Summer 2002

GOT MATH? Implementation Guide

Margo Shea

Christopher Nye

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Implementation Guide

Prepared by
Margo Shea and
Christopher Nye

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Education in Action/Service Learning
Berkshire Community College
1350 West Street
Pittsfield MA 01201
cnye@berkshirecc.edu
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CURRICULUM

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THANKS

First of all to the INTEL Foundation for funding this dissemination effort and the most recent cycle of Got Math? Our program officer Rob Richardson immediately saw the value in our unorthodox approach and advocated for us from start to finish.

Thanks also to mentors, too numerous to name, without whom the program could not have succeeded. The bonding between the mentors and their groups was the ingredient that made this cake rise.

In the development of the first curriculum and the overall conception of Got Math? Math professor Annette Guertin did the pioneering work. She also was the first program coordinator. The second year Crosby School teachers Vic Beaudin, Andy Mickle, and Meagan Ledendecker conducted the sessions.

The third year it was Berkshire Community College Service Learning Coordinator Margo Shea. All contributed value to the evolving Got Math? Professor Nancy Zuber contributed her math and teaching expertise to bringing the curriculum into its present form. We also want to thank the principals and consulting teachers at Stearns, Crosby, and Highland Schools, where Got Math? was offered in its first three-year rotation.

The authors and Berkshire Community College have not copyrighted this material in order to encourage its dissemination.
INTRODUCTION

Why Got Math?

For many kids math is like spinach--something to be avoided if possible. This may well be because they see learning math as a rather abstract process, cut off from the real world. For many teachers, with large classes and pressure to prepare for standardized tests, opportunities to individualize math instruction and to experiment with creative group activities that bring math alive remain out of reach. As a result of these and other factors, across the nation our children's math achievement levels remain pretty disappointing.

Got Math?, an out-of-school-time mentoring program for third through fifth graders, is one model that aims to turn that dynamic around. Staffed with math-savvy volunteer mentors from the nearby college, the program allows for small group and individual work in a structure that helps children learn by applying math to problem solving and by working closely together in small task-groups of three or four. The strong relationships that evolve over the course of a school year both with the mentors and with other participants encourage children to try hard and to perform well in math. In contrast to one-on-one tutoring, our one-on-four groups develop more like teams, with the mentor serving as coach. This is a key aspect of our model.

The Got Math? model helps children both improve math skills and become much more comfortable with the subject. When you ask them what they like about Got Math?, participants describe the games, the field trips, and the chance they get to make “really real” objects like pies and key chains. They also talk about the chance they get to make new friends and to have fun. The classroom teachers remark on the increased math confidence of children in the program. Unlike conventional teaching or after-school tutoring, Got Math? does not teach math as an isolated subject. It is not “schooling” but rather experiential learning using math-rich projects and activities that forms the core of the model. This is made possible by partnering with businesses in the community that have an interest in math-proficient future employees. The partners assist with curriculum advice, field trips, and limited instruction. They could also fund the program.

Developed first by Berkshire Community College in 1999, the program has served children in Pittsfield, Massachusetts, schools each year since. Typically we use six or more mentors to engage twenty-four fourth-grade children whose performance in math has been below grade level or who have been identified as showing signs of emergent math anxiety. The sessions here occur Tuesday and Thursday mornings for an hour before the school day. We have three 7-week blocks that begin once mentors are recruited and trained. They extend for the rest of the school year. Attendance by children has been excellent even though parents have to get up early and bring their children to school. Attrition has been negligible.
In Pittsfield our curriculum units have been The Math of Plastics, The Math of Paper, and The Math of Farming because we have good partners in these fields. In other communities different units might be appropriate, but many of the activities already developed could be used.

**Purpose of This Guide**

With the generous support of the Intel Foundation, this guide and accompanying complete curriculum have been prepared and made available for colleges and schools considering their own Got Math? Programs. While some of the lesson plans and suggestions for program development may not suit your institution or your community, we hope that you find ideas, suggestions, and concrete tools that will enable you to better facilitate fun and rewarding math programs that link college students with elementary school students. Most college-school partnerships require intensive nurturing in order to combat the obvious challenges – different schedules and notions of time, conflicting needs, and an array of demands on both sides. This guide is meant to help others benefit from our experience and lessons learned by trial and error.

All materials may be copied and used at will. We ask only that you share with us ideas and improvements that you feel can strengthen the model. With these materials and a capable director, a successful program can be funded and offered with about six months lead time. Some funding sources may have earlier deadlines.

**GETTING STARTED**

**Assembling Primary Players**

In order to develop a plan for a Got Math? program, it helps to pull together at the very beginning the people most likely to become involved. These might include the college’s representative, the coordinator of service learning and community service, an influential math faculty member, the person who handles Federal Work Study for the college, a couple of students with experience in your existing tutoring programs, a school principal, and possibly a fourth grade teacher, plus anyone else you think might be helpful. We recommend making personal contact with each person beforehand and making sure they are receptive to the idea before inviting them. There are advantages to starting out with a school where the college already has a sound relationship. The agenda for the meeting might include:

- Explanation of the Got Math? model
- Discussion of need at the school
- Determining if the program addresses the need
- Deciding if the school and college want to work together to secure funding
- Brainstorming appropriate business partners
- Going as far as possible in getting commitment from individuals who will:
  - Coordinate/run the program
  - Prepare the funding proposal
- Serve as liaison at the school
- Recruit mentors (through Federal Work Study, service learning for college courses, community service by student organizations)

In general, business people do not have much patience with meetings of the sort we have on campuses. Therefore, potential partners may best be contacted individually at their own offices. Again, the college will already have relationships with some firms; and these are good places to start. Do not rule out non-profits if they seem appropriate.

**Writing the Proposal**

If the college has a grant writer available, you will just have to supply the particulars and review the proposal. Otherwise, expect to write it up and prepare the budget yourself. The grant guidelines will shape how this is done. See sample budget in the budget section below. Secure hard information through the school principal on how the district and targeted classes have been doing in math. This helps you make an irrefutable case to demonstrate need. Quotes from business partners about the need for math skills in new employees can further bolster this case.

In writing up the proposal, bear in mind that most funders love partnerships. It makes them feel they are to get their money’s worth and that more segments of the community are behind doing what you propose.

Stress the partnership work that has already occurred and that will support the program you are proposing. Letters of commitment (as opposed to letters of support) from the school principal, at least one business partner, and a college official such as the president should be attached. Other letters that might be helpful, but are not essential, might come from: the school superintendent, other business partners, and the math faculty member to be involved.

**Budget**

The budget provided below reflects expenses for a program that occurs before the school day or does not require busing. In our setting we have been able to get parents to bring children to school early two mornings a week. Of course, they go home on the bus at the regular time. An after-school offering of Got Math? would probably require busing because many parents are still working in late afternoon. This budget also does not provide snacks because we assume the children have just had breakfast. Other possible expenses not reflected here are any curriculum adaptation that might be necessary in order to partner with businesses in your community. We have paid a college faculty member with elementary teaching experience to perform this service in years when it was necessary.

Costs shown are for 2002. One column includes projected in-kind match to meet grant requirements. These estimates would change under different circumstances.
### Direct Costs

#### 1. Program Staff

<table>
<thead>
<tr>
<th>Description</th>
<th>Grant Request</th>
<th>In-Kind</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Project Director</td>
<td>6,076</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 hours x 31 weeks x $28/hr.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. BCC Director of Special Programs</td>
<td>1,890</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 hrs./month x 9 months x $35/hr.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Consulting Teacher</td>
<td>400</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 hrs. x $25/hr.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Federal Work Study Students</td>
<td>1,240</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 hours of training, then 3 hours x 24 weeks = 78 hours x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 students x $7.95/hr.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Industry Partners</td>
<td>1,200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 partners x 10 hours x $40/hr.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal for Program Staff</strong></td>
<td><strong>6,476</strong></td>
<td><strong>4,330</strong></td>
<td><strong>10,806</strong></td>
</tr>
</tbody>
</table>

#### 2. Instructional Materials

Materials for instruction and activities: Math manipulatives, molds, Play Doh, calculators, micrometers, pie materials, paper, rulers, etc.

<table>
<thead>
<tr>
<th>Description</th>
<th>Grant Request</th>
<th>In-Kind</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>616</td>
<td>302</td>
<td>918</td>
</tr>
</tbody>
</table>

#### 3. Participant Travel

Field Trips

Charge for school bus @ $48/trip x 3 trips; Pittsfield School System absorbs balance of true cost.

<table>
<thead>
<tr>
<th>Description</th>
<th>Grant Request</th>
<th>In-Kind</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>144</td>
<td>90</td>
<td>234</td>
</tr>
</tbody>
</table>

#### 4. Staff Travel

Reimbursement for travel to workshops and conferences in state.

<table>
<thead>
<tr>
<th>Description</th>
<th>Grant Request</th>
<th>In-Kind</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>300</td>
<td>240</td>
<td>540</td>
</tr>
</tbody>
</table>

#### 5. Other

<table>
<thead>
<tr>
<th>Description</th>
<th>Grant Request</th>
<th>In-Kind</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CORI (Criminal Records Check) fees: 12 students x $10; absorbed by the Commonwealth.</td>
<td>120</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CORI application prep: 7 hours x $19.45; Pittsfield School</td>
<td>136</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recognition event for participants and parents: Refreshments for 60; space and some refreshments donated.</td>
<td>140</td>
<td>140</td>
<td></td>
</tr>
<tr>
<td>Certificates for completers: BCC Graphics Department.</td>
<td></td>
<td></td>
<td>110</td>
</tr>
<tr>
<td>T-shirts for completers and mentors: $9/shirt x 36 (participants and mentors)</td>
<td>324</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insurance costs: 24 students x $34; Pittsfield Schools</td>
<td></td>
<td>516</td>
<td></td>
</tr>
<tr>
<td>School facilities for program activities: 48 hours x $37/hour</td>
<td></td>
<td>1,776</td>
<td></td>
</tr>
<tr>
<td>BCC facilities for mentor training: 30 hours x $65/hour</td>
<td></td>
<td>1,950</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>Grant Request</th>
<th>In-Kind</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>464</td>
<td>5,048</td>
<td>5,512</td>
</tr>
</tbody>
</table>

**TOTAL DIRECT COSTS**

$8,000 $10,010 $18,010
Funding Sources

Got Math? is a very fundable project because so many employers are aware of poor math preparation in schools, because it provides nice public relations opportunities for business partners, and because it has already been shown to work. Here are some funding sources to consider:

- The Campus Compact organization for your state. To find out if your state has a Campus Compact, go to www.compact.org.
- The foundation associated with a major employer in your community. If that employer is one of your partners, that opens the door.
- One of the business partners as a form of direct corporate giving (but see caveat below).
- State Department of Education funds for after-school programs.
- The school district -- either through a direct grant or as a sub-grant from funds they receive to improve test scores (it’s essential not to let Got Math? be subverted into a test prep program).
- Funds available to America Counts programs. See www.ed.gov/americacounts
- A private benefactor (but see below).

Be aware that college development offices cultivate long-term relationships with well-heeled individuals and corporations in order to elicit large gifts from them. You can incur the wrath of your own development people if you independently go to one of these donors and secure a few thousand dollars for your project. Possible consequences of this include having the donor say they have done their thing for the college this year by supporting Got Math?, and the President’s pet project gets nothing.

YOU’VE BEEN FUNDED! NOW WHAT?

Once you’ve been able to secure a grant to run a Got Math? program, it seems as if everything needs to happen at once. The program coordinator should establish good communication early with those people who represent the key partners of the program – school personnel, college students who will serve as mentors, and community business partners who will help to shape much of the curriculum and activities. With each of these groups, there are key issues that will eventually arise. Some of these issues are outlined below.

Your Partner School

Once your program has been funded, it is time to clarify roles and responsibilities. An elementary school that opens its doors to you is taking a risk and in some ways adding to its already long list of duties. Making sure that your school partners understand what you expect from them and outlining what your responsibilities are in the partnership at the very beginning will increase the chances of a strong and durable association.

Success of the program will depend on a close and positive relationship with both the principal and one classroom teacher at the elementary school. It does not matter which is your key day-to-day contact – most principals find it useful to assign a teacher whose students are in the program the role of primary contact – but it is necessary to have one.
There will be occasions when you need that person’s phone number. See also the section on roles in this guide.

**Issues To Clarify**

**Primary Space**

Where in the school will Got Math? run? The cafeteria, library, or a classroom are options, the Art Room or another space that is less strongly associated with traditional classroom learning is ideal. It is important to be certain that all players with a stake in that space are informed well in advance by the principal of its use for Got Math?

**Other Spaces**

It also helps to get up-front permission to use the gym and have access to the kitchen on occasion and if possible, to provide dates you’ll need them well in advance. While it is unlikely that anyone will be using the gym before school hours, in most elementary schools the kitchen is a busy place in the early hours of the day.

**Storage and Display**

**Storage**

Find out if there is any available place to store things you use on a regular basis – the folders for each participant, balls, markers and crayons, and other art supplies, etc. Otherwise, the coordinator or lead mentor will have to carry everything to and from the site.

**Display**

Ask permission up front to display projects on the walls of your space or within the school. It is important for participants to have public recognition and most schools are happy to have you decorate the halls with Got Math? projects. There may be rules about tape or thumb tacks.

**Arrival Times**

If Got Math? is being operated as a before-school program, the school contacts and the school custodian need to be informed of the arrival times of the coordinator, mentors, and the participants. In many communities, the Got Math? coordinator will be one of the first people to arrive at school on the days the program runs.

**Appropriate Behaviors**

It makes sense to establish Got Math? ground rules with the school’s principal and to be consistent with the school’s philosophy for discipline. The program leader should have the right to drop a child from the program for persistent, disruptive behavior. However, we have
not had to do that to date. Instead, we have redirected the difficult child's energies into program activities and in one case of an ADHD boy assigned an extra mentor to his group. See Ground Rules appended to the Curriculum.

School Calendar / College Calendar

Before the program starts, it is necessary to sit down with updated school and college calendars. There will be different vacations, cancelled classes, and days off. Usually mentors prefer not to have program responsibilities during exam periods and the long Christmas and January break. A calendar for the program, once developed and cleared with the school, should be printed up for parents of participants. See Appendix 5.

Procedure for Field Trips

Field trips are an essential part of the Got Math? model. They are also a major responsibility and your school partner is placing a great amount of trust in you when it allows you to take its children off site during school hours. Thus it is important to address all potential concerns up front and establish clear responsibilities for all parties when planning trips.

Appropriate Notice

Schools often plan their field trips far in advance. Since Got Math? field trips do not usually conclude until about 10:00 a.m., it is important that classroom teachers, parents, and students have ample notice.

Ordering Transportation

Generally, a school bus is necessary to transport Got Math? participants from school to the field trip site. A school bus can be secured with enough lead time. It is often easier for a school official to order the bus. Make sure it is clear who will pay for the bus.

Field Trip Permission Slips

It is important to clarify who will print out permission slips. Got Math? participants should receive a slip a week before the session. They have two opportunities to bring it to Got Math? It is also helpful to set a policy by which they can give the signed permission slip to a designated person such as the school secretary any day between the day they receive it and the day before the field trip.

Adequate Supervision During Field Trips

It is advisable to have at least one school representative on any field trips. Unruly behavior is more common when students are away from school and not with people who generally discipline them in any significant way. It is also important to arrange for college representatives to attend field trips, as mentors often face schedule conflicts on those days.
Other College Partnerships

It is beneficial to know if your college or any other colleges have other on-going programs operating in your school partner’s site. While those other programs should not affect Got Math?, sometimes they do and knowing about the programs and the key players can often prevent confusion or miscommunication later.

Recruiting Got Math? Participants

Depending on the size of the school in which you are working, you will be recruiting from the fourth grade, the third and fourth grades, or possibly even the third through fifth grades. Bearing in mind the optimum number of twenty-four students, the school principal can help you to gauge where to begin recruitment efforts.

Your teacher liaison and the school principal will play the major roles in recruiting program participants. We send a letter explaining the program to all parents of children in the grades targeted; some parents and students will want to sign up at that point. We also work through the teachers to recruit children most likely to benefit from the program. Once you have enthusiastic students, it also helps to ask them to get their friends or neighbors to join. Because students often carpool or walk to Got Math? together, recruitment by the “neighbor” technique also is helpful with program retention.

You should not have any problems recruiting Got Math? participants. If you are encountering difficulties, see if this signals an emerging problem with your partner school.

MENTORS

It goes without saying that the college’s volunteer, service learning, or Federal Work Study mentors are at the heart of your program. Without them, all the funding, preparations, strong partnerships, and enthusiastic staff will be of little consequence when it comes to making Got Math? a success. Mentors serve as coaches, guides, and teachers to their young student participants.

Recruiting Mentors

How Many?

We recommend recruiting a minimum of six and a maximum of twelve. Two mentors per group can work well. When a mentor has to miss a session, two groups can be combined, but it is far better to have another mentor who can step in.

Where Do Mentors Come From?

College mentors can be recruited in the following ways:
- From math classes. Math faculty will know continuing students who would make good mentors. Students may respond positively if they feel it is an honor to be invited to interview for a mentorship.
• From service-learning courses where students are responsible for a community placement as part of their coursework. Ask your service learning coordinator to push this placement.
• From previous or current mentors who can recruit their peers and friends.
• From your college’s work study office.
  Make sure there is a job description on file.
  It helps to make flyers and hang them all over campus as a Help Wanted sign.
• From the volunteer center, honor societies, campus ministries, etc.
  Make sure there is an updated position description with these offices.
• From the international office. Some international students are looking for ways to connect with the local community.

**What Motivates Mentors?**

Generally, students get involved for one or more of the following reasons:
• They think they might want to pursue a career in education.
• They find it a more interesting work study assignment than the other options.
• They love math and want to share their enthusiasm.
• They do not like math and feel that if they had more support and encouragement they might be more successful in the subject; they therefore want to help a child.
• They belong to an honor society and need to perform a set number of hours of service.
• They are taking a service-learning course and need a project.
• A friend was or is a Got Math? mentor and told them it was a great experience.
• They like the early morning hours because then their service or work study job is “out of the way”
• They want to add to their resume.
• A professor has suggested to them that they would be a good mentor.

Particularly if you have a college with a large math department supportive of Got Math?, you could fill all your mentor slots from this one source.

**Mentor Orientation**

In order to keep mentors engaged and energized about the program, training and ongoing opportunities for leadership development are crucial. Mentors generally go through several stages of development in their relation to working within the program. From beginners to “experts” to humbled aspiring motivators and educators, college students often use their mentoring experiences to play out a variety of roles in relation to kids, to authority, and to the role of education in society. Without supportive and open space for them to voice ideas, concerns, and suggestions for the program, it is normal for them to feel disaffected at different times and to voice that by exiting the program. This is damaging for kids because they bond with their mentor, and their learning depends in part on this personal connection. Moreover, loss of a mentor disrupts the program and makes more work for the coordinator. Training and reflection are the best ways to keep mentors engaged.
Pre-Program Orientation

Goals of Orientation

The initial orientation needs to accomplish the following:

- Excite the mentors
- Offer the mentors a chance to get to know one another
- Discover the mentor’s individual and collective strengths vis-à-vis mentoring
- Clarify expectations for the program and expectations of mentors, i.e. consistency, reliability, punctuality, attendance at reflection sessions
- Explain the significance of the mentor relationship.
- Prepare the mentors to work with third-fifth graders.
- Provide an overview to the lessons and academic goals for Got Math?
- Offer them a chance to try some of the activities they will be leading.
- Review the math skills they can expect from participants.
- Provide them with important contact information for the coordinator and the school.
- Orient them to the partner school – location, established procedures, etc.
- Offer them the chance to ask questions.

Guests at Orientation

Usually, the best guests at orientation are one or more former mentors and the partner school’s consulting teacher. An expert in mentorship or a psychology or education professor from the college also would be useful and welcome guests.

Scheduling Orientation

It is worth the time it takes to find a time when everyone can attend orientation. A two and a half hour session that includes dinner is often a good option for college students. When scheduling orientation, it is important to offer enough flexibility to enable mentors to get to know one another and to ask questions. Additional orientation sessions may be necessary depending on the mentors, availability of guests, and other factors.

Mentor Roles

One of the key challenges for mentors is to understand their role in the classroom and the program. At orientation, it helps to ask the new mentors themselves what they believe to be an appropriate role for them. Mentors often struggle between wanting to befriend children and wanting to create space where children can learn. They rarely relish disciplining so they need to be involved and invested in the Ground Rules for the program so they can support the coordinator in enforcement.

There is a fine line between being a friend and being a mentor to a child. This distinction bears discussion. It might be helpful to establish boundaries for mentors in the form of simple rules:

- Do not give Got Math? participants rides in your car.
- Do not intervene in a Got Math? participant’s problem with a classroom teacher.
• Do secure principal’s permission before offering extra tutoring or help out of program time and off site.
• Use the reflection session to discuss learning and behavior problems that may arise.

Training

Each week the mentors will need some coaching to prepare for the following week’s lessons. In some cases this can be minimized and the session can move quickly into reflection. In others, as when mold-making or origami are scheduled, mentors really need to know what they are doing before they are expected to teach others. Normally the program coordinator conducts the training and tries to relate the specific activities and skills to the big picture of the unfolding curriculum.

Over the course of the program, certain issues will undoubtedly emerge that would be best addressed through training with an outside specialist. Some of these might include:

• Learning styles and multiple intelligences
• Learning disabilities
• Aggression in children
• Behavioral problems
• School finance
• Standardized testing
• Mentoring skills
• Leadership development
• Math anxiety

Training should be only as long as it needs to be, and it should be strongly encouraged but optional. Use your contacts and networks to bring in good speakers and trainers and try to do something nice for the mentors who come — provide dinner, give lottery tickets, or a small honorarium, etc. Work study students should be paid to attend training. Most of all, make sure the training is of interest and of use to the mentors. They already dedicate so much time to Got Math?

Reflection

College students in general are ill-disposed to reflection as a theoretical concept but supportive of it in practice. Therefore, scheduling reflection sessions or building time to reflect into an already demanding program is difficult in the beginning. It becomes easier as mentors realize they have more and more they want to digest and discuss. Many models can work for reflection; ask what makes sense in their schedules. For some groups, staying twenty minutes after each Got Math? session is the best approach. For others, an early morning or late afternoon/early evening weekly session is better. Dinner together can work for some, often more social, groups.

Who Facilitates

The program coordinator usually facilitates reflection, though a lead mentor, program aide, faculty member, or mentors themselves can certainly facilitate.
Agenda for Reflection

One can begin reflection sessions by asking the mentors themselves to set the agenda. This can be a useful preview of issues and problems that are arising. By allowing mentors to set the agenda, it usually gives them more sense of program control. Topics that usually need to be covered include:

- Relationships with groups
- Problems with specific kids
- Problems between kids
- Placing upcoming lesson plans in larger context
- The same with just completed lessons
- Issues with specific lessons or students’ difficulties with certain concepts or tasks
- What to do about mentors who do not show up (this usually makes things harder for mentors who do show up).

Allot a specific amount of time for training and reflection. People tend to relax when they know that the session will end at a definite, appointed time and are more willing to give one another room to think aloud and raise issues that may have been raised recently if they know that it won’t lead to going over the specified time limit.

Having the consulting teacher come to sessions periodically is extremely useful. If there are learning issues, behavioral issues, or problems with the site or the space, it is important to have someone present who can address these concerns, bring information back to the site and provide solutions. If a teacher cannot come, it is imperative that the program coordinator or lead mentor bring the information to the consulting teacher.

Leadership Development

An effective way to keep mentors engaged and committed throughout the course of the program year is to create leadership development opportunities for them both within the program and within the broader community and the college.

Opportunities for Program Leadership

Mentors should be given the chance to design and lead lessons. They should feel confident that suggestions they make for program improvements and changes are heard and heeded. This helps avoid resistance that can develop toward the coordinator and consulting teacher when mentors feel the agenda for Got Math? is imposed top-down by the “experts.”

Opportunities for Broader Leadership

Encouraging your mentors to design and develop workshop presentations for collegiate, K-12, and community service/service learning conferences about mentoring and Got Math? is a great way to help them develop confidence, build public speaking skills, process what they have learned and can share about their program, develop ownership of Got Math?, and increase their commitment to their work.
Other ways to develop leadership skills in mentors are: have them talk with evaluators, give them the task of communicating with the school principal or consulting teacher, ask them to go on the radio or TV when Got Math? is being highlighted, and assisting with planning and finding funding for the next year. Some mentors will appreciate and respond to these invitations and others will not.

ROLES

At The School

The Principal

The most important role of the principal is to show support for the program with all constituents – the school's staff, students and parents, and the Got Math? mentors and business partners. An engaged principal can raise the energy and commitment level of all the program's partners. It is important to inform the principal from the start if you are going to request his or her presence at events or publicity activities and to see if that kind of involvement and public face vis-à-vis the program is acceptable.

The Consulting Teacher

The consulting teacher is usually one whose students are in the program. Ideally he or she is offered a stipend to:

• Attend the program as time permits
• Attend mentor training and reflection occasionally
• Share information between the other teachers of Got Math? students and the program coordinator and mentors
• Assist with issues that arise in the day-to-day management of the program
• Offer suggestions and feedback regarding the curricular coverage of math and the participants' reported experiences of Got Math?
• Make arrangements for field trip buses
• Accompany all field trips
• Coordinate program evaluation with other assessments conducted by the school.

Having an engaged consulting teacher can make the crucial difference between a good and great Got Math? program. His or her enthusiasm, support for mentors, understanding of participants, ability to spot potential problems, and ability to communicate with others in the school about issues affecting Got Math? can help create an open, flexible, engaged learning environment for everyone. Other teachers in the school often follow this teacher's example in establishing their attitudes about the program.

However, with teachers being asked to do more and more with less and less, it is no wonder that elementary schools would be hard pressed to find someone willing and able to come to school and hour early, work with the same kids they see all day and coach inexperienced college students about teaching and classroom management techniques. While the program can be strong and effective without a Super Teacher on your side, having someone to help you negotiate the unique world of your school site can be a real asset.
With Business Partners

Partner Representatives

Each business partner will designate an employee to represent the company and serve as liaison to the program. Someone who works with math regularly and who relates well with children makes the best choice. The representative will advise on exercises and curriculum in cases where businesses other than those used here become partners. He or she also will consult with the program coordinator beforehand on what is planned for the presentation to the class (and may be reminded to keep it at least somewhat interactive). The partner presents at least one lesson and may introduce the whole unit. These partner presentations do more than expose kids to math, they expand horizons. For example, for the Math of Farming urban or suburban students may need to be introduced to a whole new way of thinking about where food comes from and what accounts for the cost of, let’s say, a tomato.

Typically, the business partner will supply samples of their product for use in the different lessons — representative grades/sizes of apples, simple molded products, varieties of paper and card stock. For the culminating event in each unit, the representative makes arrangements at the business end and will, as appropriate, prepare other employees to explain how math figures in what they do, specify where the bus is to drop the kids off, have safety goggles available, and plan the actual tour of the plant and/or related on-site activities.

Roles in the Program

Director of Special Programs

At other colleges the functions of this person might be assumed by an assistant dean or dispersed among others, but at Berkshire Community College the following administrative functions reside with this individual.

- Securing initial funding, all grant reports and grant management, securing funding for the next year
- Hiring staff
- Liaison with — work study office and service learning function, assisting program coordinator in the recruitment of mentors
- Fiscal management, making budget come out at the end, signing time sheets, etc.
- Substituting for the program coordinator on occasion
- Helping to publicize the program on campus and in the community
- Providing the quality control and coach function, as needed

Program Coordinator

The coordinator can assume some of the above duties if the funding and program are planned accordingly, but the coordinator’s primary function is orchestrating and delivering a dynamic learning experience for the children. This includes leading the after-school or before-school sessions and insuring that the necessary supplies are on hand for them to run smoothly. Liaison with the principal and consulting teacher also fall to the coordinator, as do communication with other parts of the college. Maintaining cordial relations with the college math department on the one hand and classroom teachers on the other should not be overlooked.
A major part of day-to-day implementation responsibilities of the coordinator relates to first recruiting, and then orienting and supervising the mentors. The weekly training and reflection sessions for mentors normally are conducted by the coordinator. Maintaining mentor esprit and enthusiasm for the program makes everything else go more smoothly.

Lead Mentor

While not essential, a lead mentor can ease the burden on the coordinator. Such a person could be a VISTA worker, a mentor returning from the year before, or simply a mature and responsible mentor ready to take on more responsibility. Such individuals sometimes emerge as the year progresses, and utilizing their potential provides the added plus of encouraging leadership development. Depending on the abilities of the lead mentor, duties can include:

- Insuring that there is mentor coverage for each group each time
- Recruiting additional mentors
- Conducting the reflection
- Keeping the supply closet organized and inventoried
- Getting supplies to sessions
- Conducting parts of whole-group sessions

LESSON PLANS

The lesson plans in the separate curriculum have been developed in an effort to reinforce and strengthen the central skill areas for third through fifth graders and to expose children to more advanced and sophisticated mathematical concepts and operations. The lesson plans are designed for a 50-60 minute time period. While many of the original Got Math? lesson plans can be utilized with minimal readjustment, several plans and lesson descriptions relate directly to the work of our community business partners. It may behoove you to hire someone with elementary education curriculum development expertise to help you design lesson plans that pertain to your designated partners.

ASSESSING IMPACT

In order to continue to secure funding for Got Math?, you’ll need to prove that it is effective at meeting its stated goals. If possible, hiring an external evaluator to help you create an assessment structure and assist in the data collection and interpretation takes an enormous load off of the program coordinator. Generally, assessment for Got Math? falls into the following general categories:

1. Skill Development
2. Participant Attitudes
3. Mentors’ Experience
4. Program Organization and Effectiveness
Pre- and Post Assessment

Testing Skills

A locally produced test that is grade appropriate is the least expensive and may be the best way to objectively determine progress. We have used the Stanford 9 Open-Ended Math Assessment available from Harcourt because our funding stipulated a nationally normed skills test and greater resources and emphasis on assessment than one would expect in a program that had progressed beyond the pilot or development phase.

Assessing Attitudes

Got Math? has been designed to help math-aversive students become more comfortable with the subject. The simple assessment we use at the beginning and end of the program appears on the next page.

Mentor Experience

The existing source for comprehensive assessment of the program from the mentor’s perspective is their own journals and reflection. We have had good results from asking them to do a summary reflection, which can be in the form of a memo to a college official, addressing what the program meant to them in the big picture of their learning and personal or professional growth, what benefits they saw for the children, and opportunities for program improvement.

Program Effectiveness

The evaluator will devise her or his own interviews, observations, or surveys to collect data deemed necessary in this area. Often funders will have specific questions they expect to be answered.
Sample Participant Evaluation

1. I think math is: (circle all that you agree with)
   OK  Hard  Easy  Stupid
   Interesting  Challenging  Fun
   Useful  Used in Computers  Used in Video Games

2. My friends like math.  Yes or No

3. The best thing about math class in school is: __________________________________________
   __________________________________________
   __________________________________________

4. The worst thing about math class in school is: __________________________________________
   __________________________________________
   __________________________________________

5. My favorite subject is: __________________________________________

6. On a scale of one to five (one is low and five is high), this is how I feel about math:
   1  2  3  4  5
APPENDICES

1. Task Checklist

2. Sample Mentor Recruitment Flyers

3. Sample Recruitment Letter to Parents

4. Parent’s Commitment Form

5. Session Schedule

6. Mentor Briefing Sheet

7. The Number Devil

8. The Got Math? Pie

9. Closing Celebration Invitation
<table>
<thead>
<tr>
<th>TASKS IMPLEMENTATION CHECKLIST</th>
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<tbody>
<tr>
<td>TASKS</td>
</tr>
<tr>
<td>Determine who will spearhead the program</td>
</tr>
<tr>
<td>Meeting(s) with Math Department and other players on campus</td>
</tr>
<tr>
<td>Campus representative meets with school principal and possibly an interested grade teacher</td>
</tr>
<tr>
<td>At least two business partners identified and committed</td>
</tr>
<tr>
<td>Funding source(s) identified, proposal drafted</td>
</tr>
<tr>
<td>Letters of support; college president, principal, strongest business partner</td>
</tr>
<tr>
<td>Proposal, budget, supporting materials reviewed for completeness and effectiveness before mailing. Be sure to budget for snacks and bus transportation home if program takes place after the school day</td>
</tr>
<tr>
<td>Proposal submission deadline</td>
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<tr>
<td>Award notice received</td>
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<tr>
<td>Set up grant account number and grant management system at the college</td>
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<tr>
<td>Secure remaining business partners</td>
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<tr>
<td>Prepare calendar for program; account for college and school vacations</td>
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<tr>
<td>Do press release</td>
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<tr>
<td>Recruit mentors</td>
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<tr>
<td>CORI checks for mentors, if required</td>
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<tr>
<td>Curriculum revision for first unit if needed</td>
</tr>
<tr>
<td>Mentor training; schedule ongoing training and reflection sessions</td>
</tr>
<tr>
<td>Recruit children for program</td>
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<tr>
<td>Select parents and get permission forms signed</td>
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<tr>
<td>Program and first unit begin</td>
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<tr>
<td>Pre-testing if desired</td>
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<tr>
<td>Unit Two begins</td>
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<tr>
<td>Mid-year reports</td>
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<tr>
<td>Plan some publicity</td>
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<td>Unit Three begins</td>
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<tr>
<td>Plan grant spend down</td>
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<tr>
<td>Post testing if desired</td>
</tr>
<tr>
<td>Recognition event</td>
</tr>
<tr>
<td>Final paperwork, reports, etc., completed</td>
</tr>
</tbody>
</table>
Sample Mentor Recruitment Flyer

Get Up a Little Earlier

.....Change a Kid's Life Forever!

BECOME A BCC  GOT MATH? MENTOR

If you like working with kids and you want some experience in a classroom, get involved with GOT MATH? You'll work with small groups of fourth-graders on fun, interactive projects.

What? A before-school math mentoring program run by BCC

Where? Highland Elementary School

When? Tuesdays and Thursdays from 7:30-8:45

How? To get involved, see Margo Shea in the Service Learning office (H218) ext. 337
Got Math?

Want to help kids improve their skills and increase their understanding of the world of math?

Be a GOT MATH? Mentor!

GOT MATH? meets Tuesdays and Thursdays, from 7:30a.m.-8:45a.m. at Highland School. As a mentor, you’ll work on projects with small groups of 4th graders. Have fun and help make a difference in your community!

See Margo Shea in Service-Learning (H218) or call ext. 337 to learn more.

(Federal Work Study Eligible!)
Sample Participant Recruitment Letter

10/16/2001

Dear Parent or Guardian

Math is an important success factor later in life, but nationwide many students have weak math skills and try to avoid math when they can. Fourth grade students at Highland School have the opportunity to participate in a creative new math program to be held this year.

For the past two years, Berkshire Community College has brought mentors from BCC to Pittsfield elementary schools for a creative math enrichment program called Got Math? In the first year, BCC partnered with Stearns, followed by Crosby. The mentors are math students at the college, and the children have very much enjoyed the projects and national recognition. This year the program has been funded again and will come to Highland. We invite you to apply for your child if you feel this would be beneficial. **You will also need to commit to bringing your child to the school early two mornings a week for approximately 20 weeks of the school year.**

Here’s how it will work. Beginning October 24, on Tuesdays and Thursdays fourth grade students in the program will arrive at Highland in time to begin Got Math? in the cafeteria at 7:45. They will work in small groups with trained BCC mentors in sessions under the direction of teacher Brendan Dillon and Got Math? Program Director Margo Shea. The program has been designed so that students will be doing projects and activities that require them to apply math in practical situations.

Each of the three major learning blocks has a local partner from the business world. The first is MedSource, formerly Apex Engineering, who will help us wit the Math of Plastics. The second block looks at the Math of Paper with our partner Crane Stationery Division. Our third block is the Math of Farming with Bartlett’s Orchards and the Orion Society (a national environmental education organization). Each unit culminates in a field trip to see math at work in the real world. After each session students will go directly to their regular classes.

We look forward to starting this exciting program on October 24th and hope your child can be a part of it.

Sincerely

Mary Ellen Trumble
Principal

Margo Shea
Program Director
COMMITMENT FORM
Please return to Crosby School Office by October 13.
Please use a separate form for each child.

I would like to enroll my child in the Got Math? Program, a before-school program running Tuesdays and Thursdays for this academic year. The program runs from 7:45 to 8:35 in the morning and follows the enclosed calendar.

By signing below I grant permission for my child to attend the program, for him/her to be photographed for news stories, and to take field trips. (Separate permission slips will be sent home for each field trip.)

Name of child: __________________________________________________________

Name of parent or guardian: ______________________________________________

Address: __________________________________________________________________

Phone number for the period 7:45-8:35 AM: ________________________________

Signature: __________________________________________________________________

QUESTIONS?
Call Victor Beaudin at 442-6667, ext 230 or Chris Nye at 499-4660, ext. 565.
WORD PLAY
and
GOT MATH?
SCHEDULE

<table>
<thead>
<tr>
<th>Tuesday</th>
<th>Thursday</th>
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<tbody>
<tr>
<td><strong>Session 1:</strong></td>
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<td>October:</td>
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<td><strong>Session 2:</strong></td>
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<td><strong>Session 3:</strong></td>
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<td>May:</td>
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<td>7</td>
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</tbody>
</table>

* Half-day of school

Total: 37 Meetings
MENTOR BRIEFING SHEET

GOT MATH?/CROSBY SCHOOL

Directions:

From downtown Pittsfield, come out West Street to the crest of the hill. See Crosby School back from the street on the left side.

Parking: Please bear right around the school building and use the parking lot at the back, not the areas in front.

Times: Since we will need to set up before the program begins, and since some children will be dropped off early, please be there by 7:40. The activities will run from 7:45 to 8:35. Then there will be some picking up. This should give you plenty of time to get back for 9:25 classes.

Dress: Remember that mentors are role models. You don’t need to dress up, but look clean and neat. No hats indoors.

Rest Rooms: There are rest rooms directly outside the Library entrance.

Signing in: When you get there, sign in with the teacher, Vic Beaudin for the first unit. You don’t need to sign the visitor book near the principal’s office.

Forms of address: Practice at the school is for adults to be addressed as Mr. or Ms, etc.; children are called by their first names.

FWS Timesheets: Work study money is available for BCC mentors in this program. If you think you are eligible, talk with Chris Nye about getting on the payroll. Work study students need to complete a weekly timesheet, get it signed by Vic Beaudin or Andy Mickle, and then turn it in.

Discipline: It is important to maintain order and keep the noise level down in the Library. If it is necessary to discipline a child, we recommend three levels of intervention.

1) If, for example, a child simply needs to be calmed down or centered, and verbal coaching doesn’t accomplish this, he or she can be separated from the group and asked not to return until he or she feels ready to rejoin and behave as a team player.

2) For more serious or repeated misbehavior, a more distant and decisive separation from the group needs to occur. The student rejoins only after the activity leader or teacher decides it is appropriate.

3) The final level of intervention, which should not be necessary here, the student can be referred to Mr. Mickle, the vice principal.
The Number Devil

How can one engage parents in making Got Math? even more effective? One option we recommend considering is selecting a book to be given out before the long Christmas break and then used by participants and their parents over the break and into Spring until it is completed. The paperback bestseller The Number Devil ($18.00 in 2001) can be review to see if it is a good choice for your group. The title page appears below.
TUNE in to WUPE 96 FM for the GOT MATH PIE

On April 26th, students in Got Math? had the chance to learn about fractions and measuring by baking apple pies. We saved and froze one of our pies for a good cause.

On Wednesday, May 9, 2001, from 3:10 – 3:19 p.m., the pie baked by GOT MATH? participants will be auctioned off on WUPE 96 FM and given to the highest bidder. You’ll be able to hear the students on the radio at that time. Proceeds from the pie will be donated to the American Cancer Society’s Relay for Life Campaign.
Sample Celebration Invitation

COME CELEBRATE A SUCCESSFUL YEAR OF GOT MATH?

BERKSHIRE COMMUNITY COLLEGE AND HIGHLAND ELEMENTARY SCHOOL INVITE YOU TO ATTEND THE GOT MATH? CELEBRATION TO WRAP UP A WONDERFUL YEAR OF MORNING-MATH, TO THANK THE TEACHERS AND MENTORS AND TO RECOGNIZE THE HARD WORK OF THE PROGRAM'S PARTICIPANTS WITH T-SHIRTS AND CERTIFICATES.

PLEASE JOIN US!

DATE: THURSDAY, JUNE 6, 2002
TIME: 7:00 P.M. – 8:00 P.M.
PLACE: BERKSHIRE COMMUNITY COLLEGE SBA LOUNGE

LIGHT REFRESHMENTS WILL BE SERVED.

IF YOU HAVE ANY QUESTIONS, PLEASE CALL MARGO SHEA AT 499-4660 x.337
GOT MATH?

CURRICULUM

Prepared by
Margo Shea and
Christopher Nye

Summer 2002

Education in Action/Service Learning
Berkshire Community College
1350 West Street
Pittsfield MA 01201
cnye@berkshirecc.edu

NSLC
c/o ETR Associates
4 Carbonero Way
Scotts Valley, CA 95066
#5302
FOREWORD

The *Got Math Curriculum* and its companion *Implementation Guide* should be used together. Questions that arise in going through these lessons will probably be answered in the *Guide*. We encourage adopters to be creative. As they inevitably work with different business partners, other colleges and schools will be able to adapt and improve on the lessons outlined here. For us the creative part has been the most rewarding—finding new and unexpected ways to connect math not just to the minds but to the lives of young people. *Got Math?* at its best is a matter of head, heart, and hands.

Each time we offer the *Got Math?* curriculum we find ways to make improvements. It will no doubt remain a work in progress. However, after three years the content, format, and delivery have settled enough so that Berkshire Community College staff and our funders at the INTEL Foundation both felt we had something worthwhile to share. We welcome further suggestions from replicators at cnye@berkshirecc.edu.

The curriculum and the whole *Got Math?* enterprise result from partnering on at least three levels. In chronological order, the college first partners with an elementary school that wants the program, has students who can benefit from it, and is willing to contribute in-kind resources to make it possible. Second, the college and school find three business partners who genuinely care about the kids in their community and are willing to help translate the math in their operation into age-appropriate lessons and skills.

The third partnership or bonding occurs when mentors and their groups begin to build their own micro learning communities, and the mutual support and enthusiasm they share provide a special ingredient to the learning process. This is something we don’t really understand, but we do know that it makes these experiences memorable. The program coordinator for the most part does not function as teacher. Rather she coaches and facilitates the best efforts of the mentors so that this third partnership gets off on the right foot and remains spirited and fruitful. In the lesson outlines, all activities are designed for the mentor-led groups of three or four students unless designated otherwise.

Our choice of curriculum units resulted from the choice of business partners. Communities with a different business and industrial base should be able to implement an adapted *Got Math?* without much trouble. For example, the Math of Plastics could easily be adjusted for other forms of manufacturing. In our first year we partnered with The Berkshire Museum for a unit called “The Math of Art and Nature.” In this unit we took up Fibonacci numbers, proportion, scale, and the Golden Sequence. There should be many partnership opportunities in most communities.

We hope the *Got Math? Guide* and *Curriculum* will stimulate creativity and sharing with others the profound satisfaction that comes from making partnerships and learning communities for the common good.

M.S. and C.N.
FIRST UNIT: THE MATH OF PLASTICS

Lesson 1

TITLE: Introduction to Got Math?

OBJECTIVES:
- To become acquainted with participants
- To explain and orient participants to Got Math
- To create small groups that will be in effect for the rest of the year
- To observe interactions between small group members

MATH SKILLS
- Not applicable

STANDARDS:
- Not applicable

SESSION OVERVIEW:
At the initial session, the objective is to set the tone for the program, play introduction games, create small groups and spend some time in the small groups designing name tags and playing Uno. The content is minimal in order to allow mentors the time to establish relationships with their students and to observe social interactions between group members.

SUPPLIES NEEDED:
- A bouncing ball
- Blank nametags
- A pocket folder for each participant
- Markers, crayons, drawing utensils
- 6 packs of UNO card games (one for each group)

LESSON OUTLINE:

1. Introductions: (whole group)
   - Find a large space that will enable the group to get into a circle. Create a large circle, mentors intermingled with students. Allow them to sit with their friends, so that when groups are created, the technique used to create them will result in mixed groups.
   - Toss the ball around the group with the instructions that when the ball is tossed to you, you have to say your name, and then add a category -- a food you like that begins with the same letter as your name, the street you live on, your favorite subject, your favorite band, etc.
   - Once the ball has rotated around group, toss the ball from person to person, repeating name and category, and see how fast the ball can be tossed without losing control.

2. Breakdown into Groups:
   - Staying in the large circle, instruct the students to count off but using a phrase, one word per person, i.e. "Hot Fudge Sundae With Marshmallow Topping." Each "Word" is a group.
3. Nametags
   - Students will get blank nametags that they can design and put their names on. Each group will have markers and crayons. Students will have to share. They also will get folders with pockets. Please explain that everything they work on during the program needs to go into the folder and the mentor collects the folder at the end of each session.
   - Please make a list of each student in your group.
   - Mentors should be role models, making a nametag and wearing it.
   - This is a time for mentors to get to know their students. Ask them questions about school, family, friends, etc.

4. Uno
   - Some lead-in questions might be helpful. (i.e., “How many of you have played UNO?” “How does Uno relate to math?” “Do you have to be good at math to be good at UNO?”).
Lesson 2

TITLE: Skills Assessment and Evaluation Pre-Test / Program Guidelines

OBJECTIVES:
- To determine students’ skill level and attitudes towards math
- To establish the program’s ground rules and to ensure that the students understand them

MATH SKILLS:
- Not applicable

STANDARDS
- Not applicable

SESSION OVERVIEW:
At this session, the objective is to present the skills test, the attitudinal test, and to go over the program’s guidelines.

SUPPLIES NEEDED:
- Skills test
- Attitudinal test

LESSON OUTLINE:
1. Skills Assessment:
   - Give each student a test and a pencil. Make clear to them that they will not be tested again until the end of the program and that the purpose is to determine their strengths in math and areas in which they might benefit from extra help. Reinforce that fun projects are the norm.

2. Attitude Assessment:
   - Give each student the attitude assessment

3. Overview of Program Ground Rules:
   - The program supervisor will call everyone’s attention to and go over, the program ground rules. (See sample in the appendix.) There will be time for questions and comments in small groups. Students should be asked if there is anything they wish to add to the guidelines or if they have suggestions for changes in the guidelines.

Pre- and Post-Assessments

Testing Skills  A locally produced test that is grade appropriate, is the least expensive, and may be the best way to objectively determine progress. We have used the Stanford 9 Open-ended Math Assessment available from Harcourt because our funding stipulated a nationally normed skills test and greater resources and emphasis on assessment than one would expect in a program that had progressed beyond the pilot or development phase. However, we are looking for a better alternative.

Assessing Attitudes  Got Math? has been designed to help math aversive students become more comfortable with the subject. The simple assessment we use at the beginning and end of the program appears in the implementation guide.
Lesson 3

TITLE: Can a Dinosaur Fit in the Gym?

OBJECTIVES:
- To determine whether or not an imaginary dinosaur can fit in a designated space
- To measure the length, width, and height of a large room and to compare that data with the information provided about the size of a dinosaur

MATH SKILLS:
- Working in three-dimensional space and with three-dimensional figures - understanding the concepts of length, width, height, and volume
- Measuring in both English and metric units and choosing appropriate units of measure in each system
- Problem solving to devise strategies for estimating measurements. (How do you measure the height of a gymnasium?)
- Reading tables and picking out relevant information (such as dinosaur dimensions)
- Presenting data with bar graphs
- Drawing conclusions based on comparisons between table data and measurement data
- Communicating results and conclusions clearly to the rest of the class

STANDARDS:
Geometry, Measurement, Problem Solving, Communication, Connections, Representations

SESSION OVERVIEW:
During this session, groups will determine the most effective ways to measure the designated space (gym, cafeteria, classroom), measure the space, and determine whether or not a dinosaur they have chosen from a provided list would fit in the space. After that, students will graph the dinosaurs.

SUPPLIES NEEDED:
- North American Dinosaur Data Sheet
- N.A.D. Graphing sheet
- Could a Dinosaur Fit in the Gym? Worksheet
- Rulers
- Yardsticks (can be shared)
- 3 helium-filled mylar balloons with a long string, to be shared among groups for measuring the height of the gym

LESSON OUTLINE:
1. Discussion in Groups / Preparation 5 minutes:
   - Use the North American Data Sheet to choose a dinosaur and decide whether or not it will fit inside the gym.
• Ask students the following, “How can you tell how big the dinosaur is? How can you tell how big the gym is?” Encourage them to share with you their knowledge of measurement.

• Explain the different between metric and English standards of measurement and be sure that the students can identify the two different standards on their rulers / yardsticks.

• Establish tasks and assignments. Groups can be combined to complete tasks if necessary.

2. Measurement of the Gym (or other designated space) 15 minutes:
   • Have everyone bring the worksheet and pencils into the gym.
   • Students should follow the sheet’s questions, measuring the room and the doors.

3. Data Recording and Graphing 10 minutes:
   • Use the worksheet Could a Dinosaur Fit in Our Gym? to answer the questions.
   • A lot of your students will not have graphed before. Do this activity as a whole group, going down the list and asking them to tell you, “How many dinosaurs are 2 m?” etc.

4. Whole Group Feedback 5 minutes
   • Ask one person from each group to volunteer to tell the class which dinosaur they chose and whether or not it would fit in the gym and why/why not.
# North American Dinosaur Data Sheet

<table>
<thead>
<tr>
<th>Name</th>
<th>Length*</th>
<th>Height*</th>
<th>Number of legs</th>
<th>Food</th>
<th>Where found in North America</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allosaurus</td>
<td>11 m</td>
<td>5 m</td>
<td>2</td>
<td>Meat</td>
<td>Colorado, Utah, Montana, Texas, Western Canada, Wyoming</td>
</tr>
<tr>
<td>Anchisaurus</td>
<td>2 m</td>
<td>50 cm</td>
<td>4</td>
<td>Plant</td>
<td>Connecticut, Massachusetts, Arizona</td>
</tr>
<tr>
<td>Apatosaurus (Brontosaurus)</td>
<td>21 m</td>
<td>9 m</td>
<td>4</td>
<td>Plant</td>
<td>Colorado, Oklahoma, Utah, Montana, Texas, Wyoming, Mexico</td>
</tr>
<tr>
<td>Brachiosaurus</td>
<td>23 m</td>
<td>12 m</td>
<td>4</td>
<td>Plant</td>
<td>Colorado, Wyoming</td>
</tr>
<tr>
<td>Coelophysis</td>
<td>3 m</td>
<td>1 m</td>
<td>2</td>
<td>Meat</td>
<td>Arizona, Connecticut, Texas, New Mexico</td>
</tr>
<tr>
<td>Corythosaurus</td>
<td>10 m</td>
<td>6 m</td>
<td>2</td>
<td>Plant</td>
<td>Western Canada, Mexico</td>
</tr>
<tr>
<td>Dilophosaurus</td>
<td>6 m</td>
<td>3 m</td>
<td>2</td>
<td>Meat</td>
<td>Arizona</td>
</tr>
<tr>
<td>Diplodocus</td>
<td>27 m</td>
<td>7 m</td>
<td>4</td>
<td>Plant</td>
<td>Colorado, Wyoming, Utah</td>
</tr>
<tr>
<td>Euoplocephalus</td>
<td>6 m</td>
<td>2 m</td>
<td>4</td>
<td>Plant</td>
<td>Alberta</td>
</tr>
<tr>
<td>Hadrosaurus</td>
<td>9 m</td>
<td>5 m</td>
<td>2</td>
<td>Plant</td>
<td>New Jersey, New Mexico, Montana, Alberta</td>
</tr>
<tr>
<td>Nodosaurus</td>
<td>5 m</td>
<td>2 m</td>
<td>4</td>
<td>Plant</td>
<td>Kansas, Wyoming</td>
</tr>
<tr>
<td>Ornitholestes</td>
<td>2 m</td>
<td>1 m</td>
<td>2</td>
<td>Meat</td>
<td>Wyoming, Colorado, Utah</td>
</tr>
<tr>
<td>Parasaurolophus</td>
<td>10 m</td>
<td>6 m</td>
<td>2</td>
<td>Plant</td>
<td>Alberta, New Mexico, Utah</td>
</tr>
<tr>
<td>Pentaceratops</td>
<td>7 m</td>
<td>3 m</td>
<td>4</td>
<td>Plant</td>
<td>New Mexico, Alberta</td>
</tr>
<tr>
<td>Segisaurus</td>
<td>1 m</td>
<td>30 cm</td>
<td>2</td>
<td>Meat</td>
<td>Arizona</td>
</tr>
<tr>
<td>Stegoceras</td>
<td>2 m</td>
<td>1 m</td>
<td>2</td>
<td>Plant</td>
<td>Alberta</td>
</tr>
<tr>
<td>Stegosaurus</td>
<td>7 m</td>
<td>4 m</td>
<td>4</td>
<td>Plant</td>
<td>Colorado, Oklahoma, Utah, Wyoming</td>
</tr>
<tr>
<td>Torosaurus</td>
<td>7 m</td>
<td>3 m</td>
<td>4</td>
<td>Plant</td>
<td>Colorado, Montana, Texas, Wyoming, Alberta</td>
</tr>
<tr>
<td>Triceratops</td>
<td>9 m</td>
<td>6 m</td>
<td>4</td>
<td>Plant</td>
<td>Alberta, Colorado, North Dakota, South Dakota, Montana, Wyoming, Saskatchewan</td>
</tr>
<tr>
<td>Tyrannosaurus</td>
<td>14 m</td>
<td>6 m</td>
<td>2</td>
<td>Meat</td>
<td>Montana, Wyoming</td>
</tr>
</tbody>
</table>

*Length and height measures are estimates.

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Graph the Dinosaurs' Lengths

Work in a group.

1. Follow these steps to make a bar graph to show the number of dinosaurs of each length:
   a) Title the graph.
   b) Find the length of each dinosaur from the data sheet. Mark an X on the graph for that length.

2. Write a question about the lengths of dinosaurs that can be answered by looking at your graph.

3. Write an answer to your question.

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Could a Dinosaur Fit Inside Our Gym?

Using the North American Dinosaur Data Sheet, pick a meat eating dinosaur and write down its measurements.

Name of dinosaur:

Length:

Height:

1. Could your dinosaur fit through the door to get into the gym? Tell how you know whether it could fit.

2. Could your dinosaur fit inside the gym, even if it could not squeeze through the door? Tell how you know whether it could fit.

3. Use your data sheet. Name 4 other dinosaurs that will also fit inside your classroom. Tell how you know they could fit.

Lesson 4

TITLE: Measuring and Describing Objects

OBJECTIVES:
- To practice measuring skills
- To learn how to describe objects using an array of criteria, including size, length, width, color, weight, texture, etc.

MATH SKILLS:
- Collecting and tabulating measurement data.
- Comparing and manipulating (adding) data.
- Devising a system to categorize objects based on measurable attributes, such as length, height, weight, etc.
- Applying deductive reasoning to solve “what am I?” riddles.
- Communicating results and conclusions to the rest of the class.

STANDARDS:
Numbers and Operations, Measurement and Communication, Reasoning, Representation, Data Analysis

SESSION OVERVIEW:
During this session, groups will measure smiles, outline and measure their mentors' figures and record information on a provided data sheet. Following that, groups will make up riddles, and in doing so practice describing small objects.

SUPPLIES NEEDED:
- rulers
- yardsticks
- graph paper
- roll of newsprint or at least 20 pieces of poster board
- thick markers (washable)
- tape
- measuring data sheet
- for each group a grab bag with 8 objects of assorted sizes and shapes

LESSON OUTLINE:

1. Measuring Smiles:
   - Pair up your group into teams of two. Each student will measure the other’s smile and then write down the length. Once each person has had his/her smile measured have them draw a line the length of their smile on graph paper. Tape your lines together. Measure the length of your group’s smiles. When all the groups have done this, add up the length of everyone’s smiles and tape them together to see how long that is.

2. Measuring Mentors
   (Note: If a mentor is uncomfortable with this activity for any reason, suggest alternatives, i.e. have a student volunteer or another mentor be outlined etc.)
• Tape three large pieces of white paper or newsprint together. Have students outline mentor’s body with markers. Set your own parameters for comfort (e.g. ‘only the outside lines, not the inside ones.’)
• Next, give students rulers and the yardsticks and have them measure the length and width of the entire outline, the head, the legs, the feet, etc. Have them record their answers on the data sheet.

3. Describing Small Objects:
• Have a conversation with your students about the different elements of an object one can use to describe it (Is it big or small? Is it heavy or light? How long is it? What color is it? What shape is it? Is it rough or smooth?)
• Each table has a grab bag. Have someone pull out a small object and describe one thing about it. Ask each student to add a different description. (“It is round. It is red. It can be thrown easily.”)
• Pick an object and have the group write a riddle. Other groups will have to try to guess what the object is. Example, “I am 4” wide and 6” long. I am flat and can be shiny or not shiny. I am similar to paper. I can contain images of almost anything. People like to show me off. What am I?” (a photograph.)
MEASURING AND DESCRIBING OBJECTS
DATA SHEET

Name of Team Member X

Name of Team Member Y

Length of X's smile inches

Length of Y's smile inches

Height of mentor feet inches

Width of mentor feet inches

MEASURING AND DESCRIBING OBJECTS
DATA SHEET

Name of Team Member X

Name of Team Member Y

Length of X's smile inches

Length of Y's smile inches

Height of mentor feet inches

Width of mentor feet inches
Lesson 5

TITLE: Molds and Mold-Making I

OBJECTIVES:
• To learn about molds and the mold-making process
• To use Play-Doh and molds to practice two different molding techniques
• To learn about and practice estimation
• To learn how to weigh objects with a triple-beam scale

MATH SKILLS:
• Understanding standard metric weight units.
• Performing metric conversions.
• Understanding the concepts of precision and scale when measuring weight with a triple beam balance.
• Using addition to determine the weight of an object using a triple beam balance.
• Estimating (How much material will the mold hold?)
• Understanding the role that mathematics plays in manufacturing, especially in regard to cost and conservation of resources and materials.

STANDARDS:
Numbers and Operations, Measurement, Connections

SESSION OVERVIEW:
At this session, the objective is to introduce the first major business partner, a company that designs and manufactures plastic objects used in medical fields. Most of their objects are made by using molds.

SUPPLIES NEEDED:
• Play-Doh Model Kits - 2 per group
• Play-Doh
• 3-6 Triple beam scales
• 24 foam or paper bowls
• Paper

LESSON OUTLINE:
Note: If you are sharing triple-beam scales among the groups, rotate the small group activities so that all groups get the chance to use the scales.

1. Briefing and Preparation for Activity: (whole group)
   • Ask your students why one would choose to design a mold to make an object instead of just making the object over and over. (Precision, mass production, etc.)
   • Explain that molding also known as injection, is a process by which we take raw plastic material in the form of small pellets, heat it gently to the point where it will flow under moderate pressure, and inject it (push it with a plunger) into a mold. The mold is made up of two separable halves. There are two primary types of molds – extrusion molds and compression molds.
• Extrusion refers to pushing material through a mold.
• Compression refers to flattening material between two halves of a mold.

2. Estimation: (small group 1)
• Ask your students if they know what it means to estimate. Explain to them that estimation is “an educated guess.” You can give them some examples of estimating.
• Explain that one of the important things in business ventures is to ensure that you do not waste resources. Making a guess, or estimating the material you need for a product is an important aspect of product development.
• Have your students look at their mold kits and ask them to estimate how much Play-Doh they will need to complete their mold.

3. Weighing: (small group 2)
• Each student weighs their Play-Doh in a foam bowl.
• Teams of two students can use the triple-beam scale at a time. One person can move the beams while the other is the “lookout” who watches to see when it approaches zero.

4. Making Objects with Play-Doh and Molds: (small group 3)
• Students will work together, sharing one of the two mold kits at the table.
• Encourage students to compare the difference between extrusion and compression.
• At the end, see if students had too much or too little Play-Doh.

5. Clean Up
• Make sure there are no Play-Doh remnants left over on the tables.
Lesson 6

TITLE: Reflective Transformation

OBJECTIVES:

• To design and create alphabet steps
• To learn about reflective transformation – making something “backwards” so that it comes out “forwards”
• To practice measuring skills

MATH SKILLS

• Understanding basic concepts of geometric translations and rotations.
• Understanding how geometric transformations are used in mold design.
• Working with processes that involve planning, sequencing, and following directions.
• Performing direct variation calculations to estimate the amount of material needed for a mold.
• Representing fractions with a physical model.

STANDARDS:
Geometry, Measurement, Reasoning and Proof, Representations

SESSION OVERVIEW:
At this session, students will have the chance to design and create stamps that spell out their first names. Through this process, they will learn and understand reflective transformation, a technique often employed by mold-makers. They will draw a “plan” and work from the plan to create their stamp.

SUPPLIES NEEDED:

• 4 tubs of Model Magic
• Small mirrors
• Rolling pins or smooth cylindrical glasses or bottles
• Rulers
• Brown “lunch” bags
• 8 1/2” x 11” graph paper

LESSON OUTLINE:

1. Briefing and Preparation for Activity:
   • Ask your students if they ever saw the reflection of something in a mirror or water. What is different between the object itself and the reflection? Usually things look backwards.
   • Explain that mold designers have to design their products “backwards” in order to have the material that gets injected come out of the mold “forwards.”
   • Explain that in order to do this, designers work from detailed plans.

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2. Designing Plans for Name Stamps
   • Students should write their names, the first letter 2 inches high, the rest of the letters one inch high, on a piece of graph paper.
   • Next, they will turn over the graph paper and trace the outlines of their letters on the other side.
   • Mirrors are available for students to check their names and to make certain that their plan looks the way they want it to when the product is complete.

3. Dividing the Model Magic and Fractions Discussion
   • Use the splitting of the clay material to discuss fractions. Start by splitting one bag of one color in half, then quarters, then eighths. You can ask students to volunteer to split the clay and name the fraction produced.
   • (Using different colors will not affect the final product, since students will be using stamp pads to stamp their names out.)

4. Creating the Stamp
   • Students will create a flat surface for the base of the stamp and use the model magic to create the letters. Use a rolling pin or sturdy glass to roll out clay.
   • Explain to students that the base should include an edge surrounding the actual letters that should be at least 1/2 inch, because the material shrinks (have students measure and lightly mark this margin). Each individual letter should be placed in order on the base.
   • Stress to students that they should have the material be a uniform thickness when they are shaping their letters. The letters should be exactly the same as their “plan.”
   • Each finished stamp should go into a baggie with the child’s name.
   • Explain to your students that we will use the stamps to create a poster at the next session.
   • Before the next session: allow each stamp to cure on a flat surface with baggie open so it becomes hard enough to use for stamping.
Lesson 7

TITLE: Molds and Mold-Making II

OBJECTIVES:
- To complete the stamping project by making a group poster.
- To learn about units of measure for volume and capacity.
- To explore molds by making JELLO “jigglers.”

MATH SKILLS:
- Understanding the concept of volume.
- Understanding volume measurement, including measurement methods and appropriate volume units.
- Following an algorithm (in this case a recipe for making jello).
- Using multiplication to perform direct variation calculations.

STANDARDS:
Geometry, Number and Operations, Measurement, Reasoning, Representation

SESSION OVERVIEW:
At this session, the objective is to complete the stamp project by applying ink to the stamps and stamping out everyone’s name on a collective poster. Following that, the group will make Jello “jigglers,” using ice cube molds and jello. Volume, capacity and reflective transformation will be discussed.

SUPPLIES NEEDED:
- Stamp pads
- Newsprint roll
- Ice cube trays with different shapes (dolphins, stars, hearts, etc) (one per group)
- Jello packages (one per group)
- Sugar
- Measuring cups and measuring spoons for each table
- Stainless steel bowl
- Boiling water
- Access to a refrigerator to cool the jigglers.

LESSON OUTLINE:
1. Completing the Stamp project:
   - Work with the ink pads one group at a time. Use the inkpads to stamp out names onto newsprint. Once all the groups have stamped out their names, tape the poster up so everyone can see the final product.

2. Learning about Volume and Capacity:
   - Ask your students how one might measure how much a glass or cylinder can hold. Can you use a ruler? Explain that there is a separate standard of measurement used to figure out how much something can hold.
   - Explain that cubic measure is the unit of measure for volume or capacity.
• Explain that the definition of volume is the amount of space occupied by a three-dimensional object. The capacity – how much it could hold – is expressed in cubic units. More often we talk about how much something actually holds, which is measured in milliliters and liters in metric system, in ounces, pints, or quarts in the English system.

3. Prep for Jello Jiggles Production
• Show your students an ice-cube tray. Ask them how you can measure the amount of liquid inside. Ask them how the mold was made.
• Ask, “What substances can we put into the tray that will take the shape of the mold when frozen?” (i.e. water, juice, pudding) Try to get as many answers as possible. Ask them what would not take the shape of the mold and why.
• Ask them if they think the same amount of liquid will go in each individual shape. Why or why not?

4. Making the Jello Jiggles
• Have one student read the directions completely out loud.
• Ask for volunteers to tell you what is the first thing you need to do.
• Give each student a task.
• Figure out the measurement of the amount of mix that goes into each mold. See if your students can determine how much goes into the entire ice tray. Do the calculation for them into a larger unit of measurement. (i.e. 3 teaspoons = 1 Tablespoon.
• Once the jello is mixed, have students take turns pouring the mix into the molds, one at a time.
• The program coordinator will come to each table with the kettle of boiling water and place the ice trays in the freezer for cooling.
Lesson 8  (This session could vary greatly from year to year or with a different partner. The following illustrates what has occurred most recently.)

TITLE: Presentation by Community Business Partner
Chip Schnackenberg Plastics Design Engineer for MedSource Technologies

OBJECTIVES:
• To investigate results of the Jello Jiggler project
• To learn from Chip Schnackenberg about the math involved in mold-making
• To prepare for field trip to MedSource Technologies and to become familiar with the work they do
• To learn more about mold-making

MATH SKILLS
• Not applicable

STANDARDS:
• Not applicable

SESSION OVERVIEW:
The purpose of this session is to encourage the understanding of students about the projects they have worked on and their connection to the work of MedSource in plastics and mold making.

SUPPLIES NEEDED:
• None

LESSON OUTLINE:

1. Jello Jigglers
   • Mr. Schnackenberg will lead this conversation, asking the students to explain how they made them and to explain what they know about mold making and mass production.

2. Presentation
   • Mr. Schnackenberg will show a short video and talk about how math is used at his workplace.
   • At the end Mr. Schnackenberg will give our students an assignment.
   • The assignment is to design and create a key chain that can hold a quarter.
Lesson 9

TITLE: Designing Key Chains that Hold a Quarter

OBJECTIVES:
- To review the visit from Mr. Schnackenberg
- To design and draw models for key chains that will hold a quarter
- To do practice models with Play-Doh
- To prepare for the visit to MedSource Technologies at the end of the unit

MATH SKILLS
- Understanding the meaning of diameter and circumference.
- Measuring diameter and circumference.
- Defining geometric specifications and then designing an object to meet the specifications.
- Transitioning from two-dimensional to three-dimensional representations of a design.
- Using math in the creative process.

STANDARDS:
Measuring, Geometry, Connections, Representation

SESSION OVERVIEW:
The purpose of this session is to offer students an opportunity to create a blueprint and model of an object, to teach them about the concept of making an object so that it meets specific criteria and to learn about the experimentation process.

SUPPLIES NEEDED:
- Play-Doh
- Graph paper (one half sheet per student)
- Rulers
- Quarters (a few for each table)

LESSON OUTLINE:
1. Review of Visit:
   - Ask your students what they remember from Mr. Schnackenberg’s visit. What was most interesting to them? What do they hope to see or learn at the field trip visit to MedSource? What are some things MedSource manufactures from molds?
2. Key Chain Project Prep:
   • Explain to your students that each of them will be designing a key chain that
     will have some way of holding a quarter. In essence, they will be designing a
     key chain with a quarter mold somehow embedded into it. The key chain
     shape itself can be anything.
   • Raise the following questions with your students:
     ➢ What size is a key chain normally?
     ➢ What size fits well in the pocket?
     ➢ How can you ensure the quarter will not fall out of the mold?
   • Explain to your students that they will only receive about two handfuls of
     model magic to make their final key chain, so they should design accordingly.

3. Drawing the Design
   • Students will use the ruler and the quarter to draw their design.

4. Making a “Mock-Up” of the Design with Play-Doh
   • Ask your students what the benefits of making a “mock-up” are.
   • Students can use the Play-Doh to make a three dimensional mock-up. Explain
     to them that they will not keep the Play-Doh designs.
   • Explain that they will make the actual key chains at the next session, using
     material that will harden and become more durable.
Lesson 10

TITLE: Designing Key Chains that Hold a Quarter II

OBJECTIVES:

- To create key chains that will hold a quarter

MATH SKILLS

- Understanding the meaning of diameter and circumference
- Measuring diameter and circumference
- Defining geometric specifications and then designing an object to meet the specifications.
- Transitioning from two-dimensional to three-dimensional representations of a design.
- Using math in the creative process.

STANDARDS:
Measuring, Geometry, Connections, Representation

SESSION OVERVIEW:

The purpose of this session is to offer students an opportunity to take the process of designing a model to the next step by creating an object from their design. It gives them an opportunity to take a concept and to make it a reality. The key chains they design sometimes have to be made in a more simple fashion than the students initially intended.

SUPPLIES NEEDED:

- Model Magic (six large tubs with 4 bags each – in white, yellow, blue and red and multi-colored)
- Graph paper
- Rulers
- Quarters (a few for each table)
- Brown paper lunch bags

LESSON OUTLINE:

The purpose of this session is to create the key chains that were designed during the previous session.

1. Splitting up Model Magic

   - Note: Model Magic dries and hardens so be careful when opening bags and be sure you don’t open too much. It is expensive.
   - Your group should receive two bags of model magic. Each bag should be split into eight pieces. Each child should receive 2 pieces.
   - Share with another group if you want to make additional colors available.
2. Making the Key Chains:
   • Students can create their key chains.

3. Storing the Key chains:
   • When students have completed their key chains, give each student a brown paper bag. Have them put their name on the bag.
   • The key chains can be transported in the bags to a place where the key chains can be taken out of the bags and allowed to sit for two days. The Model Magic will not harden properly if the key chains do not air.
Lesson 11

TITLE: Measuring and Weighing Review

OBJECTIVES:

- To measure the key chains, using both English and metric units
- To weigh key chains
- To record data

MATH SKILLS

- Understanding the meaning of diameter and circumference.
- Measuring diameter and circumference.
- Converting between English and metric units.

STANDARDS:

Measuring, Geometry, Connections,

SESSION OVERVIEW:

The purpose of this session is to enable students to work with their key chains, testing to see if they hold a quarter and then measuring them, weighing them and converting the measurements from English to metric units of measurement.

SUPPLIES NEEDED:

- Rulers
- Quarters (a few for each table)
- Measurements worksheets
- Scales (triple beam preferred)

LESSON OUTLINE:

1. Key Chain Testing:
   Allow students to use quarters to test if key chains can actually hold a quarter.

2. Once students have completed work with their key chains, give every one a ruler and ask them to complete the measurement sheet.

3. Within your group, have your students compare their results to determine who has the longest and shortest key chains at the table.

4. Ask students to determine how to use the information about the difference between a centimeter and an inch to figure out how many centimeters their key chains are. If students are able to, ask them to multiply in order to arrive at the number of centimeters.

5. For students without strong multiplication skills, ask them to tell you how else they might arrive at the length of their key chain in centimeters.

6. Have your students measure their key chains using the metric system.

7. Once your students have completed measurements, ask them to work in teams to weight their key chains and complete the weights worksheet.
KEYCHAIN MEASUREMENTS

1. How long is your keychain in inches?
2. How tall is your keychain in inches?
3. How wide is your keychain in inches?
4. Who has the longest keychain at your table?
   How long is it? _________
5. Who has the shortest keychain at your table?
   How long is it? _________
6. What is the difference (in inches) between the shortest and the longest keychain? _____________
   One inch is equal to 2.54 centimeters. If we multiply the number of inches by 2.54, we will find out how much our measurement is in centimeters.
7. How long is your keychain in centimeters? _____________
8. How can you check your answer to question 7?
KEYCHAIN WEIGHTS

1. How much does your keychain weigh in ounces? __________

2. Who has the heaviest keychain at your table? __________
   How much does it weigh? __________

3. Who has the lightest keychain at your table? __________
   How much does it weigh? __________

4. What is the difference (in ounces) between the heaviest and the lightest keychain? __________

5. How much does your keychain weigh in grams? __________

6. Who has the heaviest keychain at your table? __________
   How much does it weigh? __________

7. Who has the lightest keychain at your table? __________
   How much does it weigh? __________

8. What is the difference (in grams) between the heaviest and the lightest keychain? __________
Lesson 12

TITLE: Field Trip to MedSource Technologies

OBJECTIVES:
- To visit MedSource Technologies site
- To make as many connections as possible between math skills learned and math applications in this business

Lesson 13

TITLE: Thank You Notes and Evaluation

OBJECTIVES:
To write thank you notes to Mr. Schnackenberg and to query students regarding what they have and have not enjoyed thus far in the program.

SUPPLIES NEEDED:
- Construction Paper
- Markers and crayons
- A sample thank you note
- Notebook paper

LESSON OUTLINE:

1. Field Trip Review:
   Ask your students to tell you what they liked and what they learned at Med Source. What was most memorable? Who did they meet? Did anything surprise them? Where was the use of math most crucial to the operation?

2. Thank You Notes:
   Each member of the group should create a card and write a thank you note to Mr. Schnackenberg and the staff at Med Source. Using the sample to check spelling and format, each student should write at least three things s/he liked or learned. Students can draw pictures once they have finished writing.

3. Evaluations:
   Once students have completed their thank you letter, give each one a piece or a half piece of notebook paper and ask them to write down the things they have liked so far about Got Math? as well as anything they might not have liked. Explain that this information will be used to make improvements in the next unit.
SECOND UNIT: THE MATH OF PAPER

Lesson 14

TITLE: Math Ball

OBJECTIVES:

• To reorient participants to Got Math after the month-long break
• To practice critical questioning.
• To learn the basics of number patterns and multiples.

MATH SKILLS

• Understanding numbers, including number patterns, multiples, and factors.
• Developing fluency in addition and subtraction.

STANDARDS:

• Number and Operations, Reasoning

SESSION OVERVIEW:

The purpose of this session is to build high energy and spirit for Got Math following the month-long program break. By playing an interactive game in the gymnasium or other large space, participants will have the chance to play with the concepts of factors and multiples or addition and subtraction.

SUPPLIES NEEDED:

• A bouncing ball
• Access to a gym or other large space

LESSON OUTLINE:

1. Math Ball Game (whole group)
   • Form a big circle.
   • A mentor will start the game by naming a category or problem, for example, “Add 2 to the number, beginning with 0.” They will start (0+2=2, 2+2=4, 4+2=6, 6+2=8.) Another example is, “Subtract 3 from the number, beginning with 30.” They will start 30-3=27 and so on.
   • If it is too hard, students can say, “PASS” if the ball comes to them.
   • Once the category gets either too difficult or too boring, a mentor can change the category. Have mentors ask for suggestions for a new category.
   • When doing addition, start with 0.
Lesson 15

TITLE: Twenty Questions

OBJECTIVES:
- To learn the basics of number patterns and multiples.
- To learn the relative magnitude of numbers.
- To understand the order of numbers.
- To learn to ask questions using logic and reason.
- To learn to track and record data.

MATH SKILLS:
- Understanding numbers, including relative size and patterns
- Understanding the concepts of multiples and factors
- Using mathematical concepts, deductive reasoning and logic to solve a number problem
- Developing fluency in multiplication and division

STANDARDS:
- Numbers and Operations, Reasoning

SESSION OVERVIEW:
The purpose of this session is to use a familiar game, twenty questions, to increase students’ ease and fluidity using numbers. By playing a guessing game with numbers, students can practice concepts like relative size, patterns, multiples, and factors.

SUPPLIES NEEDED
- Number line charts scaled from 0 to 50.
- A large piece of paper or newsprint for each group

LESSON OUTLINE

1. Twenty Questions Explanation and Preparation
   - Give each student a number line chart. Two types follow this lesson.
   - Explain to them that we are going to play a game where someone thinks of a number between one and fifty and everyone has to ask questions (up to 20 questions) to try to determine the number.
   - To start, have one of them guess a number and see if you can get it. This will give you a chance to model the kinds of questions you want them to ask.
2. Playing Twenty Questions
   - Encourage your students to ask smart questions. For example, “Is it smaller than 20? is a better question than, “is it 20?”
   - Have them cross off the numbers that they disqualify on their number lines.
   - Write their questions on the big sheets of paper.
   - Each new set of Twenty Questions requires a new number line.
   - Do a few, then give them turns doing a few. See if you can get them to ask harder questions.
   - After you’ve done it with a scale of 0-50 a few times, go to larger and larger numbers.
Lesson 16

TITLE: Stepping Through Paper and Balancing a Book

OBJECTIVES:

• To introduce the Math of Paper
• To problem solve by trying to “step through a piece of paper.”
• To learn about basic physics by trying to get a piece of paper to hold up a book.

MATH SKILLS:

• Working with area and perimeter.
• Problem solving using geometry and the concepts of area and perimeter.
• Exploring the connection between an object’s geometric characteristics and its strength.
• Communicating conclusions and results of observations to the class.

STANDARDS:
Geometry, Connections, Communication

SESSION OVERVIEW:
The purpose of this session is to engage groups in teamwork for problem solving. In the first activity, they will each have an individual piece of paper but they should brainstorm together about how to step through it. In the second activity, the group will work together to create something from paper that will hold a book.

SUPPLIES NEEDED:

• Plenty of copy paper (from the recycling bin if possible)
• Construction or thick stock paper
• Scissors for everyone
• Some newsprint

LESSON OUTLINE:

1. Stepping Through Paper Explanation:
   Give each student a piece of 8 1/2 x 11 copy paper with extra readily available and ask them how to step through it without tearing it, and by keeping it intact around all its edges. How can you make the center bigger? Let them experiment and then lead them through the following steps.
2. Stepping Through Paper Instructions:
   • These are the directions for how to step through paper:
     • First, take a sheet of paper and fold it in half so the short ends meet.
     • Now, cut a large rectangle from the center of the paper at the fold.
     • Next, make alternating cuts from the cutout rectangle toward the outer edge
       and also from the outer edge toward the cutout rectangle. Do not cut all the
       way through on any of the cuts and do not let any of the cuts touch each
       other.
     • Now unfold the paper and see how easily you can get yourself through the
       sheet of paper without ripping or tearing it.

3. Balancing a Book on a Piece of Paper
   • Ask your students if they think it is possible to balance a book on a sheet of
     paper. How might it be possible?
   • First, have them try to balance a book on an upright sheet of paper. What
     happens?
   • Try to fold paper into a V shape. What happens now?
   • Roll a piece of paper along its short end using masking tape as adhesive.
   • What other shapes will support something as heavy as a book?
   • Explain why the shape of the paper structure affects its strength because of
     the distribution of weight and multiple plies.
Lesson 17

TITLE: Origami

OBJECTIVES:
- To learn about origami and its cultural significance in Japan
- To follow directions and make a crane from origami

MATH SKILLS:
- Using directions to create basic geometric shapes, such as a square, rectangle, circle, and ellipse.
- Following directions to create origami figures.
- Connecting math and art.

STANDARDS:
Geometry, Connections

SESSION OVERVIEW:
The purpose of this session is to follow step by step directions and models to create an origami crane. In the process, the students will learn about the significance of paper cranes made from origami in Japan.

Note: Mentors need to be trained in advance to make cranes. Either the program coordinator or the mentors or both need to sit down prior to this session and create step-by-step models of each fold. That way, students can both follow directions from the mentor but also have a visual model to look at each step of the way.

SUPPLIES NEEDED:
- Packages of Origami
- Origami Models at each step for each table
- Origami instructions for each table

LESSON OUTLINE:

1. Introduction to Origami:
   - Explain the following story to your students:
     It is Japanese legend that folding 1000 cranes (senbazuru) so pleases the gods that the folder is granted a wish. Sadako, a little girl who contracted leukemia after a nuclear bomb was dropped on her home city, wished to get well. She folded almost 1000 cranes but then she died. All of her friends made cranes in her honor. Her story, as presented in several books, has become an inspiration for school children worldwide to fold cranes in a wish for peace.
     - Explain that origami is a traditional Japanese art form and that we will be making paper cranes.
2. Making Cranes
   - At each table there should be a set of origami paper, at least one set of directions for making cranes and the full series of folds, step one through the final step.
   - Students will need a lot of help trying to decipher the directions and make the folds. This project requires patience.
How to Fold a Paper Crane

by Camy Condon

1. Fold a square piece of paper in half horizontally. Then fold A back to bottom center (D), and B forward to front bottom center (C).

2. Your paper should look like this.

3. Pull C (the front) and D (the back) apart all the way until you have a 45° diamond (as in small diagram).

4. Fold top layers of C and D inward to center line at E and fold down F along dotted line.

5. Your paper should look like this.

6. Here's the tricky part. Unfold step 4. Take top layer only at G and pull it up making use of the crease (dotted line). This allows points C and D to fold back to center line along crease. Turn paper over and repeat steps 4, 5 and 6, ignoring new flap topped by point G.

7. With split at bottom, fold H and I inward so that edges meet center line. Turn paper over and repeat.

8. Temporarily open flaps at L1 and L2. Pull J up to top between flaps and close flaps (L1 and L2). Repeat with K. Fold down head. Fold down wings.

One Thousand Paper Cranes by Takayuki Ishi © 1997. Reproduced with permission of Random House via Copyright Clearance Center.
Lesson 18
Presentation by Business Partner

TITLE: The Math of Paper and Division

OBJECTIVES:
- To enable our partner from the paper industry to explain how math is used at Crane and Co.
- To practice division skills using Crane as a real world case study.

MATH SKILLS
- Division

STANDARDS:
- Division

SESSION OVERVIEW:
The purpose of this session is to learn about the ways in which math skills are utilized at a stationery factory and to practice division skills using Crane and Co. problems as case studies.

SUPPLIES NEEDED:
- A worksheet of division problems
- scrap paper

LESSON OUTLINE:

1. Introduction to the Math of Paper:
   - Our partner, Mr. Giuliani, will explain how math is used at the stationery factory. The students will have ample opportunity to ask questions.

2. Division (as time permits)
   - Use the division worksheet in the appendix to solve division problems from the factory. Students may need mentor help here.
Examples

From one (1) sheet of paper, ten (10) cards can be cut. How many sheets are needed to cut 2,000 cards?

The answer is: $2,000 \div 10 = 200$

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From one (1) sheet of paper, six (6) cards can be cut. How many sheets are needed to cut 9,000 cards?

The answer is: $9,000 \div 6 = 1,500$ sheets
Solve The Following

If you have 8 cards?
Tom, the Trimmer Operator, must gather enough sheets of paper to cut 4,800 Cards. How many sheets of paper will he need?

If, from one (1) sheet of paper, eight (8) cards can be cut.

1 Sheet = 8 Cards

A. 99  
B. 500  
C. 600  
D. 700

If you have 9 cards?
Tom, the Trimmer Operator, must gather enough sheets of paper to cut 4,500 Cards. How many sheets of paper will he need?

If, from one (1) sheet of paper, nine (9) cards can be cut.

1 Sheet = 9 Cards

A. 99  
B. 500  
C. 625  
D. 700

If you have 12 cards?
Tom, the Trimmer Operator, must gather enough sheets of paper to cut 7,200 Cards. How many sheets of paper will he need?

If, from one (1) sheet of paper, twelve (12) cards can be cut.

1 Sheet = 12 Cards

A. 99  
B. 500  
C. 600  
D. 1,000
If you have 16 cards
Tom, the Trimmer Operator, must gather enough sheets of paper to cut 8,000 Cards. How many sheets of paper will he need?

If, from one (1) sheet of paper, sixteen (16) cards can be cut.

1 Sheet = 16 Cards

A. 99
B. 500
C. 625
D. 700

Bonus Question

Sometimes, some of the cards get damaged and have to be thrown away. This is called "WASTE", and in the paper industry it is known as "BROKE"!

To make up for the damaged ones (BROKE), Tom will add some extra sheets of paper.

Tom adds 4 extra sheets for every 100 sheets he takes.

Tom has an order for which he will need to gather 1,000 sheets, how many extra sheets must he gather?

A. 4
B. 40
C. 50
D. 100
Supplemental Division Worksheet

1. The paper company has a piece of paper 18” tall x 24” wide? What are three ways they can find the center? (estimating, folding, and dividing).

   1a. How far will the center be from the bottom (a shorter side)?

   1b. How far will the center be from the sides (a longer side)?

2. Another piece of paper is 11” tall x 17” side

   2a. How far will the center be from the top?

   2b. How far will the center be from the side?

3. We want to make four Mother’s Day cards, all the same size, out of card stock, the card stock size is 24” x 40”. How big will the card pieces be before they are folded? After?

4. If the printer for this same job requires one half-inch trim (waste) from the top of each card, how big will each card be when folded and completed?

5. If the price of a sheet of card stock is $.12. What is the paper cost per card in the above example?

6. There has been a price increase to $.14. What is the new per-card paper cost?
Lesson 19

TITLE: Greeting Cards

OBJECTIVES:
- To introduce division by seeing how many greeting cards can be made from a single large sheet.
- To explore waste reduction in the paper industry by finding the most efficient cutting pattern.
- To give students an opportunity to creatively incorporate math in greeting cards.

MATH SKILLS:
- Estimating
- Measuring in two dimensions
- Dividing and multiplying measurements

STANDARDS:
- Measurement
- Problem-solving
- Numbers and Operations

SUPPLIES NEEDED
- Rulers
- Two sheets of 24"x 36" paper per group, card stock is ideal but butcher paper will do
- Pencils
- Scrap paper for figuring
- Six sample greeting cards, all the same size

LESSON OUTLINE:
1. Mentor assigns the problem to the team of seeing how many cards can be cut from one sheet. Use the sample cards as the standard size.
2. Encourage them to discuss options for accomplishing this (estimating, tracing, dividing).
3. Once they have determined an answer, add two more conditions: as little waste as possible, and as few cuts as possible (explain that commercial cutters take the whole sheet in one straight slice).
4. Calculate the amount saved per sheet by eliminating what would have been waste. Assume a half-cent per square inch of card stock in this case.
5. In the remaining time, each child or team of two designs a card involving numbers. It can be for any occasion, birthday, anniversary, get well, graduation, etc.
6. Save the cards for possible use on the T-shirts at the end of the program. See Lesson 24.
Lesson 20

TITLE: Camera Prep

OBJECTIVES:
• To prepare for the distribution of disposable cameras to the students to use while we have Spring Break
• To learn how to find and see math in different settings
• To learn how to identify different mathematical concepts, functions or ideas in the world around us

MATH SKILLS:
• Recognizing and naming geometric attributes, such as basic shapes and angles, in everyday settings.
• Recognizing and naming patterns and symmetry in everyday settings.
• Connecting math to nature, art, and everyday life.
• Communicating observations to the rest of the class (by making a poster).

STANDARDS:
• Geometry, Connections, Communication

SESSION OVERVIEW:
The purpose of this session is to help students open their eyes to the existence of math all around them.

SUPPLIES NEEDED:
• "Collections" Nature cards or photos or images of objects and patterns found in the natural world
• Some everyday objects that illustrate a mathematical concept, i.e. patterns, numbers, rhythms, etc.
• "Where do you see math?" worksheet
• A disposable camera for each student with the student's name on it
• Photograph data sheet

LESSON OUTLINE:
1. Introduction (whole group)
   • This introduction should be offered by the program coordinator, a mentor, or a visiting Math professor from the college. Everyday objects will be displayed and students will have the chance to explain why objects like cereal boxes, pine cones, Escher artwork, etc. are math-related.
2. Math Cards
   • Each table will receive a Math & Science in Nature Collections card set (available from www.pearsonlearning.com) or other images and will try to find math connections with the cards.

3. Explanations:
   • We will regroup and a representative from each table will show their cards and offer several examples.

4. Math Scavenger Hunt:
   • Using the “Where do you see math” worksheet, each group will look for the following examples of math in their surroundings. They will look either in the cafeteria, the gym, or outdoors and locate the following:
     • a pattern
     • the smallest evidence of math
     • the biggest evidence of math
     • the funniest evidence of math
     • the simplest evidence of math
     • the most complicated evidence of math

5. Camera Distribution
   • Explain to your students that they are to document where they see math in their everyday life and that when we come back we will be making posters out of the photos they take.
WHERE DO YOU SEE MATH

MENTOR NAME

Describe:

- the pattern you found

- the smallest evidence of math

- the biggest evidence of math

- the funniest evidence of math

- the simplest evidence of math

- the most complicated evidence of math

- the evidence of math on clothing

- evidence of math on your mentor
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Lesson 21

TITLE: Multiplication 1

OBJECTIVES:
• To practice multiplication
• To help students understand the relationship between addition and multiplication

MATH SKILLS:
• Developing fluency in multiplication.
• Representing multiplication with simple models.

STANDARDS:
Operations and Numbers, Representation

SESSION OVERVIEW:
The purpose of this session is to review multiplication and practice multiplication by playing games.

SUPPLIES NEEDED:
• Blank times tables
• Supplies for Multiplication Bingo
  ➢ construction paper
  ➢ pencils
  ➢ scissors

LESSON OUTLINE:

1. Camera Collection
   • Please make sure every student's camera has his or her name on it clearly. Cameras go in the box on the supply table.

2. Multiplication Review
   • Ask your group to explain to you what multiplication is. Explain to them that multiplication is essentially REPEATED addition. What this means is: multiplication is a fast way of adding a series of numbers. $3 \times 5$ means to add 3 together 5 times or $3 + 3 + 3 + 3 + 3$. Or, $6 \times 4$ means 6 added together 4 times or $6 + 6 + 6 + 6$.

   49
• NOTE TO MENTORS: Research shows that rote memorization is the LEAST EFFECTIVE way to teach multiplication. What do you think?

2. Multiplication Table:
• Give each student a blank multiplication table. See if your group can complete the blank multiplication tables provided. Try it together or separate those who are faster multipliers from slower multipliers.

3. Multiplication BINGO:
• One version of Multiplication Bingo is given on the following sheet. Depending on the skill level of your group, students may use their filled-in tables.
TITLE: MULTIPLICATION BINGO for Grades 3-5

AUTHOR: Elizabeth Lofties, St. Charles Borromeo; Oklahoma City, OK

MATERIALS:
• 2 pieces of construction paper per student
• pencil or marker
• scissors

ACTIVITIES AND PROCEDURES:

**Setting up the game board:**

1. Each child needs two pieces of construction paper.
2. Instruct the students to take one piece of paper and do the following:
   a. Fold in half from top to bottom.
   b. Fold again from top to bottom.
   c. Fold in half from side to side.
   d. Fold again from side to side.
3. When the students open the paper, there should be 16 squares.
4. As you call out the products of sixteen multiplication facts, the students write those products in a different square. Keep a list for yourself of the facts that you are using that day.
5. Students should fold the second piece of paper exactly as they did the other. Using scissors, cut out the squares so that there are sixteen pieces of paper to use on their game board.

**Playing the game:**

1. Decide which kind of bingo you want to play. Some of the games we play are: (a) horizontal, (b) vertical, (c) diagonal, (d) postage stamp (four in the top right hand corner), (e) "L" (four on the left and four on the bottom), (f) bulls eye (four in the center) (g) picture frame (all but the four in the center), (h) "X" (two diagonals). Your students will come up with other ideas.
2. Using the list of sixteen multiplication facts, call out the factors only. For example, you say "2 x 5". The students must know the product, find it on their game board, and cover it with a piece of paper. Students are not allowed to tell other students what the product is.
3. Continue calling out facts until someone gets a bingo. Be sure to mark on your master copy the facts you called, so you can check your winner to see if he/she covered the correct products.
4. Keep a record of who wins the most games.

**TYING IT ALL TOGETHER:**

This is a fun way for students to use their knowledge of multiplication facts.
Lesson 22

TITLE: Multiplication II

OBJECTIVES:
• To practice multiplication
• To find different ways to learn the times table.

MATH SKILLS:
• Developing fluency in multiplication.
• Representing multiplication with simple models.

STANDARDS:
Operations and Numbers, Representation

SESSION OVERVIEW:
The purpose of this session is to find creative ways to learn to multiply.

SUPPLIES:
• A ball
• Scrap paper
• Access to the gym

LESSON OUTLINE:

1. RHYMES
   • Make up a set of rhymes with your students for a set of tables. All the groups
     will share their rhymes.
   • Here are some examples of rhymes students and teachers have made up:
     
     \[ 2 \times 2 = 4 \]
     Two shoes kicked the door. Two times two equals four.

     \[ 9 \times 9 = 81 \]
     He stood in line and ate a ton, nine times nine is eighty-one.

     (Surely we can do better!)

2. MULTIPLICATION RAP
   • Have your group find a beat that works for a times table. They can perform a
     rap instead of the rhymes.
3. MULTIPLICATION Conga Line (whole group)
   - Go to the gym (or outdoors) and create a conga line. (One of the best ways for children to learn numbers and geometric forms is to experience them with their bodies). The program leader or a mentor leads the line around the gym making sure that everyone is in step and counting out loud. Every step is a number, and on the multiples all make a clap over their heads.
     Example for the threes: one two THREE (clap), four five SIX (clap).
   - Subsequently invite students to join in on the “clap” numbers.

4. MULTIPLICATION Team Tag (whole group)
   - Divide the students into two groups. Have them form two single file lines facing forward. The first student should be about 10 feet from the front of the room.
   - When play starts, the first person in line races to the mentor assigned to their team and answers a multiplication question asked by the mentor. If the student does not know the answer or gives the wrong answer, he or she gets another question. This student is detained answering until he or she gives a correct answer. The two teams play simultaneously. The first team to go through all players wins.
Lesson 23

TITLE: Camera Project Poster Making

OBJECTIVE: To create posters to display and explain the photos students took documenting where they found math.

MATH SKILLS: This project aims to reinforce as many previously introduced math skills as possible.

STANDARDS: Geometry, Connections, Communication

SESSION OVERVIEW: The purpose of this session is to give students an opportunity to take their photos from the camera homework assignment and to create posters to display their favorite pictures and to use text to explain their images.

Note: if for any reason, a child does not have photos, s/he can cut pictures out of magazines to make a poster.

SUPPLIES NEEDED:
• Magazines
• Photos
• Poster Board
• Markers
• Glue Sticks

LESSON OUTLINE:

1. Poster Making:
   • Each student will be given a piece of poster paper and their photos. If they do not have photos, they will use magazine pictures or shared photos from other students. Send students without pictures to the resource table to collect some raw materials for poster making.
   • Each poster must be titled, “Where Do You See Math?” Tell your students to title their posters first, but the title can go anywhere on the poster paper.
   • For their posters have your students choose at least three and up to seven of the photos which most clearly show math.
   • Particularly if the completed posters turn out well, they can be displayed in the school, at the offices of the business partner, or a local library or museum.
Lesson 24

TITLE: Field Trip to Crane
        Rob Giuliani, Crane Stationery Factory

OBJECTIVES:

- To learn from Mr. Giuliani about the math involved in making stationery
- To prepare for field trip to Crane and to become familiar with the work they do
- To learn more about making, painting, folding, storing and shipping paper products

MATH SKILLS
- Not applicable

STANDARDS:
- Not applicable

SESSION OVERVIEW:
    The purpose of this session is to encourage the understanding of students about the projects they have worked on and their connection to the work of Crane & Co in stationery manufacture and production.

SUPPLIES NEEDED:
- None

LESSON OUTLINE:

Presentation by business partner
Lessons 25

TITLE: Field Trip Review, Thank You Notes, T-Shirt Designs.

OBJECTIVES:
• To use a review of the field trip to prepare for writing thank you notes as in Lesson 13, and also to reinforce the applications of math seen at the plant.
• To make designs for use on Got Math? T-shirts.

MATH SKILLS:
• As many as possible from this unit.

STANDARDS:
• Communication, Connection, Geometry, Numbers and Operations.

SUPPLIES NEEDED:
• White card stock, cut to size
• Markers and crayons
• 8 ½ x 11 paper for T-shirt designs

LESSON OUTLINE:

1. On the inside of the card blank each member of the group should write a thank you note to Mr. Guiliani and the staff at Crane Paper Company. Using the sample to check spelling and format, each student should write at least three things s/he liked or learned. Once they have finished writing students can create a picture for the front on their card.

2. T-shirt designs
   If funds are available, we like to present each child and mentor with a Got Math? T-shirt at the closing ceremony. Students in this lesson create the designs for the front and back. If funds are strictly limited, plan on a white T-shirt with a simple design on the front only. Otherwise,
   • Each student uses markers or crayons to create a design that includes the words Got Math? and something they feel that represents the program.
   • Then, if time permits (or in a subsequent session) the designs are displayed and students vote to decide which ones will be printed on the T-shirt.
UNIT THREE: THE MATH OF FARMING

Lesson 26

TITLE: An Introduction to the Orchard Business
Presentation by Community Business Partner
Cindy Bartlett of Bartlett’s Orchards and Store

OBJECTIVES:
• To learn about the range of considerations and factors involved in farming generally and this orchard operation in particular.
• To see where the money goes, and where it comes from in the apple business.
• To introduce the unit and begin the process that will culminate in the field trip to the orchard.
• To introduce some new terms, such as pollination rate and value-added, that will become important in math problem solving.

MATH SKILLS:
Not applicable

STANDARDS:
Not applicable

SESSION OVERVIEW:
The purpose of this session is to introduce the real world of apple growing, the range of cost factors (especially hidden ones like renting bees and contracting for migrant pickers), and the contrast between the previous businesses and one which involves living systems and depends on the weather.

SUPPLIES NEEDED:
Apples and demo materials supplied by the orchard.

LESSON OUTLINE:
1. Presentation by Cindy Bartlett to whole group.

2. (Time permitting) Small groups work problems to determine how many apples of three popular sizes (grades) will fit in a bushel box.

See “Bartlett’s Orchard, Costs of Production” worksheet to be used with this and the next lesson.
Lesson 27

TITLE: What Does It Cost to Produce One Apple?

OBJECTIVES:
• To use data in order to determine the costs of producing an apple
• To use that information to determine what to charge for an apple
• To work in teams to solve real life math problems

MATH SKILLS:
• Developing fluency in multiplication and division.
• Multiplying decimals (money).
• Understanding the concept of markup.
• Problem solving by performing successive direct variation calculations to arrive at an estimate for the cost of one apple.
• Connecting math with business operations (apple harvesting).
• Communicating problem-solving methods to the rest of the class.
• Summarizing class results by creating a graph to compare group cost estimates.

STANDARDS:
Numbers and Operations, Data Analysis, Problem Solving, Communication, Connections, Representation

SESSION OVERVIEW:
Each student should have an apple (not to be eaten yet!). Their challenge is to figure out how much they think that apple should cost, based upon the production costs supplied by the orchard. Each student will be responsible for figuring out different parts of the production costs. Each group will then have to combine the costs of production and determine the costs of each apple. Finally, they decide how much they'd like to charge. When the group finishes, a representative will write their apple's cost on a number line of 0 to 30 on the board.

SUPPLIES NEEDED:
1. Apple Data Sheets
2. Index cards or headbands with index cards stapled to the front and indicating role, e.g. Tree Grower
3. Number line on the blackboard, 0-30
4. (optional) Costs of Production worksheet
1. Each group starts with a review of the business partner's talk. This can lead into brainstorming about what influences the cost of one apple. If students are having a hard time remembering, refer to the Apple Data Sheet.

2. Once the group has reviewed the different costs of producing apples to provide an overview, assign each student in the group a role or roles. The headbands will help the students get into their roles. Some students will be better suited to more complex roles (e.g. Tree Growers), while others might be able to compute a few of simpler roles (e.g. Pickers or Transporters). Each student in the group will be calculating costs for one part of apple production. Use Costs of Production worksheet if appropriate for your students.

3. When they become their roles, also let them know that one group will get a chance to explain to all how their group figured out the apple's cost of production.

5. As the group determines the per apple cost of production, one student can come up to the board and record it on a number line.

6. As time allows the groups can work on what to sell the apple for at the farm store. Assume a mark-up of 50%. Apples reduced for clearance might be sold for a mark-up of 25%.

NOTE: This lesson lends itself to being covered in two sessions.
APPLE DATA SHEET
for 2001

HINT: Data listed beneath certain roles may be used by other roles.

Tree Growers:

340 trees grown per acre
42 acres in production
Each tree costs $5.80
Stakes cost $2.10 each (let's say it takes one stake per tree)
Average life span of trees - 45 years
700 bushels of apples produced per acre
120 apples in a bushel

Tree Keepers (Fertilizing, Spraying, and Pollination):

$40 to fertilize (once a year)
$500 per acre to spray (per season)
$40 for bees per acre

Apple Pickers:

Pickers' wages are 88¢ per bushel

Transporters (from orchard to storage at store):

4 people x $8.16 per hour x 6 hours per acre

Sorters & Packers:

3 people x $7.50 per hour (six hour workday)
100 bushels per six hour workday
Wholesale boxes cost $1.60 each (hold 100 apples)
Half-bushel bags cost 24¢ each (hold approx. 60 apples)

Bartlett's harvests 18,000 - 20,000 bushels/boxes of apples per year. There are 120 apples per bushel and 100 apples per wholesale box.
Bartlett's Orchard
Costs of Production

* * * * * * * 700 bushels of apples are produced per acre * * * * * * *
* * * * * * * 120 apples are in a bushel * * * * * * *

How much does it cost to grow the trees per acre?

How much does it cost to grow the trees per bushel?

How much does it cost to grow the trees per apple?

(Since the trees can live for 45 years, you can divide your answers by 45 to find out the cost for one year!)

How much does it cost to fertilize, spray, and pollinate the trees per acre?
How much does it cost to pick the trees per acre?


How much does it cost to pick the trees per bushel?


How much does it cost to pick the trees per apple?


How much does it cost to transport the trees per acre?


How much does it cost to transport the trees per bushel?


How much does it cost to transport the trees per apple?
How much does it cost to sort and pack the trees per acre?

How much does it cost to sort and pack the trees per bushel?

How much does it cost to sort and pack the trees per apple?
Lesson 28

TITLE: What's the Chance: Picking Apples and Probability

OBJECTIVES:

- To introduce probability
- To enable students to test probability theory
- To enable students to record and track data

MATH SKILLS:

- Learning the basic concepts of sampling and probability.
- Calculating and estimating probabilities
- Organizing and recording data.
- Representing data with tables and graphs.
- Communicating probability results to other groups in the class.
- Combining and interpreting data from several groups.
- Predicting outcomes based on computed probabilities.

STANDARDS:

Data Analysis and Probability, Communication, Representation.

SESSION OVERVIEW:

To investigate probability, students will be picking different kinds of apples out of a bag and recording their results. On the data sheet, they will also be creating a simple bar graph. You can do the data sheet as a group, or have each student complete it individually. After completing the experiment, take a few minutes to review their results and the combination of their results. You can also introduce numerical ways to represent probability for example, “there is a one in six chance of picking an Empire apple” can also be written as “the probability of picking an Empire apple is 1/6.” You can also determine the probability of picking an apple that is NOT an Empire apple (which would be a probability of 5/6).

SUPPLIES NEEDED:

- Six paper bags
- At least six apples in at least 5 different varieties for each bag
  (You can also do this activity with pencils or something else that is uniform in shape but varied in appearance and less expensive than apples.)
- Data Sheets
**LESSON OUTLINE:**

1. Students can pick an apple out of the bag. They can then record which kind they picked on their data sheet. They will repeat this for a total of 30 picks.

2. Students should calculate their totals at the bottom of the data sheet.

3. Review the results with the students. Do they notice any patterns?

4. One student can come up to the board and add their group’s data to the class graph.

5. Introduce ways to numerically write their results. For example, if there is a one in six chance of picking an Empire apple, you can also write that as "the probability of picking an Empire apple is 1/6." Challenge students to figure out other probabilities (i.e. What is the probability of picking an apple that is NOT an Empire apple?).

6. If students seem confident and comfortable with this, there are some extra Red Delicious apples to add to the bag. Let students graph their results with three Red Delicious apples and one of each of the other apples. There are extra data sheets for them to use. Discuss the results.
Pick an apple
Record which kind of apple you picked (use the boxes below).
Repeat this 30 times

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TOTAL ________________________
Lesson 29

TITLE: Apple Pie

OBJECTIVES:
- To learn about fractions and following algorithms by making apple pies

MATH SKILLS:
- Measuring fraction and mixed number quantities
- Reinforcing the concept of equivalent fractions
- Multiplication and addition of fractions
- Following an algorithm (recipe)
- Connecting math and baking

STANDARDS:
Numbers and Operations, Measurement, Problem Solving, Communication, Connections.

SUPPLIES NEEDED:
- 6 sets of measuring cups and spoons
- 3-6 apple slicers
- 6 mixing bowls
- Aluminum foil
- Ingredients for apple pie making (see below)
- Access to ovens
- Paper plates to give each child a piece of pie (they will have to come and get it during the school day)
- Copies of the recipe

LESSON OUTLINE:
This lesson should take place in a space near the school kitchen.
1. Assign jobs.
2. Have students share each of the jobs (i.e. each person gets to measure out one of the ingredients, everyone gets a chance to mix the ingredients, etc.).
3. Help students discuss (briefly) and choose which parts of the pie preparation they’d like to do.
4. Let students draw different jobs out of a hat (or bowl).

As the students measure and slice, you might want to review some fractions. When using the apple slicer, students might recognize that it cuts the apple into a certain number of pieces. If they were going to take one of those pieces, how would they write the fraction? The measurements (like 3/4 cup) also offer a chance to review fractions.
Ingredients:

2 9-inch pie crusts
3/4 cup sugar
1/4 cup all-purpose flour
1/2 teaspoon ground nutmeg
1/2 teaspoon ground cinnamon
dash of salt
6 cups thinly sliced tart apples (about 6 medium apples)
2 tablespoons margarine or butter

RECIPE:
1. Heat oven to 425°.
2. Mix sugar, flour, nutmeg, cinnamon, and salt.
3. Stir in apples.
4. Turn into pie shell.
5. Dot with margarine.
6. Cover with top crust that has slits cut into it.
7. Seal top crust and flute the edges.
8. Cover edge with 3-inch strip of aluminum foil.
9. Remove foil during last 15 minutes of baking.
10. Bake until crust is brown and juice begins to bubble through slits in crust (40 - 50 minutes).

THE GREAT PIE AUCTION:

One year there was an extra pie that was saved for auction on a local radio station. Representatives from the program went to the station to be interviewed and to sing the "Got Math Buy Our Pie Song". The pie went for $200, and the proceeds were donated to the Relay for Life.
Lesson 30

TITLE: How You Slice It? Fractions and Equivalency

OBJECTIVES:

- To learn about fractions

MATH SKILLS:

- Developing fluency with fractions
- Representing probabilities as fractions
- Representing fractions with an apple model. (creating halves, fourths, eighths, etc)
- Understanding equivalent fractions
- Communicating methods and concepts to the rest of the class

STANDARDS:
Numbers and Operations, Representation, Communication.

SESSION OVERVIEW:

We'll review our probability work from last week and use the numerical representation of probability (for example, she had a 1/5 chance of pulling out a Cortland apple) as a transition into fractions. The students will divide and cut apple slices and then play a trading game to help them understand equivalent relationships.

SUPPLIES NEEDED:

- Construction paper, pre-cut into circles
- scissors
- Crayons and markers

LESSON OUTLINE:

1. As a whole group, we'll review the probability graph that we created and discuss the results that we found. We'll then briefly talk about how to numerically express probability.

2. Next we'll brainstorm what the class already knows about fractions (perhaps things that they remember from their paper unit).

3. Get into the small groups and give each person big apple circle. They should spend a couple minutes adding seeds, apple color, stems and leaves, etc.

4. Next the mentors will guide the students through a process of dividing and cutting their apples. Depending on your students, you might want to wait to introduce words like fourth, eighth, sixteenth, etc.
5. First have students show you how to divide the apple in half. They can then cut the apple into two halves.

6. Take one of the halves and ask that students divide it in half (creating a fourth). They can then cut the half into two fourths.

7. Repeat the process by asking students to divide one of their fourths in half (creating an eighth). They can then cut the fourth into two eighths.

8. If they want to, they can then cut one of the eighths in half, thereby creating a sixteenth.

9. Spend a few minutes figuring out different equivalent relationships (for example, they could put two of their fourths on top of one of the halves, creating a tangible example of equivalency). Encourage them to find an equivalent relationship for the eighths (or sixteenths) and one of the larger fractions.

10. Students can then start a trading game. First they should try to trade equivalent slices with others in their group, with the goal of ending up with a completely different apple than what they started with. (If students trade their whole apple with another whole apple, praise their understanding of wholes and then challenge them to trade for an apple that has at least two ... or three ... slices from different apples.)

11. Once they accomplish this, they can branch out to a neighboring table to try to trade for a completely different apple.

12. Pull the students back together to discuss why fractions are written the way they are. Explain why one-half is written as a 1 over a 2. Take two of the halves and demonstrate how there are two pieces. The 2 on the bottom (the denominator) shows us that we cut the apple into two pieces. Put one piece away so that you only have one of the two. The 1 on top (the numerator) tells us how many pieces we have. Continue explaining with fourths. Show four of the fourths together (making a whole) because it's still divided into four pieces we need to write a 4 on the bottom. Ask for someone to explain why. Then ask what we need to write on the top. This is the symbol for one fourth (1/4) or one quarter. See if students can explain how to represent one eighth.

13. If they get it, challenge them to try representing two fourths. Ask them if two fourths is equivalent to anything else. See if they can start to figure out the numerical pattern in 1/2 = 2/4 = 4/8 = 8/16.
Lesson 31

TITLE: Field Trip to Bartlett's Orchards

Lesson 32

TITLE: Final Assessment

OBJECTIVES:
- To determine students' skill level and attitudes towards math.
- To establish the program's guidelines (rules) and to ensure that the students understand them.

MATH SKILLS:
- Not applicable

STANDARDS
- Not applicable

SESSION OVERVIEW:
At this session, the objective is to present the skills test, the attitudinal test, and to go over the program's guidelines.

SUPPLIES NEEDED:
- Skills test
- Attitudinal test
- Invitation too parents for closing celebration, if appropriate

LESSON OUTLINE:

1. Skills Assessment:
   - Give each student a test and a pencil. Administer the assessment per instructions.

2. Attitude Assessment:
   - Give each student the attitude assessment.

3. Remind students about and hand out parents invitations to the final celebration.
APPENDICES

1. Sample Schedule
2. Ground Rules
3. Sample NCTM Standards
4. Extra Lesson: Fibonacci Numbers and Patterns
APPENDIX 1
SAMPLE SCHEDULE

GOT MATH? 2001-2002

UNIT 1: The Math of Plastics

TUESDAY OCT. 30 – WELCOME. GET TO KNOW EACH OTHER. WHAT DO I THINK OF MATH?

THURSDAY NOV. 1 – EVAL. PRE-TEST

TUESDAY NOV. 6 – MEASURE TO FIND OUT IF A DINOSAUR COULD FIT IN OUR GYM?

THURSDAY NOV. 8 – DESCRIBE SMALL OBJECTS, WRITE A RIDDLE INCLUDING MEASUREMENTS OF A SMALL OBJECT

TUESDAY NOV. 13 – USE PLAY-DOH SETS TO LEARN ABOUT THE DIFFERENT TYPES OF MOLDS. WEIGH FINISHED PRODUCT WITH A TRI-BEAM SCALE

THURSDAY NOV. 15 – VISIT FROM CHIP SCHNACKENBERG, OF MED SOURCE, MOLD DESIGNER – CHILDREN GIVEN AN OVERVIEW OF THE MOLDING PROCESS AND GIVEN THE ASSIGNMENT TO MAKE A KEY CHAIN THAT HOLDS A QUARTER

TUESDAY NOV. 27 – START WORK ON KEY CHAIN THAT HOLDS A QUARTER USING CRAYOLA MODEL MAGIC

THURSDAY NOV. 29 – COMPLETE KEYCHAIN LEARN MORE ABOUT MOLD AND MOLD-MAKING, DESCRIBE AN OBJECT IN DETAIL (WRITING AND DRAWING)

TUESDAY DEC. 4 – FIELD TRIP TO MED SOURCE ENGINEERING

THURSDAY DEC. 6 – WRITE THANK YOU NOTES TO MED SOURCE CREATE A MOLD OF EACH KID’S NAME OUT OF CRAYOLA MODEL MAGIC

TUESDAY DEC. 11 – FINISH MOLDS MEASUREMENTS AND CONVERSIONS FROM AMERICAN SYSTEM TO METRIC SYSTEM

THURSDAY DEC. 13 – UNIT WRAP UP
UNIT 2: THE MATH OF PAPER

THURSDAY JAN. 24 – WELCOME BACK/MULTIPLES AND FACTORS IN THE GYM

TUESDAY JAN. 29 – TWENTY QUESTIONS WITH MULTIPLES AND FACTORS

THURSDAY JAN. 31 – SNOW DAY – NO GYM?

TUESDAY FEB. 5 – INTRO. TO MATH OF PAPER. STEP THROUGH PAPER ACTIVITY, AND CAN PAPER HOLD BOOKS?

THURSDAY FEB. 7 – VISIT FROM MR. GUILIANI FROM CRANE’S. WORK ON PROBLEM: HOW MANY PIECES OF PAPER WOULD BE NEEDED TO MAKE 10,000 ENVELOPES WITH LINERS IF THEY EXPECTED 4% WASTE?

TUESDAY FEB. 12 – MATH OF ART. ORIGAMI. PAPER CRANES

THURSDAY FEB. 14 – VISIT FROM ROB GUILIANI OF CRANE PAPER COMPANY – VOLUME ACTIVITIES WITH SLATS AND BOXES

WINTER VACATION

TUESDAY FEB. 26 – ROB GUILIANI (MULTIPLICATION, ENVELOPE, FOLDING, FRACTION REVIEW)

THURSDAY FEB. 28 – FIELD TRIP TO CRANE STATIONARY FACTORY

TUESDAY MAR. 5 – THANK YOU NOTES AND REVIEW

THURSDAY MAR. 7 – VISIT FROM ROB FEIGEL OF CET – RECYCLING AND PAPER MAKING FROM AN ENVIRONMENTALIST

TUESDAY MAR. 12 – WHERE DO YOU SEE MATH? A VISIT FROM PROFESSOR ANNETTE GUERTIN

THURSDAY MAR. 14 – COMPLETE WHERE DO YOU SEE MATH? ACTIVITIES

SPRING BREAK

TUESDAY MAR. 26 – MULTIPLICATION UNO. MULTIPLICATION TAG TEAM

THURSDAY MAR. 28 – MULTIPLICATION BINGO

TUESDAY APR. 2 – MAKE WHERE DO YOU SEE MATH? POSTERS

THURSDAY APR. 4 – POSTERS, VOTE, AND NUMBER PATTERNS

75
UNIT 3: MATH OF FARMING

TUESDAY APR. 9 – INTRO. TO MATH OF APPLES – VISIT FROM CINDY BARTLETT

THURSDAY APR. 11 – PROBABILITY – PICK A DIFFERENT APPLE

TUESDAY APR. 23 – HOW MUCH SHOULD IT COST? CALCULATIONS FOR PRICING APPLES AT BARTLETT’S

THURSDAY APR. 25 – BAKING APPLE PIES

TUESDAY APR. 30 – HOW DO YOU SLICE IT? FRACTIONS AND EQUIVALENCY

THURSDAY MAY 2 – FIELD TRIP TO BARTLETT’ APPLE ORCHARD

TUESDAY MAY 7 – THANK YOU LETTERS AND TEE SHIRT DESIGN

THURSDAY MAY 9 – POST-PROGRAM ASSESSMENT

THURSDAY MAY 16 – GOT MATH? CELEBRATION
APPENDIX 2

GOT MATH GROUND RULES

- No shouting
- No running
- No leaving the cafeteria without asking permission
- Keep your hands to yourself – No horseplay
- No saying unkind things
- No fighting
- No talking back or showing disrespect to mentors

CONSEQUENCES

- If you break a rule, you go sit by yourself until you feel you can come back and behave;
- If you do it again or a mentor decides, then you sit by yourself and wait until you are asked back;
- If you break rules repeatedly, you will be asked to not come for a week;
- If you break any rules after that, you’ll be asked to not participate in the program.
Appendix 3

Representation Standard for Grades 3–5

Instructional programs from prekindergarten through grade 12 should enable all students to—

- create and use representations to organize, record, and communicate mathematical ideas;
- select, apply, and translate among mathematical representations to solve problems;
- use representations to model and interpret physical, social, and mathematical phenomena.

In grades 3–5, students need to develop and use a variety of representations of mathematical ideas to model problem situations, to investigate mathematical relationships, and to justify or disprove conjectures. They should use informal representations, such as drawings, to highlight various features of problems; they should use physical models to represent and understand ideas such as multiplication and place value. They should also learn to use equations, charts, and graphs to model and solve problems. These representations serve as tools for thinking about and solving problems. They also help students communicate their thinking to others. Students in these grades will use both external models—ones that they can build, change, and inspect—as well as mental images.

What should representation look like in grades 3 through 5?

Students in grades 3–5 should continue to develop the habit of representing problems and ideas to support and extend their reasoning. Such representations help to portray, clarify, or extend a mathematical idea by focusing on essential features. Students represent ideas when they create a table of data about weather patterns, when they describe in words or with a picture the important features of an object such as a cylinder, or when they translate aspects of a problem into an equation. Good representations fulfill a dual role: they are tools for thinking and instruments for communicating. Consider the following problem:

What happens to the area of a rectangle if the lengths of its sides are doubled?
Students who represent the problem in some way are more likely to see important relationships than those who consider the problem without a representation. One student's initial response to the problem was that the new rectangle would be twice the size of the first rectangle. Her thinking might have stopped there, but another student questioned her answer, prompting her to think more deeply. She decided she needed a picture to help her think about the problem. Her drawing (see fig. 5.38) helped her consider the complexity of the problem more carefully and showed her that the new rectangle is not only bigger but that it is four times bigger than the original rectangle. It was also a way to show her answer and to justify it to others.

![Diagram of rectangles](image)

Fig. 5.38. A student's representation of the results of doubling the lengths of the sides of a rectangle.

Students will have learned about, and begun to use, many symbolic and graphical representations (e.g., numerals, equals sign, and bar graphs) in the primary grades. In grades 3–5, students should create representations that are more detailed and accurate than is expected in the primary grades. Their repertoire of symbols, tools, and conventional notation should expand and be clearly connected to concepts as they are explored. For example, in representing algebraic and numerical relationships, students should become comfortable using equations and understanding the equals sign as a balance point in the equation. Many students who have only seen equations with an arithmetic expression on the left side of the equation and a call for the numerical answer on the right side, such as $6\square30=\square$, don't understand that equations may have several symbols on each side, as in $2\square5\square5=3\square4\square5$. 

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Students in grades 3–5 should also become familiar with technological tools such as dynamic geometry software and spreadsheets. They should learn to set up a simple spreadsheet (see fig. 5.39) and use it to pose and solve problems, examine data, and investigate patterns. For example, a fourth-grade class could keep track of the daily temperature and other features of the weather for the whole year and consider questions such as these: What month is coldest? What would we tell a visitor to expect for weather in October? After two months, they might find that they are having difficulty managing and ordering the quantity of data they have collected. By entering the data in a spreadsheet, they can easily see and select the data they want, compare certain columns, or graph particular aspects of the data. They can conveniently find the median temperature for February or calculate the total amount of rainfall for April. In January, if the class notices that temperature alone is no longer giving them enough information, they can add a column for wind chill to get a more accurate summary of the weather they are experiencing.

![Spreadsheet Example](image)

Fig. 5.39. A simple spreadsheet can be used to organize and examine data, pose and solve problems, and investigate patterns.

Learning to interpret, use, and construct useful representations needs careful and deliberate attention in the classroom. Teaching forms of representation (e.g., graphs or equations) as ends in themselves is not productive. Rather, representations should be portrayed as useful tools— for building understanding, for communicating information, and for demonstrating reasoning (Greeno and Hall 1997). Students should become flexible in choosing and creating representations—standard or nonstandard, physical models or mental images—that fit the purpose at hand. They should also have many opportunities to consider the advantages and limitations of the various representations they use.
What should be the teacher's role in developing representation in grades 3 through 5?

Learning to record or represent thinking in an organized way, both in solving a problem and in sharing a solution, is an acquired skill for many students. Teachers can and should emphasize the importance of representing mathematical ideas in a variety of ways. Modeling this process as they work through a problem with the class is one way to stimulate students to use and analyze representations. Talking through why some representations are more effective than others in a particular situation gives prominence to the process and helps students critique aspects of their representations. Teachers can strategically choose student representations that will be fruitful for the whole class to discuss. For example, consider the following question, which a third-grade class might explore:

Are there more even or odd products in the multiplication table shown in figure 5.41? Explain why.

Students may initially generate many examples to formulate an answer, as illustrated in figure 5.40. Other students may use a multiplication table to organize their work, as illustrated in figure 5.41. Organizing the work in this way highlights patterns that support students in thinking more systematically about the problem.

\[4 \times 3 = 12 \text{ even}\]
\[2 \times 5 = 10 \text{ even}\]
\[3 \times 7 = 21 \text{ odd}\]

Fig. 5.40. An exploration of odd and even numbers in the multiplication table
Each representation reveals a different way of thinking about the problem. Giving attention to the different methods as well as to the different representations will help students see the power of viewing a problem from different perspectives. Observing how different students select and use representations also gives the teacher assessment information about what aspects of the problem they notice and how they reason about the patterns and regularities revealed in their representations.

As students discuss their ideas and begin to develop conjectures based on representations of the problem, the teacher might want to represent the students’ thinking in other ways in order to support and extend their ideas. For example, when students notice that an even number multiplied by an even number always produces an even result, the teacher might record this idea as “even • even = even.” This representation serves as a summary of the students’ thinking. It suggests a way to record the generalization and may prompt students to look for other generalizations of the same type.

Some students will need explicit help in representing problems. Although in the rectangle problem (fig. 5.38), the student quickly decided on a representation that was effective in showing the important relationships, many students need support in constructing pictures, graphs, tables, and other representations. If they have many opportunities for using, developing, comparing, and analyzing a variety of representations, students will become competent in selecting what they need for a particular problem.

As students work with a variety of representations, teachers need to observe carefully how they understand and use them. Representations do not “show” the mathematics to the students. Rather, the students need to work with each representation extensively in many contexts as well as move between representations in order to understand how they can use a representation to model mathematical ideas and relationships.

By listening carefully to students’ ideas and helping them select and organize representations that will show their thinking, teachers can help students develop the inclination and skills to model problems effectively, to clarify their own understanding of a problem, and to use representations to communicate effectively with one another.
APPENDIX 4
Extra Lesson

TITLE: Fibonacci Numbers

OBJECTIVES:
- To introduce students to number patterns embedded in nature.
- To gain more facility working with numbers in series.
- To see further connections between numbers and life.

STANDARDS:
Numbers and Operations, Communication, and Connections

SESSION OVERVIEW:
After a presentation on Fibonacci and patterns in nature, students examine the Fibonacci pattern in pinecones and work on numbers in pattern series.

SUPPLIES NEEDED:
- A pineapple
- A cross-sectioned nautilus shell, or picture of one
- A sunflower seed head (if available)
- 6 daisies
- One pinecone for every child
- A set of markers for each table

LESSON OUTLINE:
1. In advance ask a mentor to prepare a presentation to the whole group on Leonardo Fibonacci (see Number Patterns resource sheet). Use the nautilus, pineapple, sunflower seed head if available, and one daisy for each table to demonstrate the Fibonacci numbers in nature. Some scientists even maintain that these numbers are reflected in the architecture of the human heart.
2. Have each student use different colored markers to trace the whorls in a pinecone so as to be able to count them. Compare results. Does everyone get a Fibonacci number?
3. Ask students to study the tree diagram and work out how the branching forms a specific pattern.
4. Students work the number pattern sheet.
Leonardo Fibonacci was born in Pisa, Italy, about 1175 A.D. The son of a merchant, he had the opportunity to travel widely in North Africa, where he must have been exposed to the then advanced mathematical and scientific knowledge of the Arab world. Returning from travels in Algeria, Egypt, Syria, Greece, and Southern France, he returned to Pisa in 1200 to write Liber abaci (Book of). This book among other things introduced the decimal number system to the Latin-speaking world.

Fibonacci was also interested in rabbits. He knew that rabbits are ready to breed a month after they are born and wondered if a pair of rabbits, a male and a female, were put in a field, how many pairs there would be at the end of each month for a year. Assuming that no rabbits died, the number of pairs works out like this:

1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144

This sequence, which now bears Fibonacci's name, could be continued indefinitely. Each new number consists of the sum of the two previous numbers.

For more information see:
www.camosun.bc.ca
www.mca.surrey.ac.uk/personal/r.knott/fib
# NUMBER PATTERNS

Please complete the following patterns:

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Make up some patterns and see if your group can guess the next numbers.

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In one month, would you rather have a million dollars or would you like to receive 1 dollar on Day One, and have the amount double every day for the month...($1, $2, $4, $8).

Do the math and tell your group.