The Math Forum: Measuring the Aliveness of a Community

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Abstract: The Math Forum is an enduring virtual community. The aliveness of this community was measured using seven principles derived by Wenger, McDermott, & Snyder (2002) as design principles for communities of practice: (1) Design for evolution. (2) Open a dialogue between inside and outside perspectives. (3) Invite different levels of participation. (4) Develop both public and private community spaces. (5) Focus on value. (6) Combine familiarity and excitement. (7) Create a rhythm for the community. The principles proved to be good measure of aliveness in an existing community. As a point of discussion, a conjecture was made that the principles are necessary but not sufficient for a community to be alive.

Introduction

Does your daughter need help with her math homework? Does your son's teacher need some professional ideas to use in the classroom? Do you have questions about mathematics education? All three of you can get the assistance you seek at The Math Forum. Since 1996, it has been online to help students, teachers, parents, researchers, and anyone interested in learning mathematics or bettering math education. The Math Forum is an enduring virtual community.

The Math Forum bills itself as "the leading online resource for improving math learning, teaching, and communication since 1992" (Drexel University, 2008, The Math Forum Is, ¶ 1). The website consists of several areas, each of which contributes to making The Math Forum an enduring community. The abundance of resources and communication options available to students, teachers, parents, and researchers provide for a wide variety of needs. Figure 1 lists the major areas of The Math Forum, gives a brief description of each, and indicates which type of community members typically accesses each area.

Renninger and Shumar state, "The Math Forum can be characterized as a virtual community because it engenders feelings of belonging and purpose" (2002, p. 82). The authors, who have done extensive study of The Math Forum, go on to say that it serves as both a place for people with a shared interest and as an extension of the physical community. Mathematics education is clearly the shared domain. It can be approached from several different perspectives – learner, teacher, parent, researcher, concerned

Area	Description	Accessor
Ask Dr. Math	• Experts answer math questions • Discussions archived	Students
Teacher2Teacher	• Experienced math teachers and math educators answer questions about math in general and specific content • Contains math tidbits, keys to success, best practices, and stories from the classroom • Discussions archived	Teachers Parents
Problem of the Week	• Challenges presented to students weekly • Resources for teachers	Students Teachers (fee)
Math Tools	• Library of interactive math tools that use such technology as Java, spreadsheets, dynamic geometry software, and graphing calculators • Search available for tools and activities • Discussions linked to each resource archived	Students Teachers
Discussion Groups	• Dozens of discussions on topics such as AP courses, investigations, curricula, history, policy, news, professional teaching associations, puzzles, and software • Discussions archived	Teachers Parents Researchers
Math Community Issues	• Collection of articles and websites that are devoted to critical thinking about the teaching and learning of mathematics	Teachers Parents Researchers
Internet Mathematics Library	• Library with access to thousands of math and math education-related resources	Teachers Researchers
Teacher Exchange	• Lessons for classroom use created and published by teachers	Teachers
Workshops	• Events and programs to support teacher professional growth and school and district integration of technology into the teaching and learning of mathematics.	Teachers
Math Forum Internet News	• Weekly newsletter	Teachers
Math Digital Library & JOMA	• (External Sites)	Teachers Researchers

Figure 1. Description of the areas available at The Math Forum and who accesses them.

citizen – yet the interest in people, mainly K -12 students, learning math remains the focus of the community. The Math Forum shares characteristics of a neighborhood school, a local university, or a town meeting hall in that it serves as a place where students can receive help with homework, pre-service teachers can learn about mathematics pedagogy, and concerned citizens can discuss the direction of mathematics education. The Math Forum is a virtual community; those who join do so to further math education with a diverse group that welcomes all.

Wenger, McDermott, & Snyder (2002) are interested in cultivating communities of practice. They have derived seven principles of "aliveness" and advocated application of these principles to the design of communities of practice to foster their long-term success. Aliveness is the energy of a community which helps sustain it over time. The principles of aliveness, and a brief description of each, (Wenger, McDermott, & Snyder, 2002) are:

(1) Design for evolution. The community must be purposefully dynamic, allowing for redesign to fit the needs of its members as it grows over time.

(2) Open a dialogue between inside and outside perspectives. The insiders know the domain and the "issues"; the outsiders help see the possibilities.
(3) Invite different levels of participation. Members of the core group, active group, peripheral group, and those with an interest in the community need to all feel welcome.
(4) Develop both public and private community spaces. Private, one-on-one activities are as important to the community as the public activities.
(5) Focus on value. The community must offer some value to its members but this value is not always explicit.
(6) Combine familiarity and excitement. Add novel events to the familiar ones provided everyday.
(7) Create a rhythm for the community. The tempo of the interactions is the strongest indicator of its aliveness.

If designing a community with these aliveness traits leads to it becoming successful then a successful community should display these traits. The purpose of this study is to evaluate The Math Forum with respect to each of these principles. This community stands in the forefront of math education; it is successful in its domain. Measuring The Math Forum against the seven principles of aliveness will give insights into its longevity, provide a measure of aliveness with which to measure other virtual communities, and further validate the seven principles of Wenger, McDermott, & Snyder as design considerations for future online communities of all types.

Finding, Evaluating, and Measuring The Math Forum

Google was used in October 2008 to search the Internet for a successful math education community. Math was chosen as the domain since the researcher has expertise in this field.[i] A search of "math community" returned 4,200,000 results of which The Math Forum was one. "Math" returned 117,000,000 results; The Math Forum was number seven. Tens of permutations using math returned The Math Forum within the top ten positions, most within the top two. Google uses PageRank, a search algorithm based on links, to list the most important query results at the top when it returns search results (Google, 2008). Therefore, The Math Forum's numerous top Google listings indicate its success in the domain. The 1996 establishment date indicates its endurance.

The community's website, www.mathforum.org, was accessed throughout November, 2008. The site was evaluated extensively over the course of the month for evidence of the community's adherence to the seven principles of aliveness. The evaluation consisted of examination of all areas of The Math Forum. Information about the community from sources other than the website was also considered, as were personal communications with a researcher from The Math Forum.

The following seven sections address the seven principles of aliveness, summarizing evidence found that indicates The Math Forum possesses the traits engendered in the principles.

(1) Design for evolution. The Math Forum was born in 1996, with the help of National Science Foundation (NSF) grants, out of the Geometry Forum (Klotz, 1995; Klotz & Weimar, 1997). The original site, started in 1992, established a tradition of responding to the needs of its audience. To aid teachers in understanding the expanding Internet so that they could participate in discussion groups and contribute resources for sharing, workshops were developed. These led to the development of the Geometry Problem of the Week (PoW), which itself fed discussions and lead to the expansion of discussion topics. The success of the PoW spawned another interactive service, Ask Dr. Math.

When the Math Forum reported back to the NSF in 1999 they indicated extensive growth had occurred from a "bottom up approach" (Klotz & Weimar, 1999). They were focusing on mentoring, building community, and establishing a resource center. Professional development offerings expanded, the PoW grew, and more community members added to the resources available. The community opened to encompass more educators, parents, and concerned citizens. At the same time, there was a need to scale the website to meet the demands of a growing community.

The Math Forum continued to grow after its initial years to meet the needs of its community members and take advantage of the expanding affordances of the Web. Since 1998 they have: developed an Online Learning Guide to the National Council of Teachers of Mathematics (NCTM) standards-based math; worked to integrate hyperlinked multimedia in math education; referenced online learning materials; developed an Online Mentoring Guide for professors; collected and catalogued electronic math tools; adapted groupware so that students could work with the Math Forum Digital Library (MFDL) collaboratively; and reorganized, customized, and eased usage of the MFDL (Klotz, 2002; Moore, Klotz, & Albers, 2000; Nemirovsky & Carraher, 1998; Shumar, Lasher, Lavelle, & Bach, 2001; Stahl, Weimer, Shumar, & Bach, 2003; Weimar & Fan, 1998; Woolf, Weimar, & Arroyo, 2005). The Math Forum is currently involved: creating workgroups of math students, teachers, and researchers; holding workshops for teachers to use the affordances of the site with their classes; and working with pre-service teachers on a virtual field experience (Klotz, et al., 2005; Shumar, Weimar, Renninger, & Silverman, 2007; Stahl, Weimar, Wesley, & Bach, 2003).

The Math Forum continues to evolve to meet the needs of its community. This is acquired by involving its founder, Gene Klotz, other members of the core community, the assistance of NSF and other funding, and with input from the entire community.

(2) Open a dialogue between outside and inside perspectives. In addition to government organizations such as the NSF, The Math Forum has worked with math education groups, mathematics organizations, higher education institutes, K-12 schools, and commercial companies. The Math Forum has provided services to many of these organizations at the same time opening up a dialogue which strengthens the forum's view of mathematics education. This quid-pro-quo provides outside perspectives to the core and participating community members.

Recent community activities found at http://mathforum.org/whatsnew.html highlight some interactions. In September The Math Forum offered workshops on using the National Science Digital Library (NDSL), a huge NSF project that involved over 280 grants to dozens of universities throughout the US, educational organizations, non-profits, and professional organizations (NDSL, n.d.). That project followed from the creation of a mathematics digital library they worked on with the Mathematical Association of America (MAA). Also in September they offered free PoW mentoring with pre-service teachers from several universities. The What's New page of the website also highlights other workshops that The Math Forum delivers to various physical communities and online as well as conferences, and meetings at which core community members speak.

The Math Forum website shows evidence that the community has interacted with math education groups such as the National Council of Teachers of Mathematics (NCTM), the National Council of Supervisors of Mathematics (NCSM), and the Council of Presidential Awardees (CPAM). They have worked with mathematics groups such as the Mathematical Association of America (MAA) and the American Mathematical Society (AMS). They have worked with higher education organizations like Swarthmore College where the community was founded, Drexel University where it currently resides, and scores of other universities. Their K-12 contributions span from Philadelphia to San Diego.

The Math Forum has gained an outside perspective from its work with various other institutions and its diverse community members. Another perspective comes from research. Beyond the research of insiders studying their work, outside organizations have studied The Math Forum. These studies provide further perspectives from which the community can gage itself and see possibilities.

(3) Invite different levels of participation. The Math Forum was established as a collection of services. These services are provided by a combination of paid staff and volunteers. Staff members run the website, administer the Problems of the Week, lead math education programs, direct professional development, engineer software, facilitate professional collaboration, conduct research, and see to all the community administrative tasks. Volunteers answer questions from students, as Dr. Math, and from other teachers as Teacher2Teacher Associates. These two groups make up the majority of the community's core members. They ensure day to day operations, keep the resources available, provide the expert assistance, and are accessible to communicate with other members.

Some community members, either as collective classes or individuals, subscribe to the Problem of the Week (PoW), the community's only paid service. Teachers and students involved in the PoW can access new problem weekly and obtain solutions problems; reason to return to the site regularly. Some community members are deeply involved in The Math Forum discussions. Doug, for example, has posted to the ap-calculus discussion 1095 times since he registered with the site in December 2004. He represents members who are active in the community. These members may confine themselves to a

particular area or be involved in several areas. They have evidenced their presence in the community.

Other members may take advantage of the resources, like the computer applications in the Math Tools or math knowledge in the Math Forum Internet Math Library, on a regular basis but choose to do so without comment. These can be considered peripheral members of The Math Forum. And still others just "stop by" and try a PoW, read some of the conversations, use a tool, or just check out the site. They may come back or not. No matter what level of involvement, all are welcome to The Math Forum.

(4) Develop both public and private spaces. The Math Forum contains numerous open spaces. All information about mathematics, math education, and math tools is open to all who access the site. The PoW and most of the workshops are offered on a paid basis to defray costs involved in running the community but this only limits their availability to those who wish to pay. Anyone can post to the community discussions or ask questions of experts.

Some private conversations are made public, to a degree, to assist others. When writing to Ask Dr. Math or Teacher2Teacher, correspondents are asked if they want their name and email made public. If they choose not to make their personal information public then the questions and responses are still posted but without names. This anonymity allows private conversations to be taken public but still remain private. And almost all public discussions are archived so that they can be used as resources.

Other private interactions remain between the involved community members. A classroom discussion about a PoW between a teacher and student, thoughts on a workshop activity among participants, and debate on the direction of math education amongst citizens are private activities which are most assuredly sparked by involvement in The Math Forum although they are not evidenced on the website. One other interaction, private emails between community members, exemplifies the private one-on-one activities of members. The researcher has evidence of this type of private interaction as an email discussion with a core community member carried on during the study (Tchen, R, personal communications, various October and November 2008 dates).

(5) Focus on value. The Math Forum provides value to the students, teachers, parents, and other community members it serves in different ways. To the students it offers challenging, thought provoking problems, mentors to assist with problem solving, experts to provide answers to math questions, and tools to enhance the learning of math concepts. To teachers, both pre-service and in-service, it offers expert assistance with math content and pedagogy, lesson plans, activities, and enhancements, tools to enhance the teaching of math concepts, and workshops for professional development. Parents and others interested in math education can browse articles on current issues, research topics, see what teachers are talking about, and learn what students are doing. The Math Forum contains an abundance of information and resources which provide value to all community members.

People seek out a virtual community not only for the information it can provide but also, more importantly, for the interactions it can foster through communication (Heuer, 2008; Rheingold, 1993). Moreover, the ability to communicate mathematical concepts and thinking is a process which NCTM calls a basic skill, giving it equal value with the content learning of mathematics students in K – 12 (NCTM, 2000). The Math Forum is replete with opportunities for discussions among members, communications with experts, and the interchange of ideas. Students can Ask Dr. Math or a PoW mentor. Teachers can participate in discussions, ask expert math teachers, discuss the selection and use of math tools, and work with other teachers at both online and face-to-face workshops offered by the community. Parents and other adults are welcome to participate in the discussions. Public discussions are archived, indexed, made searchable, and kept ongoing for years. The value of these communications can be illustrated with a couple examples.

Ask Dr. Math is one of the oldest and most used services of The Math Forum. When a student, or any community member, comes to the Ask Dr. Math page they are first instructed to browse or search the site for previous Dr. Math answers to similar questions. If none can be found then they can make a submission to the expert or, if time is of the essence, click to get immediate help for a fee at an outside tutor site. The Dr. Math experts, drawn from the ranks of presidential award winning math teachers, are trained to offer assistance with concepts but not give answers to students' homework. Figure 2 shows Vivian's question and Doctor Achilles response from the Ask Dr. Math archives. In this exemplar, the expert explains the concept behind the problem, gives an example, encourages Vivian to try her problem again, and, as in all Dr. Math responses, ends with the offer of further assistance. The researcher found this problem in the archives where other community members can use it as a resource, locating it by browsing, searching for some specific terms, or being directed to this historic response as a reply to a Dr. Math inquiry.

Teacher2Teacher (T2T) has much the same format for professionals and adults who have questions on mathematics or math education. These community members can submit a question to an expert if they are unable to find appropriate answers in the T2T archives. A T2T Associates responds to inquires by email. The associate then posts the exchange to the archives and it becomes open for public discussion. Figure 3 shows an example of an archived discussion. An anonymous user wrote "I need interesting ways to begin class that will get high schoolers interested. I have a project due on this so I need sources and places to find the information" in a submission dated November 19, 1999. Within a few days, two T2T Associates had responded with advice. The threads show that additional advice has been posted every year since. Perhaps the person who made the initial inquiry nine years ago is still following the discussion, perhaps not. Nevertheless, the information is available for those who come across the topic in the archives.

Cost, Overhead, Selling Price, and Profit

Date: 06/24/2008 at 14:27:10
From: Vivian
Subject: word problem on finding the selling price

Larry's Lamp Shop buys lamps for $18 each. If Larry's overhead is
$7.29 per lamp and he makes a profit of $3.38 per lamp, what is the
selling price of each lamp?

What does the overhead mean? Does it mean the mark up price? This
entire question's wording is very confusing to me. I tried:

  7.29 - 3.38 = 3.91
  18 + 3.91 = 21.91

but the answer in the book says it is $28.67.

Date: 06/24/2008 at 19:31:26
From: Doctor Achilles
Subject: Re: word problem on finding the selling price

Hi Vivian,

Thanks for writing to Dr. Math.

The overhead is all the other expenses Larry has. The gas it takes
him to get in to work each day, the rent he pays on his building, the
electricity bill, and so on.

Let's say he buys the lamps for $20 each, plus he spends an average of
$5 per lamp on overhead. If he sells each lamp for $28, what is his
profit?

  Total-price = item-cost + profit + overhead

  $28 = $20 + profit + $5

  $28 = $25 + profit

  $3 = profit

So in the problem I made up, profit is $3.

Do you understand how I solved the problem I made up? If you don't,
please tell me what about it is confusing.

Now that you have seen me solve that problem, can you figure out how
to solve your problem? If you're still stuck or you want me to check
your answer, please write back and show me the steps you've tried so I
can help you find the right answer.

- Doctor Achilles, The Math Forum
  http://mathforum.org/dr.math/

Figure 2. Example of Ask Dr. Math submission and response

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Description: Warm up activities and class "grabbers" for starting off the math class.
Level: Middle School (6-8), High School (9-12)
Math topic: Algebra
Ed. topic: Activities, Teaching Styles/Practices

Original Question/Response

18 Nov 99	Classroom Openers
20 Nov 99	Re: Classroom Openers by Suzanne A.
22 Nov 99	Re: Classroom Openers by Claudia

Public Discussion

26 Feb 01	Classroom Openers by Dale
28 Jun 01	Classroom Openers by Marty S
13 Mar 03	help by brittany
17 Jan 05	Opener using slightly large numbers by Loyd
19 Nov 08	Re: Opener using slightly large numbers by Bernie LaRiviere
07 Sep 05	9th grade math by john ford
28 Jul 06	math class opener trick by Kim
21 Aug 07	math by sahar metwali
21 Aug 07	math by sahar metwali
23 Aug 07	Classroom Openers by Michael Sakowski
04 Feb 01	Re: Classroom Openers by Marty S.
19 Feb 01	Re: Re: Classroom Openers by Mike Brennan
18 Jul 04	Re: Re: Re: Classroom Openers by Joe
21 Jul 06	Re: Re: Re: Classroom Openers by Steve Waltz
09 Aug 01	Re: Re: Classroom Openers by Mrs.Goff
22 Aug 04	Re: Re: Classroom Openers by D Hales
28 Jul 05	Re: Re: Classroom Openers by Carol
22 Feb 01	Re: Classroom Openers by Marty S.
24 Apr 01	Re: Re: Classroom Openers by Fred Triana
26 May 01	Re: Re: Classroom Openers by K. Adams
21 Jun 01	Re: Re: Re: Classroom Openers by Chris
27 Jul 01	Re: Re: Re: Re: Classroom Openers by Rene
01 Jul 02	Re: Re: Re: Re: Re: Classroom Openers by Ray
10 Apr 03	Re: Re: Re: Re: Re: Classroom Openers by Mike Sanders
26 Aug 04	Re: Classroom Openers by Patricia
09 Aug 08	Re: Re: Re: Re: Re: Classroom Openers by Reni
11 Aug 08	Re: Re: Re: Re: Re: Classroom Openers by Kelly
20 Jun 06	Re: Re: Classroom Openers by debra boyd
28 Jul 06	Re: Re: Re: Classroom Openers by kim

Post a public discussion message

Figure 3. Example of Teacher2Teacher submission and ensuing discussion submissions

The value that can be obtained by a community member from The Math Forum is as varied as the number of members. Explicit value is to be had in the information, resources, and conversations of the community. But not all value is explicit. Insights into math concepts, a better attitude towards the discipline, and connections all have value.

(6) Combine familiarity and excitement. When one first comes to The Math Forum, the whole site is new and exciting. It is rather large consisting of tens of thousands of pages. Simple exploration will lead a new community member to the resources, discussions, and activities that are most helpful. The novice may choose to be active, passive, or not join the community at all. After time, those who join will decide what works for them and continue to use that resource, participate in that discussion, add to that set of resources, or

otherwise engage in community activities. Still, sometimes new things keep the community going. Since The Math Forum continues to evolve, it continues to add new resources. It has been keeping up with the affordances of the Web in ways which address member needs. It adds new tools, new resources, and new links. It creates new workshops and discussion topics. What's New, http://mathforum.org/whatsnew.html, keeps track of the innovative community happenings by quarter; seventeen new activities are listed for the Jul/Sep 2008 quarter. In typical Math Forum fashion, all announcements of new community activities since February 1998 are archived on the site evidencing all novel events which supplement the regular list of community activates.

(7) Create rhythm for the community. Wenger, McDermott, & Snyder pronounce "The rhythm of the community is the strongest indicator of its aliveness (2002, p. 63)." As an outside observer this can be hard to gage. Like a person's heartbeat, you know it's there because they stand alive before you but you can't see the beating. The Math Forum has shown evidence of the other six principles of aliveness. As an observer, the weekly nature of the PoW, the change in discussion flow, and the scheduling of workshops would seem to follow an academic year indicating the rhythm of the community follows the beat of the school drum.

Statistics from the inside give a clue to the rhythm of the site. "The weekly 'rhythms' … largely follow to form what we've observed for years: site activity begins ramping up after Saturday lulls … , peaking Wednesdays" says Richard Tchen, a webmaster at The Math Forum (personal communication, November 20, 2008). Such statistics as Tchen collects can show the rhythm of the community much like an EKG shows a heartbeat. Still, they don't show the heart of a community.

Discussion

The Math Forum is an alive virtual community. The Math Forum has shown evidence of adherence to the seven principles derived by Wenger, McDermott, & Snyder (2002) as design principles for communities of practice: (1) Design for evolution. (2) Open a dialogue between inside and outside perspectives. (3) Invite different levels of participation. (4) Develop both public and private community spaces. (5) Focus on value. (6) Combine familiarity and excitement. (7) Create a rhythm for the community. These principles were a good measure of the aliveness of The Math Forum. They can be used to measure the aliveness of other existing virtual communities and should be used to guide the design of new virtual communities.

When studying The Math Forum by examining its website, the researcher was able to find evidence supporting each principle. Some principles were easier to evidence than others. Wenger, McDermott, & Snyder say that rhythm is the most import design principle but it is the hardest to evidence. Rhythm is something that is felt by the community over time. An outsider looking in can look at a timeline of events and say that it has a rhythm because it goes in cycles but the outsider cannot feel the rhythm. It takes a member of the community to have such a feeling. And if the member does not feel it then they will most likely not stay with the community.

People leave a community for several reasons and when a preponderance of members leave, the community dies. The community could fail to evolve. It could become too egocentric. It could make people not feel welcome. The opportunities to work one-on-one could disappear. The value to members could erode. The community could just become passé. All of these counterexamples of the seven principles could kill a community, flat lining its rhythm. The question then is whether adherence to these principles is a necessary and sufficient condition for a community to be alive?

The researcher can see a hierarchy of traits; some principles are more important than others. Value is paramount in any endeavor. This principle was most easily evidenced in this study and appears to be easiest for members to ascertain even though value takes different forms for different people. Voluntarily remaining a member of a virtual community which holds no value seems to be, in the very least, counterproductive. For an intentional community, accepting different levels of participation, changing with the times, and providing novelty alongside familiarity seem to rank next in importance. Still, all seven principles are important, show interdependence among each other, and are necessary for the rhythm and aliveness of a virtual community. They would be a good measure of aliveness for any community. However, these seven principles alone cannot ensure the survival of such communities. Leadership, money, and vision are also needed.

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