to other members, or *lock* it (to keep it in their PQ). If no option is chosen within 48 hours, the question is automatically moved to the GQ. Team members may visit their PQ at any time to answer questions, seek ad-

ditional questions in the GQ, view their exchanges, or alter their profiles.

Features

The *Archive* is a searchable database including 14,000 answered questions. Each entry may contain several exchanges between a team member and student, and comments may be added by any team member. The *Best of MathNerds* is a polished exposition of samples pulled from the archive, maintained by Stenger and De Angelis. The *Texan Section* offers a collection of inquiry-based instruction materials, maintained by Mahavier. The *Links* section offers readers other on-line resources in mathematics.

Sample exchanges from *MathNerds*

This section transcribes some actual exchanges held on the *MathNerds* site. They are verbatim except that they have been slightly edited for length and for spelling.

I. Grades 6-8 Middle School question. The volunteer gives the first step of the solution, and the student is able to complete the solution from there.

User: 1) Ms. Vaccaro's class surveyed 1500 sixth graders about television viewing habits. They surveyed twice as many girls as boys. How many boys did they survey? 2) Students rated two dozen programs excellent and 5 poor. How many fewer poor than excellent ratings were given?

I know the answer to the first question is 500 boys and 1000 girls. But I don't understand how one arrives at that number. Please explain. The second question I simply don't understand. Thanks for your help. The questions come from Progress in Mathematics by Sadler-Oxford.

MathNerds: Hint for 1: Let's write B for the number of boys. Write an expression, in terms of B, for the number of girls. We know the sum of the number of boys and the number of girls is 1500. What's the next step?

Hint for 2: This is the same as asking "what's the difference in the number of excellent ratings and the number of poor ratings?"

User: Thank you for taking the time to help me with my homework.
b+2b=1500
3b=1500
b=500
There are 500 boys and 1000 girls.

24-5=19
There are 19 fewer poor ratings.

II. An extended exchange about a Complex Analysis question where the volunteer leads the student through several ideas until the student discovers a solution.

User: Suppose that f(z) is analytic in the set 0 < abs z < 1 and that the integral of f(z) is zero along every C: abs z = r where 0<r<1. Is f(z) necessarily analytic at z=0? I might be missing an important theorem here, because this question is only worth 2 marks. I'm guessing that the answer is no. Any hints, please? Thank you so much!

MathNerds: Suppose f was a surface whose domain was the unit circle plus its interior and that a plane was tangent to f at every point of its domain except zero. Does this suggest an analogue to your problem? Write back if you need more help.

User: I still am having difficulties with this question. Do I want to show an example where f(z) is analytic in the deleted neighborhood but not at zero i.e. f(z) = 1/z, ... do I have to choose an example where the integral is zero? Do you have an example that you could suggest, or do I just need to reason it out? Sorry that I'm not clueing in very well. Thank you for your help.

MathNerds: Suppose the answer to the original question is no. What has to be true? Write back if you need more help.

User: Thank you for your help. I think that I figured it out. I think that the answer is no and that you can use f (z) = $1/z^2$ and show that it is analytic on the unit circle except at the origin, but its integral is zero because it has an antiderivative! Thanks!

MathNerds: Nice example!

Conclusion

The *MathNerds* project shows that discovery learning is still a viable method, even in the rapidly changing world of the Internet. In fact, rapid electronic communication opens new possibilities for this kind of learning, both for the learners and for the teachers.

The reach of the Internet transcends geographic and economic boundaries. We have fielded queries from Canada, China, Iran, Mexico, Thailand, and Turkey to name a few countries. Several members have replied in Spanish and Italian as needed. As such, *MathNerds* reaches those who have no one else to turn to including the single parents, the home schooled, the commuters, and the rurally isolated students.

The informal nature of the *MathNerds* system allows volunteers to set their own level of participation on their own time. As a result, it is possible to recruit not only many who are already teaching full-time, but also talented hobbyists and industry mathematicians who would be unable to teach a full-time traditional course because of lack of time, inclination, or credentials. Just as the open source software movement and MIT's OpenCourseWare project are providing free materials, *MathNerds* seeks to provide free expertise with a discovery-based flair. ■

MathNerds thanks the volunteers who have contributed their time and expertise to answer questions, and recognizes the following for answering over 400 questions each: Valerio De Angelis, Doug Dillon, Esther Fontova, Mark Morse, Jose Antonio Perez, Murray Siegel, and Allen Stenger. We give special thanks to our first programmer, Donald P. Lasseigne, for the HTML and database programming, and to graphic designers Bart P. Everson and Ryan J. Hutchinson for the web site design. Finally MathNerds thanks Lamar University and Xavier University of Louisiana for their generous support.