

How to Start a Learning Community Without Knowing How

The Aravaipa Learning Community
Central Arizona College
Aravaipa Campus

Flint Anderson, Student Services Director
Shay Cardell, Professor of Mathematics
Maren Wilson, Professor of Social Studies

Visit our web page:

<http://www.geocities.com/lcomavc>

For more information contact:

Flint_Anderson@centralaz.edu

Shay_Cardell@centralaz.edu

Maren_Wilson@centralaz.edu

Table of Contents

Demographics	2
Objectives	5
Tips for Pioneers	8
Weekly Schedule	11
Daily Schedule	13
Assessment.....	14
Project Specifications	17
How to Put Math in a Project.....	20
Math Activities.....	22
Active Learning	23

A LEARNING COMMUNITY: “Coming Together Where the Waters Meet” by Flint Anderson

How does one learn? There must be more exciting and meaningful ways to carry on this enterprise called higher education! A second question: What methods or environments best foster persistence and retention? We are a team of three, Shay Cardell, Professor of Mathematics, Maren Wilson, Professor of Anthropology/Social Sciences, and Flint Anderson, Director of Student Services and Adjunct Faculty, Sociology, Philosophy.

We deconstructed traditional approaches, developing and implementing an alternative model for orientation, academic assessment, advisement, and instruction for non-traditional and developmental students. By exploring our own experiences, listening—really listening—to students, and reviewing pertinent literature, we asked what are the essential elements for a creative learning environment.

We wanted new students to experience at the very beginning of their college life the **best** of what an institution of higher education can offer: a collaborative, project- and theme-based learning environment that promotes critical thinking and exploration, without the constraints of time or faculty domination; a learning community that challenges instructors to step out of traditional roles, to work intensely as one member of a team, willing to venture into arenas where they surrender control.

Socio-Economic Context*

The Aravaipa Campus is located in the San Pedro River Valley, a rural area in the heart of Arizona’s copper country. Once a boom industry, U.S. copper mining is in a severe recession; this has resulted in the complete closure of BHP Copper, the area’s largest employer. 2400 miners were laid off. Historically, no formal education was necessary to enable one to earn a good income working in the mines.

Approximately 50% of the area population are of Mexican/Yaqui descent. Over 40% identify themselves as Roman Catholic. Fewer than 8% of current students’ parents have earned a college degree. Almost 50% are from families with annual incomes of \$30,000 or less.

Compared with students at other public two-year institutions, twice as many students at Central Arizona College (CAC) need remedial help in math, science, reading, and writing. They also report less confidence in their academic ability, computer skills, math and writing ability. Two-thirds spent five hours or less a week studying or doing homework in high school, while half of those at other institutions report doing five hours or less. Twice as many CAC students report never talking with their high school teachers outside of the classroom.

The cohort of twenty-seven students which began the semester in the Learning Community (LC) reflect even more challenging demographic status (the numbers in the parentheses represent full-time CAC students and other two-year public institutions respectively):

- 25% (51%, 66%) have used a personal computer.
- 50% (31%, 23%) spent six to 10 hours a week in last year of high school socializing with friends.
- 83% (55%, 18%) spent three to 10 hours a week watching TV
- 25% (12%, 3%) spend over 20 hours a week doing household/childcare activities.
- 42% (26%, 8%) listed joblessness as important in deciding to go to college.

- 17% (33%, 49%) have attended an art gallery or museum within the last year.
- None (27%, 14%) listed a mentor/role model encouraging them to attend college.

The Concept

A partnership of student services and instruction, the three instructors created a nine-credit learning community that met Mondays and Wednesdays from 10:00 to 3:30 p.m. for sixteen weeks with an hour off for lunch. Each student could earn four credits of math (MAT 81, 91, or 121), three credits of anthropology (ASB 201 Indians of the Southwest), and two credits of college success skills (CPD 111).

Through the spring and summer of 2001, new students were given the option to sign up for the nine-credit block rather than taking the ASSET academic assessment tests (math, reading, and composition). Those choosing the LC would experience academic assessment as an ongoing process in which they actively participated. Seventeen new students enrolled. Fourteen returning students who had previously been assessed but were not successful in one or more developmental courses were also included in the class.

No formal examinations were administered. Informal quizzes checked students' progress, especially in math. Each student maintained a portfolio that constituted 60% of his/her final grade. The remaining 40% of the grade was determined by attendance/participation.

Students self-selected a group with which they would work for the entire semester. Each collaborative group was responsible for a major research project and presentation.

The Content

The theme for the semester, "Coming Together Where the Waters Meet," refers to the confluence of two desert riparian waterways near the Aravaipa Campus. In this area are multiple pre-historic Indian sites, a former military fort, as well as the location of the infamous Fort Grant Massacre in 1873. We would explore many facets of this unique environment. The semester was divided into historical segments: prehistoric, early historic, current, and future times.

Activities included archeological dating, a survey of plants along the San Pedro River, visiting Native American ruins and natural/historical museums, an ecological simulation game (Fish Banks), Internet and other library research, guest speakers, group presentations, videos, tree ring dating, a microbacterial and salinization lab, extensive writing exercises, and daily "plus delta" evaluations of activities/projects.

Initial Outcomes

Of the 27 who registered and attended, 24 completed the semester, an 88% persistence rate, compared to 69% for CAC in fall 2000. 83% of the LC participants, compared to 69% for CAC, continued classes in the subsequent spring semester. Participants ranked their overall experience in the learning community 8.7, on a 10-point scale ("didn't like at all" to "liked it very much"). They would recommend the instructors to others (9.4), and would encourage this experience for others (8.6).

* All data are from the fall 2001 Cooperative Institutional Research Project (CIRP, UCLA) Freshman Survey, in which CAC participated, and internal district research.

Aravaipa Learning Community Shared Vision

Students will:

1. Develop critical thinking and writing skills.
2. Understand college procedures and bureaucracy.
3. Acquire good study skills.
4. Understanding subject areas and making connections between them.
5. Develop an appreciation for life long learning.
6. Construct their own knowledge and reality.
7. Experience hands-on and real world applications.
8. Understand systems thinking: interdependence, long-term results, and unintended consequences.
9. Extend knowledge horizons beyond their immediate community.
10. Feel valued as individuals.
11. Develop mutual respect and value diversity.
12. Increase self-awareness.

Learning Community Subject Area Objectives

Archaeology

Students will

1. Develop understanding through archaeology of who we were, who we are, and what we can become.
 - a. Value others' history.
 - b. Understand the necessity of preserving sites
2. Use Archaeology to learn from earlier people's successes and failures.
3. Recognize political uses of Archaeology.
4. Distinguish valid Archaeological concepts and methodologies.
 - a. Learn how to identify, classify and analyze data.
 - b. Learn how Archaeologists find and study sites
 - c. Develop understanding of dating methods in Archaeology. Become more critical reader of popular articles citing use of dating methods.
 - d. Understand limits of single studies
 - e. Learn how to reconstruct and analyze the past.
5. Appreciate the importance of culture and cultural diversity.
6. Apply the study of Archaeology to one's own life issues and interests.
7. Use Archaeology to learn more about present life styles and how our cultures can affect the future.

English

Students will

1. Communicate clearly through verbal and written expression.
2. Enhance vocabulary to maximize personal, academic, and career success.
3. Acquire critical thinking skills to verify research results and evaluate assertions.
4. Analyze literature (symbolism, themes, conflict) to explore the subtleties of social interactions and to improve personal relationships and self-understanding.
5. Develop methods of self-expression that access the creative mind.

Math

Students will:

1. Communicate using meaningful and relevant mathematics.
2. Use multiple approaches to solve mathematics problems.
3. Experience math as a laboratory discipline.
4. Use technological tools to solve math problems.
5. Analyze system behavior using mathematical models.

Computer Science

Students will

1. Become independent and confident computer users.
2. Become empowered members of the virtual community.
3. Research, retrieve, analyze critically, store and evaluate information obtained through the use of the computer.
4. Broaden the scope of presentations.
5. Anticipate lapses in computer security and be prepared to restore a system to normal operation.
6. Become familiar with the most commonly used software applications and hardware components.
7. Experience hands-on success using skills needed in computer careers.

Study Skills

Students will

1. Develop critical and analytical, and creative thinking.
2. Read and take notes of texts effectively and efficiently.
3. Take notes of oral discourse.
4. Increase vocabulary skills to better understand oral and written discourse.
5. Manage time well.
6. Improve goal setting and planning.
7. Discover most effective personal learning methods.
8. Develop interpersonal skills for productivity and well-being in teams, communities, family, friendships, and work.
9. Identify personal purpose for completing college and set appropriate academic goals.
10. Identify classes needed to reach goals.
11. Identify and develop habits of mind that lead to academic/work/personal success.
12. Learn about additional study skills to prepare for future classes.

Tips for Learning Community Pioneers (How to be Untracked Without Getting Derailed)

1. The Toolkit

Organizational commitment to the learning college – If the institution wants to change it will have to get involved with administrative and financial support

A positive attitude and confidence

Patience to say the same thing the same way a hundred times

Involve people to the greatest extent possible. Trust them to do well. Celebrate their failures

Believe that with the proper setting and encouragement anyone can shine

2. The Players

Learning Community Instructors – Traits that lead to success

Intellectually honest

Take risks and embrace change

Support each other; are team players

Curious and creative

Follow through with responsibilities

Dedicated to making the Learning Community work

Diversely complement partners strengths

Understanding student needs

Communication well orally and in writing

Philosophical, critical thinkers, who think outside the box

Tolerant; celebrate diversity

Intrinsically motivated

Willing to try new ideas

Optimistic and encouraging

Angels – Lend support and ideas

Student advisors at registration

Student services director

Administration

Public Information Office

Faculty

Library staff

Child care center

Title V grant administrator

Governing board

Consultants

Guest Speakers

Student assistants

Students – Our reason for being

Student learning is priority #1

Diverse in as many ways as possible: skills, background, culture, age

3. The Planning

Define objectives and refer to them often

Research similar successful programs: visit sites, attend conferences

Meet before the semester begins to plan activities for the first month

Include all instructors in all planning

Test drive the simulations with a small group who are not Learning Community students

Integrate skill subjects such as English and math around a central theme: e.g. social studies or science

Choose activities that integrate subject areas as often as possible

Prepare weekly and daily schedules but prepare to be flexible

Begin with activities that welcome students and set a positive, inclusive tone

4. The Journey

Create a safe, nurturing atmosphere

Demonstrate student centered learning, then give responsibility to students

Invite students to comment and volunteer new ideas

Invite college personnel to present and participate in activities

Include guest speakers, field trips and local experts

Gradually add more activities that integrate subject areas

Meet often during the semester to plan together

Provide a written daily schedule of activities for instructors and students

Provide a checklist for students to record achievement of course learning outcomes

Share responsibilities according to instructor preferences and strengths

Keep records of student achievement and assessment

Assess and give feedback to every student daily. Often this is observation and oral comments.

Use daily anonymous evaluations to acquire student feedback

5. The Challenges – Often from within the institution

Resistance accompanies change

The current majority usually opposes changes

Fear of Unknown

Lack of Understanding

Turf and Faculty Load Issues

Leaders will find everyone else is behind them

New programs may not fit into existing structures

Proving learning outcomes can be achieved with new pedagogy

Eighty percent of college instructors continue to deliver instruction with only lecture

Rejection and negative labeling by faculty and elite students who fear competition

Attempts to limit and track Learning Community Students

6. The Celebration of Success

Publicize activities and events

Educate college personnel

Invite families, friends, and college employees to participate

Students write articles for school and community newspapers

Local and national awards
Database of student assessment and followup
Posters, brochures, and flyers
Learning Community alumni as student ambassadors and recruiters
Offer videotape and photo archives to the public in the college library
Create a Web page
Follow Learning Community student successes in subsequent classes
Publicize achievements and awards garnered by Learning Community alumni
present
Help student to organize an Learning Community alumni reunion
Give presentations at educational conferences

7. The Education of college personnel

Inservice presentations for governing board and faculty
Connections to AQIP goals
Including college personnel in activities
Employing consultants from college and community

8. The End of Semester Activity

Involves the community, helps review learning and recruits new students.
Invite college personnel to participate
Distribute memorable souvenirs to participants

Aravaipa Learning Community Weekly Schedule

<p>(1) Monday, August 19 Introduction SS: Writing Sample, Video Careers in Archaeology MA: Icebreaker, Boardwork, Value Auction</p>	<p>(2) Wednesday, August 21 SS: Reading about Archaeology MA: Cause and Effect, Math Attitude Survey SK/CS: Library Orientation and Research</p>
<p>(3) Monday, August 26 SS: Discuss Video; Petroglyphs MA/SS: Linear Model – Dirt vs. Time SK: Meyer Briggs SC: Science Lab - Scientific Method</p>	<p>(4) Wednesday, August 28 SS: Material Remains, Classification MA/CS: System Dynamics Models – Vensim SK/CS: CCRP Survey, Email Addresses</p>
<p>Monday, September 2 No Class - Labor Day</p>	<p>(5) Wednesday, September 4 SS/SK: Reading for Main Idea SS/CS: San Pedro River Research MA: Circles, Percents</p>
<p>(6) Monday, September 9 MA/CS: Attitude Survey, Vensim Samples SS/MA: Human Needs SK/CS: Writing Using Word Processing Tools: Spelling, Grammar, Thesaurus</p>	<p>(7) Wednesday, September 11 MA/SS: Vensim Model; Percents Prep for Plant Survey SS/CS/SK/SC: Research Plant Types WR: Grammar Workshop</p>
<p>(8) Monday, September 16 SS/MA: Site Identification MA/SS: Mapping, Angles, Ratio SS/CS: Research on Archaeology Sites</p>	<p>(9) Wednesday, September 18 SS/MA Site Transformation MA/SS: Area, Pythagorean Theorem SS/CS: Design Artifact Database</p>
<p>(10) Monday, September 23 SS/MA: Site Transformation Visit, Web Archeology Simulation MA/SS: Percent Growth SS/MA/CS: Research on Archaeology Site</p>	<p>(11) Wednesday, September 25 SS/MA: Fishbanks Ecology Simulation WR: Grammar Workshop SS/MA/CS: Research on Archaeology Site</p>
<p>(12) Monday, September 30 SS: Guest Speaker on Arch Preservation MA: Percent Growth, Leaf Percents SS/SK/WR: Fishbanks Reports SS/CS: Research on Archaeology Site</p>	<p>(13) Wednesday, October 2 SS/MA: Field Trip to San Pedro River Guest Speaker, Weaving SS/SK/WR/CS: Write News Article</p>
<p>(14) Monday, October 7 SC/MA: Prep for Water and Soil Lab MA/SS: Plant Survey Reports SS/SK/WR/CS: Write News Article SS/MA: Weaving</p>	<p>(15) Wednesday, October 9 SC/MA: Water and Soil Lab MA: Metric and English Measurement SS/SK/CS: Research on Archaeology Site</p>
<p>(16) Monday, October 14 SS/MA: Measuring a Million MA: Metric Lab, Fractions, Sci Notation SS/SK/CS: Research on Archaeology Site</p>	<p>(17) Wednesday, October 16 SS/MA: Site Transformation MA/SC: Estimation SS/SK/WR/CS: Write Report SS/SK/CS: Research on Archaeology Site</p>

Aravaipa Learning Community Weekly Schedule

<p>(18) Monday, October 21 MA/SS: Building Height, Ball Court Size SS/MA: Prep Romero Ruins Field Trip WR: Grammar Workshop</p>	<p>(19) Wednesday, October 23 SS/MA: Field Trip to Romero Ruins</p>
<p>(20) Monday, October 28 MA/SS: Population Growth, FT Reports CS: Making a Web Page SS/SK: Cultural Diversity</p>	<p>(21) Wednesday, October 30 CS/SS: Excel Graph Site Trans., Web Page SS/SK/WR/CS: Write News Article</p>
<p>(22) Monday, November 4 SS/SK: Cultural Diversity MA/SS: Sci Notation, Population Growth SS: Site Transformation Reports</p>	<p>(23) Wednesday, November 6 MA: Exp Decay, Carbon Dating, Half Life SS: Absolute Dating, Cultural Preservation SS/SK/CS: Research on Archaeology Site</p>
<p>Monday, November 11 No class - Veterans Day</p>	<p>(24) Wednesday, November 13 SK: Essay; Asset Test MA/SS: Population Growth SS/SK/CS: Research on Archaeology Site</p>
<p>(25) Monday, November 18 SK: Advising & Registration SC: Water Quality Lab SS/SK/CS: Web Page Design</p>	<p>(26) Wednesday, November 20 SS/SK/CS: Project Presentations MA: Tree Ring Simulation SS: Tree Ring Lecture, Project Groups SK: Cornell Notes</p>
<p>(27) Monday, November 25 MA/CS: Number Properties, EQ Solving SS/MA: Tree Ring Lab SS/MA: Site Transformation Reports</p>	<p>(28) Wednesday, November 27 MA/CS: Signed Numbers SS/SK/WR/CS: Write News Article SS/CS: Project Groups</p>
<p>(29) Monday, December 2 MA/CS: Patterns, Sequences, Area & Vol SS/MA: Height from Bones SS/CS/MA: Work on Archaeology Projects: Nature Trail, Petroglyphs</p>	<p>(30) Wednesday, December 4 MA/CS: Statistics CS: Computer Systems Research SS/CS/MA: Work on Archaeology Projects: , Desert Plant Guide</p>
<p>(31) Monday, December 9 MA/CS: Statistics CS: Computer Systems Presentations SK: Writing Sample #2 SS/MA: Work on Archaeology Projects</p>	<p>(32) Wednesday, December 11 Archaeology Project Presentations Archaeology Day Activities for Elementary School Children</p>

MA = Math

SS = Social Studies – Archaeology

CS = Computer Science

SK = Study Skills

Aravaipa Learning Community Daily Schedule

Day: 23

Date: 11/6/02

10:00 - 10:15	Announcements; Homework
10:15 - 10:30	SS/SK: Absolute Dating
10:30 - 10:45	>>>>
10:45 - 11:00	MA/SS: Exponential Decay, Half Life
11:00 - 11:15	>>>>
11:15 - 11:30	>>>>
11:30 - 11:45	>>>>
11:45 - 12:00	>>>>
12:00 - 1:00	Lunch
1:00 - 1:15	WR/CS: Writing Workshop –Newspaper Article
1:15 - 1:30	>>>>
1:30 - 1:45	MA/SS: Exponential Decay - Radioactive Dating
1:45 - 2:00	>>>>
2:00 - 2:15	>>>>
2:15 - 2:30	Break
2:30 - 2:45	MA/SS: Exponential Decay -Anazazi Mystery
2:45 - 3:00	>>>>
3:00 - 3:15	>>>>
3:15 - 3:30	CS/SS: Research on Archaeology Site
3:30 - 3:45	>>>>
3:45 - 4:00	>>>>

Hours: SK .5 SS 4 MA 3.75 WR .5 CS 1.25

Assessment Fall 2003

In our third year of the Aravaipa Learning Community we had good news to report about our current and former students:

Three-year demographics as of Fall 2003:

Students new to the college: 61%
Recent high school or GED graduates: 58%
Ages: 15 to 52
Mexican Americans: 58%
Anglo Americans: 41%
Native Americans: 1%
Female: 72%
Male: 28%

Honors and Awards

16 students on the Deans List
3 students on the Honors List
3 students in Phi Theta Kappa Honorary
2 more students invited to join Phi Theta Kappa this semester
3 students are officers of the Student Leadership Board
Other awards include:
 Outstanding Business and Technology Student
 President of WIND
 Aravaipa Service Award
 CAC Foundation Scholarship
 Candidate for U.S. All-Academic Team
 Outstanding Arts and Science Student Award
 Associate of Arts Scholarship Award
 Academics Plus Award

71% of students progressed to the next level of developmental math after leaving the Learning Community. By the end of the Fall 2002 semester

29% placed into first level math
29% placed into second level math
29 % placed into third level math
13% placed into fourth level math

Students self-selected into the Learning Community, bypassing assessment at the beginning of the semester. According to the COMPASS assessment test administered at the end of the Fall 2002 semester

30% placed into a reading skills class
None placed into the first level composition class
50% placed into the second level composition class

50% placed into the third level composition class

The performance of our former Learning Community students in their subsequent classes differs from traditional students in many ways. Below are some observations

From professors of subsequent classes:

Benefits

The students who were in the Learning Community the previous semester

Support each other...

- Form lasting alliances, meet outside class, take other classes together
- Hold easy, comfortable conversations, like old friends
- Help each other
- Work well collaboratively
- Engage other students in the class who have not experienced a Learning Community

Have good study skills...

- Complete assignments
- Have good attendance
- Are unafraid to take risks and make errors
- Engage in lots of chatter, but quiet without prompting and work diligently on task when necessary
- Learn new ideas and skills quickly

Are interested in learning...

- Ask deep questions in class about the subject
- Are enthusiastic, request to learn more, probe more deeply into subject
- Ask why things work the way they do; desire to understand rather than memorize

Think critically...

- Hold heated, well-informed discussions among themselves of current news events and issues, e.g. Space shuttle crash, Why no more trips to the moon?, Should we go to war with Iraq?
- Seem to enjoy a challenging problem that requires creative thinking
- Offer creative solutions to problems
- Investigate and search for answers to real life problems

Feel empowered and appreciated...

- Enter enthusiastically into discussions – are unafraid to speak their minds
- Each feels his/her opinion is worthwhile
- Act as though they own the class
- Offer suggestions on how to run the class
- Bargain with and tease the instructor
- Are confident, fearless learners

Are tolerant...

- Tolerate varied points of view
- Listen to each others' ideas
- Accept and welcome diversity

Are successful in subsequent math class...

- Progress faster than traditional students
- Use multiple approaches to problems
- Exhibit good problem solving skills
- Approach complex word problems confidently
- Achieve uniformly high scores on the math final exam
- Can explain the concepts behind the procedures
- Use common sense and reality checks in math problems
- Have well-developed number sense
- Say math is easy

Challenges

Some students in the Learning Community who have who have a history of low achievement may continue to perceive themselves as inferior to traditional students.

- They are unaware of the benefits they have derived.
- They do not fully appreciate their achievements.
- They attribute their successes to low performance standards.
- Some worry that they did not learn as much as they would have in a traditional class (By request we administered a standard final exam to some of the Learning Community students who were reassured to find they performed as well as students who had taken several more semesters of math).
- They view Learning Community as a fun class and a good way to become part of a supportive group at college, but not a “real” college class.
- Previous enculturation at educational institutions leads them to believe that if a class is fun and interesting, they must not really be learning.
- They are afraid that without lecture and drill they will not be adequately prepared for their subsequent classes.
- They choose to work with former Learning Community students rather than other classmates.

From Learning Community students:

- We covered multiple objectives simultaneously which allowed more time for active learning.
- The class piqued our interest without informational overload.
- We learned to recognize problems with their hats on.

Simulation Project Outcomes

Research and Writing

A paragraph each research day that summarizes your research for the day:

- ❑ Information on a topic that seems especially interesting to you.
- ❑ Contains a topic sentence, 2-3 supporting sentences and a conclusion
- ❑ Handed in at the end of each research day.
- ❑ Typed or handwritten neatly
- ❑ Doublespaced
- ❑ In blue or black ink.

Presentation

Topics

Plants and Animals

Indians

Trappers

Ranchers and Farmers

Government

Miners

Townspeople

Types of Products

Your product should be of interest to the class. Please do not just read or lecture about your topic. Do something more interactive and dynamic.

Products can be, but are not limited to the following:

Dramatic reenactment

Debate

Computer Simulation

Interactive Web Page

Video

Guest Speaker

Field Trip

Role play simulation

Story

Annotated photo album or scrapbook

Powerpoint presentation

Panel of Experts

Interviews

Simulation Project Grade Sheet

Presentations will be graded on a scale of 0 to 4, based on the following criteria:

Content Rubric

- Typifies an aspect of your topic.
- Demonstrates an understanding of your topic
- Reflects thoughtful research
- Pertains to the time period 1400 - 2000 A.D.
- Pertains to the area within a 200 mile radius of Aravaipa Campus
- Shows depth of awareness of the topic
- Portrays the topic accurately
- Includes math
- Written list of information sources

Process Rubric

- Interests audience
- Takes from one to four hours of class time to present
- Includes written instructions and/or information to hand out
- Helps audience to better understand your topic
- Involves all members of the group
- Delivered at the specified date and time
- Demonstrates creativity
- Clearly explains the math
- Uses appropriate language and symbols
- More than a lecture or reading.

Project Plan Form

Topic:

Group Members:

Product Description:

Plans for preparing project:

Due Dates

Project plans due _____

Progress Reports due _____

Presentation due November 12

Progress Report Form

Topic:

Product:

Group Members (Names and assignments):

Progress so far:

Help needed:

How to Put Math Into Your Project

1. Find a number with a cause -effect relationship ("A Function").
2. Translate the relationship into 5 math languages.
3. Predict a result.
4. Use the math to discover an interesting conclusion.
5. Communicate your results clearly.

Five Math Languages

1. Words
2. Table
3. Graph
4. Equation
5. System Dynamics Model

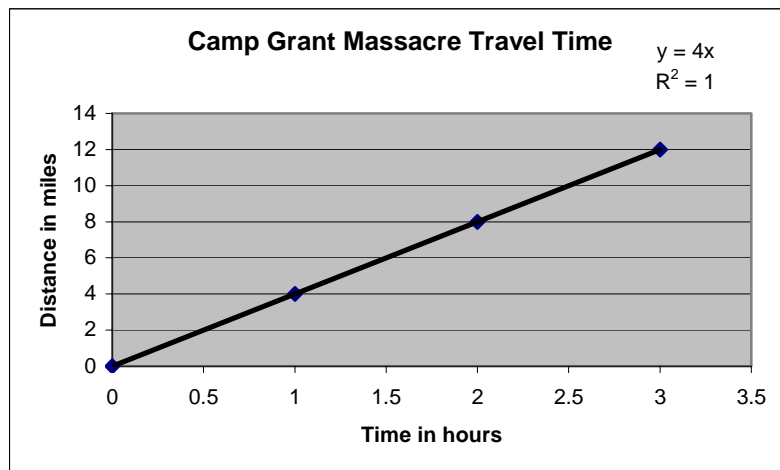
Example

1. Words: Traveling to the Camp Grant Massacre, the group of attackers left Ft. Lowell in Tucson traveling on horseback at an average rate of 4 miles per hour.

2. Table:

Time in hours (T)	Distance in miles (D)
0	0
1	4
2	8
3	12

3. Graph:



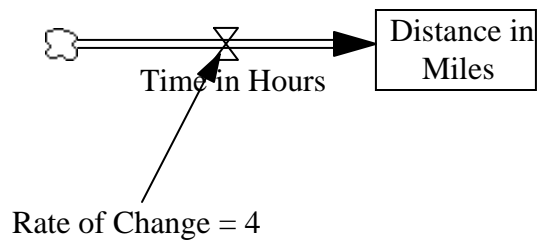
4. Equation:

$$D = 4 T$$

T = time in hours

D = distance in miles

5. Systems Dynamics Model:



Prediction: After 12 hours the attackers will have traveled 48 miles. Camp Grant is a distance of 70 miles from Ft. Lowell by the Reddington Route, so it will take them $70/4 = 17.5$ hours of traveling to reach Camp Grant.

Conclusion: Seventeen hours is a long time to travel in one day. The attackers will probably need to camp overnight on the way to Camp Grant.

A Partial List of Math Activities from the Aravaipa Learning Community Fall 2002

Activity and Math Concept

1. Measurement - Fractions, Decimals
2. Scale Drawing - Measurement, Ratio
3. Radioactive Carbon Dating
 - Geological Features - Exponential Decay
 - Anazazi Artifacts - Exponential Decay
4. Cause and Effect - Systems Thinking, Exponential Feedback Loops
5. Riparian Plant Survey
 - Tree Diameter - Circle Circumference and Diameter
 - Percent Canopy Cover - Percent
 - Height of Canopy - Ratio
6. Anazazi Land Use - Area, Population Density
7. Soil Salinization Lab - Density and Concentration, Volume
8. Fish Banks Ecology Simulation - Number Sense and Estimation, Systems Thinking
9. Tree Ring Dating - Ratio, Linear Model, Solving Equations
10. Population Growth - Exponential Growth, Scientific Notation
11. Limits to Growth - Logistical Functions
12. Temperature Lab - Exponential Decay
13. Camp Grant Massacre - Linear Model
14. Depth of Mine Shaft - Quadratic Function
15. Ranch Management - Statistics, Systems Models
16. Seismic Testing - Ratio, Equations
17. Preparing an Archeological Dig Site - Measurement, Pythagorean Theorem
18. Finding Height from Bones - Ratio, Linear Model, Equations

Active Learning:

Why Cling to Traditional Teaching with Lectures, Worksheets, Drill and Tests?

1. What do you mean by "student-centered" teaching?

Students create and construct their own knowledge through activities, collaborative groups, technology, research, and projects. Classroom instruction is interactive with students talking more than teachers. Teachers facilitate instead of pontificate. The teacher serves as "guide on the side" rather than "sage on the stage." Teachers coach and encourage students by asking questions that lead to understanding. Students play an active part in the learning process by asking questions, discussing among themselves, and solving complex problems.

Assessment is designed to enhance understanding. Testing of student progress is often accomplished by a variety of methods such as essay questions, rubrics, projects, peer groups, and observations rather than single answer written tests. Students receive frequent feedback on their progress.

Student Centered Teaching:

1. Allows students to choose their own learning style.
2. They are allowed to work in groups.
3. The students solve real-life problems
4. The students get excited about expressing how they can solve the problems in different ways.
5. The students seem to continue learning after class because what they learn, they can use.
6. Students seem more motivated.
7. All levels of students learning abilities are accommodated.
8. Teachers are more sure what the students are learning. ...Janet Lopez, Student

2. The old way works better...

Most students can learn best by lecture, worksheets, drill and practice.

Lectures leave a lot of children out. Some students may not understand lectures and worksheets. Worksheets do not show how or why a problem was worded a certain way. Children have different learning styles; teachers need different approaches. Some students need hands on learning to understand concepts.

I learned it the old way.

You were successful because you were one of the 10% of students who learned best the old way, so you are here learning to teach. The other 90% of students who could not learn the old way are not here. Many dropped out of classes or school because they could not learn that way. Do you want to lose 90% of your students? Often it is the most creative and intelligent students, who do not want to memorize and follow someone else's rules, that drop or fail. These talented students are convinced that they are not capable of learning, when in reality, when their learning styles are accommodated, they often turn out to be the best students.

Those successful students, who were forced to give up their own ideas and play the school game, have a hard time unlearning rules so they can begin to understand the concepts to use in real life applications.

You made it through classes, perhaps with good grades, but can you really understand what you learned? If you had learned it the new way, you would be able to understand and use it now.

This way has been used for 500 years, why change now?

This way has been tried for 500 years, and has never worked except for a few students. Since it does not work, what do we have to lose by trying another way? More drill and practice on useless stuff will not help students learn how to apply knowledge to real life applications, the skills needed in today's world.

Times and technology has changed in the past 50 years. Computers and calculators can do the basic operations, people are needed to decide what to put in, what buttons to push, and whether the output is reasonable. No one will pay a person \$30,000 per year to do the job of a \$20 calculator, so learning to be a calculator is useless.

Understanding will automatically follow memorization.

Understanding does not automatically follow memorization. I can memorize the words to a German song without understanding German.

3. It is easier to teach the old way...

It is easier to teach the old way.

It may be easier for you right now because that is the way you learned, but it is less effective. After you have mastered the new way of teaching, you may find it is easier. The new way helps the teacher to better understand the lesson. Also by learning a new way to teach, the teacher models for students how to learn something new.

Testing knowledge is easier than testing higher order thinking skills.

Like anything else, alternative assessment becomes easier with practice. It is more interesting because it shows how differently people approach the same problem, often with astonishingly creative results. Most of the new elementary school textbooks include alternative assessment methods.

I don't want to add more work to my teaching load.

Anything new will be more work for a while, but in time you will discover ways to make it easier. The time spent gathering information and writing lectures can be spent assessing student work and giving feedback instead.

I am too old to learn a new way.

Many older teachers have found trying new ways of teaching invigorating and rewarding. They have renewed their enthusiasm and enjoy working more closely with students.

4. It is risky to try something new...

I feel uncomfortable doing something new.

This is what we ask of students every day; cannot we also ask it of ourselves? Having a teacher be a role model for life-long learning is good for students. We can model for them how to react positively to mistakes, how to approach new problems, how to cope with confusion, how to react when someone doubts your intelligence or is disrespectful. These are important lessons for students to help them develop confidence and assertiveness. If you do not understand how to do things the new way, you can model what to do when you don't know what to do, where to go for help, and how to persevere until you succeed. You can model honesty when you don't know the answer and you can reinforce their self esteem when they help you discover something new.

My colleagues will laugh at me for doing activities when everyone else lectures.

You will have the last laugh because your students will understand the material and be able to use it. Retention and student success will increase without sacrificing quality of learning. Associate with more understanding colleagues whenever possible. There are always those who will criticize you no matter what you do. Better that they criticize you for something you are doing well.

Many remedial students are kinetic learners. Hands-on activities are the best way for them to learn. You are wise to have chosen to help all your students to learn, not just the best memorizers.

The students will think I don't know the subject unless I present eloquent lectures.

Lectures are the most common and least effective method of teaching. Lectures are also the method the students like the least. The attention span for an adult listening to a lecture is about 10 minutes; it is less for children. Showing them how well you can do the problems may help you learn the subject better but not the students. Instead the students either feel helpless and intimidated, or bored and superior. Either way, they are not learning much. They will respect you and like you more if you empower them and let them do the talking.

There may be more discipline problems.

There are many ways to maintain control and avoid discipline problems when students work in groups. Working in groups is a skill that can be learned by both teachers and students. When students are engaged in active learning, they are often too busy learning to get in trouble. On the other hand, as one student says, "The old way is very boring. All you do is listen. Students will be easily side-tracked, start doodling or even talking. Student-centered learning gains the students undivided attention." "Hands-on tactics get and give more attention. The students get more involved." Research shows that the best indicator for learning is time on task. Students are on task when they are working on problems, not when they are listening to a lecture.

I am evaluated as a teacher on how well I lecture.

Many administrators are aware of the new teaching paradigms. For those who are not, they seldom visit your classroom, and you can arrange a lecture for the days that they visit, if necessary. Then you can gradually educate them by sending them research-based information about student-centered learning and involving them in inservice activities.

You cannot teach well without coaching. Students need to engage their emotions as well as their intellects for maximum learning.

Some students may know more about the topic than I do.

This is a wonderful opportunity to let students feel good about their expertise. You don't even have to let them know you don't know. Just pretend you don't know and have them explain it to you until you understand it. If they can't explain it then they probably don't really understand it either, and you can try to figure it out together, or catch up on it after class.

5. The students learn more the old way...

We must cover a lot of material quickly in order to finish the curriculum in time.

It is said that the American curriculum is a mile wide and an inch deep. Instead of learning any concept well, American teachers teach the same shallow stuff again and again each year, with little understanding or remembering by the students. In contrast, many countries whose children do better on International tests, teach fewer subjects, more in-depth, so that the children truly understand and remember the concepts.

You can talk about more material faster by lecturing, but the students will learn less than if they experience the concepts. Talking is not teaching.

The new way is "dumbed down".

On the contrary, the new way allows time to explore topics in-depth and technology allows students to explore more complex concepts than in traditional classes. Real life problems can be applied later in life and thus are more useful to students. Many of the tricks employed in traditional classes are obsolete and unnecessarily in a technological world.

Hands-on activities teach silly stuff that is not in the syllabus and does not relate to the subject. Unfortunately some teachers have interpreted hands-on activities to be games unrelated to the subject. All activities should further the purpose of instructing the students in the subject matter.

Students won't understand unless I explain it first.

How many people do you know who have read the instructions to their VCR's?

Students do not have the motivation and self-discipline to plan and research on their own.

When given the opportunity, motivation, and audience for challenging projects, students have produced incredibly creative and thoughtful projects. The projects that motivate best are those that students find interesting and relevant to their lives. For this reason, letting students choose their own areas of research usually results in better projects. Clearly defining the parameters, timelines and providing rubrics for the project outcomes when the project commences, keeps students on-target and engaged.

Students who are absent will find it difficult to make up work

Meaningful tasks and sharing ideas with other students can make it easier for a student who is absent to catch up with the work s/he missed. Teachers can assess the progress of students who have missed class by assigning makeup work that requires concept mastery. If a student proves to be missing concepts due to absence, the teacher can schedule a review session to go over the work missed.

6. The students prefer the old way...

The students want me to tell them what to do.

The students have been conditioned to believe that their precious grades depend on the whim of a teacher, so that memorizing instructions directly from a teacher will insure success. Assessment drives learning. People like to do what they are rewarded for. Alternative assessment such as observations and rubrics that require critical thinking in ambiguous, real-life applications must be used instead of tests of rote memorization and mechanical manipulation exercises. Frequent feedback to students on their progress, and rewards for creative ideas will encourage and reassure anxious grade-seekers.

Students don't like to think.

By culturally defining confusion as a symptom of failure instead of a symptom of learning, we condemn ourselves to the risk-free, but unproductive memorization of pieces of information labeled as facts. Without the intellectual curiosity to examine the sources of our information, we cannot even distinguish between facts and opinions. Dutifully we take in and regurgitate the bits of information we are served so we can ultimately take home a piece of paper that proves we have passed the tests. The naive curiosity and excitement of learning has been purged from all but our most resistant students after the first few grades of primary school. People love to be challenged and learn when they believe they can. Why else would people spend hours playing video games for entertainment? If we give students challenging but solvable problems and reward them, they will enjoy learning.

7. I care about students...

I prepare my lecture carefully

You are very dedicated and hardworking. However, since students only retain 10% of what they are told in lectures and videos, wouldn't you be more effective if you check your impulse to "show and tell" and instead "facilitate and coach" the students? Getting A's and B's is not a measure of understanding but a measure of compliance. You can choose to demand they pay attention to your lectures or that they actively participate in learning experiences.

I am preparing my students for their next classes.

What if their next classes are not traditional lectures, but follow a more modern paradigm of student-centered with interactive learning? It is easier to go from student-centered to lecture style classes because in lecture classes all the students need to know how to do is to take notes and memorize.

8. I do not know how to teach any other way...

I was trained to teach the old way.

Training is readily available in the form of workshops, inservice, Internet Web Pages, etc. Many complete lesson plans can be found on the Web.