# Designing Digital Resources for Developmental Math


*The Monterey Institute for Technology and Education*
*P.O. Box 890, Marina, CA 93933  831-642-9459*
*montereyinstitute.org*

# Introduction

Improving high school graduation rates and post-secondary success requires a better understanding of the roadblocks that impede student progress. Algebra is one of the primary obstacles to student success, both in middle or high school where students take the class for the first time, and in community colleges where students too often require remediation. A better understanding of why students are struggling, and new instructional approaches that can contribute to their success, are critical to improving graduation rates.

Online and blended learning, as well as digital curricula, present a new way to address these challenges. Community colleges and high schools around the country are beginning to use online options as part of the solution, with promising signs of success. The move to online courses is new enough, however, that many educators and institutions are still determining how to address key implementation questions, including understanding the important elements of online content, ways in which students and instructors can and should use these materials, and barriers to adoption.

The nonprofit Monterey Institute for Technology and Education (MITE), with funding from the Bill and Melinda Gates Foundation and The William and Flora Hewlett Foundation, is developing new online algebra and developmental math content as an open educational resource. As part of the development effort, the Evergreen Education Group conducted extended focus groups and roundtable discussions around the country.[1] This research effort (detailed below) differs from the endeavors of traditional publishers in two ways. First, we have spoken directly and extensively with students, in addition to educators, and their voices come through clearly in our research. Second, because the effort is part of a nonprofit undertaking, we are freely sharing the results with educators. The findings, which we share below, are enlightening for any educator who is embarking on developing or expanding the use of online and blended courses to help students succeed.

[1]The focus groups were not the only source of research informing the project. In addition, extensive literature reviews were conducted, and an advisory group representing educators, educational institutions, and national educational organizations provided guidance.

## The algebra hurdle

> *"It [algebra] triggers drop outs more than any single subject. I think it is a cumulative failure of our ability to teach math adequately in the public school system."*
>
> —Roy Romer, Los Angeles Superintendent of Schools [2]

The power of algebra in U.S. education is daunting, as its role in determining a student's future in the job market is almost absolute. Algebra is traditionally used to distinguish college-bound students from the rest and it has denied vast numbers of students their high school diploma. Failure rates for algebra are hovering at 40-50% for the general student population, with even higher rates for African-American and Latino students.[3] With algebra now positioned as a gatekeeper to the job market, access to quality mathematics instruction has become an equity issue.

For many students, their problems with algebra do not end with high school. More than half of students entering community college are required to take remedial math before they can take credit-bearing courses. Fewer than half pass these remedial courses and continue their college studies.[4] In addition to the social cost, the financial cost of remediation is staggering. A recent study reported that community colleges spend more than $1.4 billion on remedial math courses each year.[5] The cost to the competitive position of the United States in the global economy is also substantial. The U.S. Department of Education reported that 15 year olds in the United States rank 25th among their peers in 30 developed nations in math literacy and problem solving.[6]

Why are failure rates so high? Many educators believe that schools have not been given the resources to teach algebra to every student, and students have not been prepared to learn it. Some argue that inadequate pre-algebra preparation in elementary school results in much higher failure rates for algebra in middle school. Secondary schools have been forced to expand algebra classes rapidly despite a shortage of credentialed math teachers. In California, for example, more than 40% of 8th grade algebra teachers lack math credentials or are teaching outside their field of expertise. At the end of this chain of failure are the community colleges, forced to try to fix an educational problem that often has its roots in elementary school.

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[2] Lisa Fratt, *Algebra's At-Risk Solution,* www.districtadministration.com, October 2006
[3] Mary Pat Sjostrom, *Teaching Efficacy and Attribution for Student Failure,* Annual Meeting of North American Chapter of the International Group for the Psychology of Mathematics Education, Toronto, Canada, October 2004
[4] Ronald R. Kelly, *Special Issues,* Mathematics and Computer Education, Winter 2003
[5] Dennis Carter, *Update: Online math program could boost learning*, eSchool News, http://www.eschoolnews.com/2008/09/22/update-online-math-program-could-boost-learning/, September 2008
[6] National Mathematics Advisory Panel. (2008). *Foundations for Success: The Final Report of the National Mathematics Advisory Panel.* Washington, DC: U.S. Department of Education

The open educational resource movement seeks to provide access to high-quality, low-cost instructional materials for educators and students. These instructional materials are typically provided online, in order to maximize reach at minimum cost to providers and funders. The materials are not meant to replace instructors, but can assist educators and students in a variety of use cases (some of which are discussed below). The focus groups were conducted to ensure that the voices of students, instructors, and administrators were prominent in the development process, in terms of both editorial development and in planning for a variety of uses.

## Focus group reach and methodology

In spring 2009 the Evergreen Education Group, on behalf of MITE, began running focus groups with students, faculty, and administrators at community colleges and high schools. In addition, focus groups and roundtable discussions were held at several conferences run by the League for Innovation in the Community College. Colleges targeted for the focus groups were primarily those identified by the Bill and Melinda Gates Foundation as financially disadvantaged and with developmental math programs (sometimes known as remedial or pre-college math). The focus groups have continued throughout 2009 and 2010.

> *We need to provide options for learning: something for younger students, something for older students.*
>
> —Dallas area college administrator

The first point of contact on each campus was usually an academic dean, a division dean overseeing the math department, or the chair of the math program. With this person's approval and often a direct referral, we contacted additional administrators and faculty by phone and email. Students were recruited via instructors, math labs, and in some cases, posters placed on campus. All community students were required to be taking or have recently completed a developmental math course.

Sessions were held with each segment (students, instructors, administrators). In some cases administrators and instructors attended a focus group together. In all cases student sessions were limited to students to ensure that their opinions would not be affected by the presence of instructors or administrators.

### Student focus groups were designed to:

1) Find out what digital materials students are using, if any,
2) Better understand use cases from the student perspective,
3) Identify areas of student frustration in developmental math curriculum, and
4) Show materials and get students' reactions, and use the findings to improve the content.

**Administrator and faculty focus groups were used to**:

1) Determine shortcomings in existing materials,
2) Better understand use cases from faculty and administrator perspectives,
3) Hone the marketing message; including exploring whether the term "open educational resource" was recognized and perceived as positive or negative,
4) Develop leads for the market development team, and
5) Show materials and get feedback, particularly in areas that students might not flag.

The effort to include the voice of students and educators in the project has been extensive, and is ongoing (details can be found in Appendices 1 and 2, and notes from focus groups are provided in Appendix 3). As of January 2011, the research effort has included:

*57 focus groups and roundtable discussions, divided into:*

- 22 student sessions
- 18 instructor sessions
- 17 administrator sessions

*546 participants:*

- 253 students
- 167 instructors
- 126 administrators

*150 institutions, mostly community colleges but including a small number of high schools representing urban, suburban, and rural regions.*

*29 states represented*

Key findings are presented in two sections below. The first section reviews the challenges that struggling algebra and developmental math students face, and the second discusses the ways that educators can help address those challenges. Detailed notes from the focus groups are provided in Appendix 3.

## Key findings: students

### *Developmental math students are often intimidated by math because they have struggled with it previously. Adult learners are usually juggling college with jobs, family, and other time pressures.*

These first findings explain many subsequent conclusions. Students have struggled with math, so they require the online materials to demonstrate lessons in a logical, straightforward fashion. Because they are often combining college with jobs, families, or other life issues, they want their lessons to be efficient and useful.

### *Most developmental math students benefit from a step-by-step, easy-to-follow approach.*

> *"I like the drawing and steps, they make it really easy to understand."*
>
> —Denver Algebra student

In early versions of the instructional materials, students often pointed out where a small gap in the stages of a problem or concept would challenge them. Baltimore students suggested using animation and audio to show how a math problem is pulled out of a word problem, because applying math to a real-world example is a challenge. California students agreed, and liked listening to the instructions instead of seeing "big words" such as "dimensional analysis." A Denver student noted, "I like the drawing and steps, they make it easy to understand."

### *Students often recognize their preferred learning style and want to be able to learn in the style that best meets their needs.*

Students are surprisingly aware of their learning style; a Denver student said, "I am a visual learner so that makes it easier and more fun to learn." Online resources teach to different learning styles using audio, video, worked examples, projects, and other methods. They provide different paths through a topic, so that a student has multiple options for mastering a concept. Students often realized the contrast with a classroom lecture, in which they must follow the approach and style of one instructor. Many students said they would use the presentations to reinforce classroom lectures and discussions, and as a way of reviewing topics. While most students did not choose reading about math as their chosen learning style, a non-trivial minority of students wanted to have a reading option, especially as an efficient way to review a term or concept quickly. Students recognized that the ability to easily find and cross-reference definitions and concept reviews would be useful as they worked through presentations and problems.

## *Students like the self-paced and always-available nature of digital curriculum.*

Many students like the opportunity to go back and revisit concepts they don't understand, as many times as they need. California students shared that it can be embarrassing to ask questions in class, so they like having a way to review ideas on their own. Denver students also noted that being able to rewind, pause, and move ahead at their pace as needed would allow them to revisit concepts that they needed extra time with, and move more quickly through topics that they understood. Students also appreciate being able to access the materials whenever their schedules allow it, whether late at night after children have gone to sleep or on a break from school or a job.

## *Real-world examples help students connect with the material and understand how it applies in their lives.*

The views of many students were reflected in the comment of a California student, who noted: "I want to know why this matters to me, what does it have to do with my daily life? It makes me more interested about why I need to learn it." Developing materials that are applicable to a range of student backgrounds and ages is challenging, but possible. It means avoiding the use of presenters wearing neckties in examples as noted by teachers in Michigan and Iowa, including presenters who are diverse in age and ethnicity, and using animated figures and scenarios to which the students can relate. Lansing students pointed out a common downfall of traditional math problems: stories need to be more relevant to their interests. A bakery story was deemed not interesting: "How many people are going to do the math to figure out exactly how much flour they need to make a few dozen cookies? You just go buy a big bag and use what you need." Students identify with the real-world example of borrowing money, or cell phone plans, unlike typical textbook examples. "When will I ever care about the speed of a train?"

> *"I want to know why this matters to me, what does it have to do with my daily life?"*
>
> —California community college student

## *Many students like games and puzzles as a learning tool, but the games must be carefully constructed and presented.*

Games can be used to motivate students. They can be relatively simple, but must be presented as such to ensure that students don't expect the design and graphics to be on par with commercial offerings. Lansing and Iowa students said the games should have a competitive aspect; either keeping score or allowing students to progress to a higher level. Some students doubted they would play the games on their own if there wasn't credit attached. When credit is attached,

however, Baltimore students said, “It’s fun and I’m still learning something. It makes me want to do more problems.”

### *Humor must be used carefully, if at all.*

Humor can help students by alleviating stress, reducing intimidation, and making the presenter more likable. The negative potential of attempted humor that does not work, however, is larger than the potential positive aspects. Humor can fail because it seems juvenile, or, alternatively, because it uses word play or references that students do not understand. This can be particularly challenging for English language learners. When humor fails, students may be intimidated (because they realize they did not understand a joke), or students may become disengaged from the material.

*Students identify with the real-world example of borrowing money, or cell phone plans, unlike typical textbook examples. “When will I ever care about the speed of a train?”*

### *Cost of online resources is a leading concern.*

The cost of college is a key concern for students, and fees for textbooks and instructional materials add to the overall expense. Online products add to the total price tag, often in addition to the charge for a textbook. Students in Tennessee often noted that they are frustrated by having to buy a textbook in order to get the online access code. Students in Dallas reported that they don’t like that if they fail a course and must retake it, they must purchase access to the digital content again. Students appreciated the role that open educational resources can play in supporting their studies at no cost to them. Few students knew of any available open educational resources and expressed interest in learning more about them.

## Key findings: instructors and administrators

### *The flexibility of online content allows educators to meet the needs of the range of students.*

Instructors in many of the focus groups talked about the wide variety of student types, ages, and levels of sophistication; from mature military students and mothers returning to education, to recent high school graduates and students taking developmental math to get into mainstream community college courses. Administrators must address the challenge of pushing all students through the same curriculum that is designed for one type and level of student; they need more flexible curriculum with multiple tracks.

### *Online content can be adapted to meet the demands of varied use cases.*

Instructors and administrators identified a variety of use cases for online content, including:

- Online and blended courses
- Use of content elements by instructors in the classroom
- Supporting tutors in math labs
- Providing help to students outside of class and math labs

To meet this variety of uses in the most efficient manner, online materials must be available within or outside of a learning management system, and should have the attributes listed below.

### *Digital content should be modular, adaptive, and diverse.*

Faculty and administrators identified a variety of use cases that drive their digital content needs. Remedial mathematics curriculum should be modular, adaptive, and diverse. A modular offering allows schools and instructors to specify the concepts and procedures in which a student should gain competence in order to qualify for credit, meet necessary standards, or satisfy prerequisites for further study. Adaptive content allows learners to pursue a path through the materials that is ideally suited to what they know and what they wish to learn. Diverse content accommodates different learning styles, different learning needs, and different cultural contexts for the course of study, and can be used at the student, course, or program level as either a supplement to classroom instruction or on its own.

### *Ease of use and access issues are critical to the success of adoption and implementation.*

Ease of use is connected to both the way that the materials are accessed, and the ways in which concepts are presented. Tennessee administrators noted that developmental math students do not make connections naturally, so ideas need to be presented with all steps clearly illustrated. Colorado instructors made a similar point when they noted that the ability to pause is important so the student can think about what was just presented.

Tennessee and California administrators acknowledged the need for mobile and/or computer lab access, as rural students have cell phone coverage at home, but may not have Internet access. Baltimore community college faculty who are working with an urban population of students identified issues with students not having access to computers outside of school, and the need to provide access via computer labs.

## *Cost of online resources is a key concern for some administrators and instructors.*

The distribution of concern about the cost of textbooks and instructional materials appeared bimodal—either cost was a major concern, or it was not mentioned at all. This result stands in contrast to students, who consistently raised cost as a major concern.

## *The challenge of working with English language learners deserves special attention.*

A high percentage of English language learners require developmental math classes, which has implications for the vocabulary used in the lessons. Educators realize that reading and vocabulary difficulties should not get in the way of learning math, but the words that often become obstacles are not always clear to native English speakers. In one word problem, the term "bottleneck" confused students who were not familiar with it. California instructors noted that English language learners struggle when there is a lot of talking and the talking is fast; it is easy for them to get lost. A student in California noted that language can be a problem for her whether spoken or written; having both is helpful. Faculty in Seattle suggested using print, as cursive is hard for non-native speakers/writers to grasp.

> *Students "want to clear up basic, simple things they don't know. [If] a student was embarrassed to ask a question," online materials provide to them an independent learning option.*
>
> —Chicago community college instructor

## *Pre-assessment tests that accurately place students improve the effectiveness of the program.*

As developmental math students are often adult learners who are juggling demands from jobs and families, accurate placement makes the best use of student time. Instructors in Michigan value the way in which pre-assessment in the online math program lays out a path for the student based on pre-test results. Iowa instructors noted as well a need for a pre-test that places students out of topics altogether, as giving students "credit" for the knowledge they have would be motivating.

This was echoed in the same group by a colleague who particularly liked the idea of pre-test for credit recovery to avoid making students go back through material they have mastered previously. Some Iowa faculty also shared frustration with a product that makes students go back to work through material they have just tested out of, which is demoralizing. In particular, Baltimore and Chicago administrators noted that there is value in both topic-level and course-level pre-tests, as well as knowing results by individual student and cohort.

### *Digital learning can support competency-based, or mastery-based, learning.*

Around the country, various programs, schools, districts, and states are moving, although slowly, toward competency-based learning. Lansing administrators noted that digital content can support that move by allowing a student not only to place out of a course, but to gain course credit for that course. Tennessee administrators agreed, wanting diagnostics beyond course placement. Currently, students have to work through content that they already know to get to what they do not know.

### *Technology has the ability to give students "hints" when they are stuck, aiding in the learning process.*

Iowa administrators suggested including worked examples in a step-by-step format, audio hints, or even a talking-head video for student homework or practice. Colorado community college faculty noted that their students don't read – they just email or call tech support or their teacher. Having help immediately available for students working at any time of the day or night would allow the student to move forward rather than just quit.

## Summary and next steps

Feedback from students, faculty, and administrators has allowed us to build a profile of developmental math students and to understand the ways in which open educational resources can meet the needs of students and educators. We have used what we learned from the focus groups in product development, but in the interest of keeping with MITE's mission of increasing access to education, we also consider it important to share what we have learned with the broader academic community.

Our efforts to incorporate student and educator views into the development of these resources will continue into 2011. The focus will shift from editorial development towards creation of supporting materials for instructor professional development, integration with existing content and courses of study, and other elements that are key to driving usage and improving student outcomes. In addition, pilot programs using the first of the developed materials will provide additional information to help inform the ways in which we can continue to support educators and students.

# Appendix 1: Focus groups locations and attendees

| Host Institution | Location | Date | # Faculty | # Admins | # Students |
|---|---|---|---|---|---|
| Iowa Community College Online Consortium | Des Moines, IA | Feb-09 | 12 | 8 | ~ |
| Michigan Virtual School | Lansing, MI | Feb-09 | 6 | 6 | 10 |
| League for Innovation Conference | Reno, Nevada | Mar-09 | 12 | 4 | ~ |
| Colorado Community Colleges Online | Denver, CO | Mar-09 | 12 | 7 | 16 |
| Digital Harbor High School, Baltimore City Schools | Baltimore, MD | Apr-09 | 10 | 5 | 8 |
| Tennessee Board of Regents | Nashville, TN | Apr-09 | 10 | 11 | 9 |
| US Distance Learning Association | St. Louis, MO | Apr-09 | ~ | 7 | ~ |
| De Anza Community College | Cupertino, CA | May-09 | ~ | ~ | 13 |
| Los Angeles Unified School District | Los Angeles, CA | May-09 | 6 | 5 | 7 |
| Mesa Middle School | Castle Rock, CO | Dec-09 | ~ | ~ | 9 |
| West Denver Preparatory Charter School | Denver, CO | Jan-10 | ~ | ~ | 14 |
| Denver School of Science and Technology | Denver, CO | Jan-10 | | | 13 |
| West Mesa High School | Albuquerque, NM | Feb-10 | ~ | ~ | 16 |
| Jemez Valley High School | Jemez Pueblo, NM | Feb-10 | ~ | ~ | 12 |
| League for Innovation in the Community College Conference | Baltimore, MD | Mar-10 | 9 | 19 | ~ |
| Antioch High School | Antioch, CA | Mar-10 | ~ | ~ | 15 |
| Los Medanos College | Pittsburg, CA | Mar-10 | ~ | ~ | 8 |
| Contra Costa College | San Pablo, CA | Mar-10 | ~ | ~ | 10 |
| Highline Community College (during American Association of Community Colleges conference) | Seattle, WA | Apr-10 | 7 | 10 | 16 |
| San Diego Community College District office | San Diego, CA | Apr-10 | 4 | 5 | ~ |
| Dallas County Community College District | Dallas, TX | Jul-10 | ~ | ~ | 41 |
| Online focus groups | Nationwide | Sep-10 | 5 | 1 | ~ |
| Tarrant County Colleges | Dallas / Ft. Worth, TX | Oct-10 | 18 | 5 | 9 |
| Prairie State College | Galesburg, IL | Oct-10 | 15 | 4 | ~ |
| Harold Washington Community College | Chicago, IL | Oct-10 | 17 | 16 | ~ |
| League for Innovation STEMtech Roundtable | Orlando, FL | Oct-10 | 7 | 13 | ~ |
| Columbus State Community College | Columbus, OH | Dec-10 | 17 | ~ | 27 |
| | | | **167** | **126** | **253** |
| | | | **TOTAL # PARTICIPANTS** | | **546** |
| | | | **18** | **17** | **22** |
| | | | **TOTAL # FGS** | | **57** |

## Appendix 2: States represented in focus groups

| | |
|---|---|
| 1 | Arizona |
| 2 | California |
| 3 | Colorado |
| 4 | Florida |
| 5 | Georgia |
| 6 | Hawaii |
| 7 | Iowa |
| 8 | Idaho |
| 9 | Illinois |
| 10 | Kansas |
| 11 | Massachusetts |
| 12 | Maryland |
| 13 | Michigan |
| 14 | Minnesota |
| 15 | Missouri |
| 16 | North Carolina |
| 17 | New Jersey |
| 18 | New Mexico |
| 19 | New York |
| 20 | Ohio |
| 21 | Oklahoma |
| 22 | Oregon |
| 23 | Pennsylvania |
| 24 | Tennessee |
| 25 | Texas |
| 26 | Utah |
| 27 | Vermont |
| 28 | Washington |
| 29 | West Virginia |

# Appendix 3: Focus group themes and extended notes

1. **In spring 2009, we began by working with administrators and faculty to understand what potential obstacles there would be to implementation. We discussed cost and other roadblocks.**
    a. **Cost is the number one concern from administrators and students**
        i. Tennessee students 2009: They are frustrated by having to buy the textbook for My Math Lab (MML) in order to get the online access code.
        ii. Seattle administrators 2010: Students buy access to web-based, no licensing which is easier for administration. Slightly less expensive.
        iii. San Diego administrators 2010: Tutoring has been one of the most effective methods in helping basic skills students, but funding for tutoring is being cut and resources dwindling rather than having more resources allotted a successful strategy
        iv. Dallas students 2010: Students don't like that if they fail a course and must retake it, they must purchase access to the digital content again.
    b. **Implementation: Administrators, faculty and students all need to be "sold" on the varied benefits of the program.**
        i. Iowa students 2009: The group agreed that most students would not work problems on their own for understanding, that the problems must be assigned and graded, or carry some sort of credit. Most agreed that older, more mature students will work problems on their own because they see the value of learning the content and reinforcing the learning. Tie this to use cases.
        ii. Tennessee administrators 2009: This product needs to do something that the faculty member cannot do in the classroom. MML is closest to their way of teaching, so they select it. It doesn't mean it's good. It fits with the faculty comfort level, but it does not use technology at the level to which it could be used.
        iii. Tennessee faculty 2009: Most traditional faculty will not have time to deal with this new approach – illustrating value to faculty and students will be key to the success of the project.
        iv. Baltimore administrators 2009: Lots of adjuncts, which makes it more difficult to get commitment to all of the materials.
        v. Baltimore administrators 2009: Need viable data to move faculty in a direction of change.
        vi. California students 2010: "If this were available in Lab hours, I'd go every time, if the lab hours were as cool as that."
        vii. Seattle faculty 2010: Many faculty do not want to make the effort to figure out how various materials integrate, so materials from a single publisher or source is the path of least resistance. Curriculum from different sources has differences to account for.
        viii. Seattle Faculty 2010: Departmental decision in part due to adjuncts, but largely just to maximize the value of integration between the text, technology (MML) and Learning Management System (LMS).
        ix. San Diego faculty 2010: Faculty looked for best digital product and followed his "one-hour rule" - students and faculty must be able to learn how to use the product without a manual, and in one hour (adjuncts would need to have more training); chose MathXL due to ease of use.

c. **Identifying the depth of access issues is critical to understanding potential roadblocks to adoption / implementation.**
    i. Tennessee administrators 2009: Need for mobile access. Rural students have cell phone coverage at home, but may not have Internet access. Will this product be available on DVD?
    ii. Baltimore faculty 2009: Have issues with students not having access to computers outside of school – no computer at home.
    iii. California administrators 2009: Hand-held technologies is where students live.
    iv. Colorado students 2009: Students are not required to have computer access to register for courses at the school, but are required to have a computer for dev math courses, which causes some access issues.
d. **Decision-making happens at different levels in different institutions, but often happens at the faculty level.**
    **i.** Seattle administrators 2010: In general this is an "academic freedom" issue and decisions are left up to the department and full-time faculty
    **ii.** San Diego administrators 2010: Administrators (up to the VP of Instruction level) may have some level of input in dev math curriculum, but in general this is an "academic freedom" issue and instructional materials adoption decisions are left up to the department and full-time faculty.
    **iii.** San Diego administrators 2010: Full-time faculty can choose texts for upper level courses, but dev math is a departmental decision.
e. **Many online vendors are being used across the country. There is a difference in what is needed from a supplement to face-to-face courses vs. a fully online course, so these programs all fit different needs for different use cases.**
    i. My Math Lab (MML)
    ii. Plato
    iii. Elluminate
    iv. Hawkes Learning Systems
    v. ALEKS
    vi. Carnegie Learning
    vii. National Repository of Online Courses - NROC
    viii. Smartthinking (Pearson)
    ix. Compass
    x. ModuMaths
    xi. EduCoSoft
    xii. Gizmos
    xiii. Sparknotes (website students reference to find formulas)
    xiv. Apex
    xv. HStutorials.com
    xvi. Think Well
    xvii. Hot Math
    xviii. YouTube
    xix. Purplemath.com
    xx. Math Zone
    xxi. Academic Systems
    xxii. Washington Mathematics Assessment and Placement - WAMAP
    xxiii. Web Assign (Cengage)
    xxiv. Blackboard
    xxv. MathTV
    xxvi. Textbook CDs
    xxvii. Forward
    xxviii. MathXL

xxix. MySkills tutoring
xxx. WebCT

**f. The self-paced nature of digital curriculum is important; students like the opportunity to go back and revisit concepts they don't understand.**

i. Iowa administrators 2009: Make the audio more real, with personality instead of traditional documentary narration, "If you don't understand what I've just gone over, back up! Review by…"
ii. California students 2009: "It can be embarrassing to ask questions in class, this allows you to get questions answered."
iii. California teachers 2009: The ability to pause is important so the student can think about what was just presented.
iv. Colorado faculty 2009: Echoed the students' comments about the pace being too fast; emphasized the need for student controls to stop, pause, repeat parts of the presentation.
v. Colorado faculty 2009: If the same material is presented step-by-step ("evolving" as the faculty described it) the math is far less intimidating.
vi. Denver students 2010: "I like it because our teacher teaches so many students, but this you can make work for just you."
vii. Denver students 2010: "I like that you can rewind and pause when you want without disrupting your teacher and classmates."

**g. Faculty and administrators universally agree that pre-assessment is valuable.**

i. Lansing teachers 2009: One person using ALEKS and likes the pre-assessment that lays out a path for the student based on pre-test results.
ii. Lansing teachers 2009: Would like to see pre-test that places students out of topics altogether, to give students "credit" for the knowledge they have – would be motivating.
iii. Lansing teachers 2009: Michigan has just moved toward competency-based learning and allows a student not only to place out of a course, but to gain course credit for that course.
iv. Lansing administrators 2009: Particularly liked the idea of pre-test for credit recovery, to avoid making students go back through material they have mastered previously.
v. Iowa teachers 2009: It's demoralizing to make students go back to work through material they have just tested out of – some other products do this.
vi. Iowa administrators 2009: All agreed a pre-assessment was valuable, but felt like there would be professional development issues to train teachers to how use it and get any benefit out of it.
vii. Iowa administrators 2009: Several asked if the pre-tests were at the course or topic level, and whether the pre-test scores could be aggregated by class. For individualized instruction the student pre-test is nice (for self-paced, competency-based), but if this is to be used by faculty in a classroom or cohort setting, they need to see where the entire class is testing, not just a single student.
viii. Iowa administrators 2009: As administrators, this group kept coming back to the pre-test and the desire to have that data available to them and their teachers. They wanted data captured and available at all three levels; pre-test, throughout the course, and post-test. How will the answers and data gathered as a student works through the course be captured, and can it be accessed through an LMS?
ix. Tennessee administrators 2009: All wanted diagnostics beyond placement. Currently, students have to work through content that they already know to get to what they do not know – an emphasis on mastery learning.
x. Baltimore faculty 2009: Pre-assessed over summer for top end of academic performers, but nothing for those at lower academic performance. Shows

where the class is at as a whole to help teacher plan pace and topic coverage before they start class.

**h. Instructors often noted that one of the greatest benefits of computer programs is the ability to teach to different learning styles: audio, visual, hands on, etc.**

i. Lansing teachers 2009: Some type of learning style assessment would be useful if the product is to place such emphasis on multiple learning styles.
ii. Lansing administrators 2009: As long as it does not require the student to go through all seven learning strategies. Like the idea of giving students the option to determine what interests them.
iii. Iowa & Lansing teachers 2009: Nearly unanimous agreement that reading is a poor way to introduce a math topic.
iv. Tennessee students 2009: MML has one approach to get answer, and if you don't use MML approach it gets marked wrong even though it may be right per the way the instructor has taught it.
v. Seattle administrators 2010: The consensus is that there are many ways to teach and this product should demonstrate that in development it has considered a broader range of opinions and approaches.
vi. Seattle administrators 2010: Most students do not have HS diplomas, and over half need pre-college math courses to get into college. Have no study skills and do not see why math is important.
vii. Denver students 2010: "I like visual learning better, so it seems easier and more fun to learn."
viii. San Diego faculty 2010: Make sure you have multiple learning options for the areas students constantly have trouble with.

**2. The feedback received in 2009 was significant, and typically related to overall design.**

**a. Most developmental math students require a simple, easy-to-follow approach and vocabulary.**

i. Dallas 2010: In a one-on-one follow-up, a teacher said that the lowest skill level he had seen in his developmental math community college students was about 4$^{th}$ grade.
ii. Words that writers and educators might not flag as problematic sometimes are. An early version of a word problem used the word "bottleneck," confusing several students not familiar with the term. Age, ethnic, and educational backgrounds of developmental math students vary dramatically.
iii. Tennessee administrators 2009: Students do not abstract naturally, so things need to be presented with all steps illustrated.
iv. Baltimore administrators 2009: Make sure definitions from earlier in the course, or from an earlier dev math course, are readily available.
v. Baltimore students 2009: In the Worked Example, students want animation to show how the problem is pulled out of the word problem. The example needs audio to explain each step and especially where the information came from and why it's being placed where it is being placed.
vi. California students 2009: Liked listening to the instructions instead of seeing "big words like dimensional analysis" from the previous example.
vii. Colorado students 2009: Students feel there is not enough attention in the presentation to the details the faculty gives them, and the explanations need to be more step-by-step.
viii. California teachers 2009: English Language Learners have problems because there is a lot of talking and the talking is fast; it is easy to get lost.
    1. California students 2009: One student said she had trouble with word problems because English is not her first language. (She's been "here" for less than 5 years.) Language can be a problem for her whether spoken or written; another student said written words were less of a problem.

2. Seattle administrators 2010: Must understand English before they can understand math for international students.
3. Seattle faculty 2010: Lots of minority students - cursive hard for non-native speakers/writers to grasp.

**b. When students connect with the examples and material, they are more motivated to learn; to that end, administrators and faculty requested more diversity in the examples to appeal to a broader student audience.**

i. Lansing students 2009: Stories need to be more relevant to the interests of students. The bakery story was not interesting, "How many people are going to do the math to figure out exactly how much flour they need to make a few dozen cookies? You just go buy a big bag and use what you need."
ii. Lansing teachers 2009: Make them relevant to the kids' lives; "You have $5, so how do you get to the mall with only $5?"
iii. Baltimore administrators 2009: Need diversity – white male William, white male on bike, white male figure in project.
iv. Lansing and Iowa teachers 2009: No neckties! They are not relevant to kids today.
v. California administrators 2009: This just emulates a textbook, has some advantages because of ability to re-wind, but it lacks student engagement.
vi. Colorado students 2009: Surprisingly noted the use of the "we" rather than products/texts that say "you should," or "you must." Made it feel more personal.
vii. New Mexico students 2010: Most of the students relate to the skateboarder even though many do not have a skateboard, they all like a real example that reflects their age.
viii. California students 2010: "I want to know why this matters to me, what does it have to do with my daily life; it makes me more interested about why I need to learn it."
ix. Seattle students 2010: "I would like if in middle school, but too childish." "Like layout, but not cartoons and colors (too young) – Nickelodeon look."
x. Denver students 2010: "I think it's a bit immature; we're in high school, not 5th grade."
xi. Denver students 2010: snowboarder or skier would be better than a skateboarder (Colorado student!)
xii. San Diego faculty 2010: Seems more for high school, younger students.
xiii. San Diego faculty 2010: Be careful with examples and the names being used. For example "Juan is mowing the grass" would come across as menial tasks being done by minorities.

**c. Instructors encouraged the use of even better technology (in the MITE program), to take advantage of the medium.**

i. Lansing teachers 2009: Stressed more movement and interaction in the course; if you're building this as a technology product, you're competing with YouTube and other media that students are used to.
ii. Iowa administrators 2009: Stressed to "stay away from anything a textbook can do." The emphasis is on maximizing what working on a computer can do – taking the processes prescribed by a textbook further than has been done by MML, or ALEKS or Carnegie Learning.
iii. Tennessee faculty 2009: More than any other group, these faculty feel that the demo represents little new, and does not use the power of technology. There is too much of a "text online" feeling to this demo.
iv. Colorado faculty 2009: This is where there is an interface between words and math, and students need help in extracting the pertinent information. Take the paragraphs of the "story" and animate data extracted from the text to illustrate how the problem is to be set up.

v. Denver students 2010: “I like the color coordinated rise / run so you know what is vertical and horizontal. Makes it easy to follow.”
vi. California students 2010: In the worked example, “Like the color coordination so it’s easy to follow. “
vii. Denver students 2010: Cover rules that are used in the presentation (e.g., the sum of any number divided by zero is zero) in the "warm-up" section, to refresh the students' memories.
viii. Denver students 2010: Show the rules on the screen, example: All vertical lines are undefined.
ix. Denver students 2010: “I wasn’t paying attention until the drum roll, then that caught my attention.”

**d. Students like games / challenges especially where they can compete for points.**

i. Lansing students 2009: Students looking for extrinsic motivation. The students wanted extra credit for reaching specific goals or levels. Need some type of motivation if they are to work them on their “own time.”
ii. Iowa students 2009: All but one participant were very enthusiastic about the use of games.
iii. Iowa students 2009: Even though the games may be fun, if there is no credit attached, even extra credit, there were doubts of students would use them on their own.
iv. Baltimore students 2009: “It’s fun and I’m still learning something. It makes me want to do more problems.”
v. New Mexico students 2010: How do you relate this game and learning this way to a paper and pencil test? If you learn through games, how do you get tested?
vi. Denver students 2010: “I like this option, especially with different levels that get harder.”

**e. Students want the program to get to the point; time is valuable. However, it is also important for the program to use real-world examples, which they acknowledge creates a design challenge.**

i. Lansing students 2009: The Woo Bakery story was too long, with too much information that is not needed to work the problem. The students all were nodding as one person noted he did not want to read or hear anything extra - just the facts I need to solve the problem.
ii. California students 2010: “No time for other homework if this takes forever.”
iii. California students 2010: “I like it because he went through all the options with you, he explained them pretty clearly, wasn’t too harsh.”
iv. Seattle students 2010: “Real explanation, don't try to be cute – give me what I need to know.”
v. San Diego faculty 2010: Intro with space shuttle takes up to much time – long introduction. Get to topic!

**f. In Worked Examples, students need to be able to show their work.**

i. Lansing teachers 2009: If no work is entered, just answers, it encourages students to guess, especially if there is a long list of problems to solve.
ii. Colorado instructors 2009: Students can guess at answers, but instructors must see the work. In MML, if students don’t follow the exact steps in MML they are marked incorrect. Building flexibility to allow for different steps getting to the same answer would be great.

**g. Use the technology to create a way to give students to “hints” when they are stuck.**

i. Iowa administrators 2009: Participants wanted more help options for the problems, “If I’m a student and ‘I’m not getting this,’ what options do I have to get help?” Suggestions included similar worked problems in a step-by-step format, audio hints, even talking head video.
ii. Colorado students 2009: The more tutorial or hints resources the better.

iii. Colorado faculty 2009: Students don't read – they just email or call tech support or their teacher. Can the course incorporate questions that prompt the student to move forward rather than just quit and make a call? Could there be a live chat option (nationally of course, like a tech support line) where students could get immediate help?

3. **As the product is refined in later focus groups, faculty are buying in and thinking about how they would use the program in their classrooms.**
    a. **Instructors noted that many different use cases exist for high quality digital materials, as shown by the variety in other online programs being used in math courses.**
        i. Baltimore mix 2009: The general feeling is developmental students are less likely to succeed in a distance setting – "if struggling in a f2f setting, how can we expect a student to succeed at distance?"
        ii. Colorado 2009: The use case in developmental math at Pikes Peak CC includes traditional face-to-face classroom instructor, fully-online and hybrid (or blended) options at the students choosing. The majority, approximately 80%, are in the f2f environment although instructors are beginning to integrate online curriculum in the traditional courses as well as courses based on some level of online format.
        iii. Colorado instructors 2009: The range of students types, ages and levels of sophistication are challenges; from mature military students and mothers returning to education, to recent high school graduates and students taking math just to get into mainstream CC courses.
        iv. Seattle administrators 2010: Major challenge is that all students are pushed through same curriculum that is designed for one type and level of student – need more flexible curriculum with multiple tracks.
        v. Seattle faculty 2010: Font is too small for classroom use. Can it be designed for both? This would make a great classroom tool.
        vi. San Diego faculty 2010: Facilitate rather than teach – as much a goal to teach these students confidence as teach them math; makes this product more effective as a supplement rather than face-to-face.
        vii. Baltimore administrators 2009: Digital content must be integrated with classroom to be effective and cannot be optional. Students are not going to use it if it is not required.
    b. **Instructors raise issues that (to us) seem minor, but may become problems for adoption if they lead the instructors to believe the math or presentation of math concepts are not rigorous. It is unclear whether they are raising concerns around ways in which math varies by geography, institution, or some other factor, and whether a large and diverse group of math instructors would raise a consistent set of issues.**
        i. Baltimore administrators 2009: On the line graphs, some students would argue that BOTH are closed line graphs – one "closed" with solid red and one closed with solid white. The circle needs to be "clear" and reflect the background. Participants were distracted by the presenter using the term "straight line," noting that they make the point that all lines are straight, or by the skateboarder climbing an "impossible" slope, and by the use of the term "inverse properties."
        ii. Seattle administrators 2010: Faculty expressed concerns about some of the terminology and other math elements; for example they were distracted by the presenter using the term "straight line"; saying that they make the point that all lines are straight, by the skateboarder climbing an "impossible" slope, and by the use of the term "inverse properties."
        iii. Seattle faculty 2010: Recommended that to insure integrity of the product, include community college instructors in a review process

iv. Seattle faculty 2010: The 9 faculty in the room cannot agree on how to teach slope. It is a challenge to find a middle ground that math faculty will agree upon, therefore making it difficult to agree upon vocabulary, approach, etc.
v. Seattle students 2010: Got lost at the word "sub" - 8 have not used "sub," and 5 have used "sub" (As in "X sub 1").
vi. San Diego administrators 2010: We often have faculty call attention to one aspect of the demo or another, quibbling with terminology or some aspect of the presentation.
vii. San Diego administrators 2010: "Inverse property" is what this particular math subject matter expert (SME) calls it, but it is not the standard language and terminology used by developmental math instructors (this issue was raised by multiple focus groups).

4. **2010: feedback is getting much more detail oriented as instructors consider how they would use the program in their classrooms.**
    a. **As program is refined, comments get more detailed.**
        i. New Mexico students 2010: All but one student did not like the voice– "too soft, boring, too laid back;" and the "Drifting cursor, cursor is small."
        ii. California students 2010: Students prefer handwriting to typed characters on the screen.
    b. **As program is refined, feedback is generally much more positive.**
        i. Skateboarding is better than mountain biking.
        ii. Music downloading is a great example.
        iii. New Mexico students 2010: Most felt the explanation of slope was clear and understandable (lots of nodding heads) - no one raised an issue of clarity.
        iv. New Mexico students 2010: One mentioned that it would have been easier if he had been taught that way; straight-forward, clear, visual (most students agreed by nodding or saying something supportive).
        v. California students 2010: 13 of 15 students liked the presenter, and how he worked with the graphic of the skateboarder on the screen
        vi. Seattle students 2010: The tutor simulation will work with changes; make options more apparent, need cuter guy, choose your own adventure – frustrated if pick the wrong option.
        vii. Denver students 2010: "I like that while he's talking you can see the example."