NORTH DAKOTA STATE COLLEGE OF SCIENCE

MATHEMATICS, PROBLEM SOLVING, & CRITICAL THINKING ACROSS THE CURRICULUM

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Overview

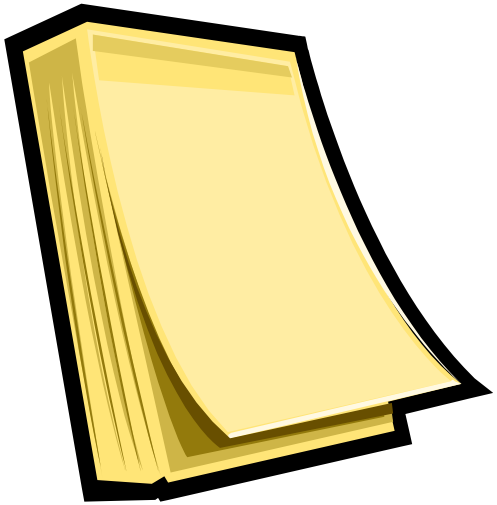
- Why are we here?
- How can this be done? What can it look like?
- What can NDSCS do?
- What can we learn from others? What we learn from ourselves?
- When can NDSCS get started?

Overview

- Why are we here? Introductions & What is MAC³?
- How can this be done? What can it look like? Strategies & Examples
- What can NDSCS do? Brainstorming & Designing
- What can we learn from others? What we learn from ourselves? Resources & Assessment
- When can NDSCS get started? Implementation Details

Note about Sticky Notes

- When you have a question about something I say, you are welcome to stop me OR you can write it on a sticky and post it for me to answer later.



Why Me?

- Edmonds CC College-Wide Ability: Quantitative Skills (1997)

- NSF Grant: “Mathematics Across the Curriculum (MAC)” NSF CCLI Adaptation & Implementation (2000-2004)

- NSF National Dissemination Grant (2005-2011*)

Why Me?

1) From 2005-2008, worked with 158 community college faculty comprising 72 interdisciplinary teams (representing dozens of different disciplines) from 36 colleges in 19 states through MAC^3
   - www.mac3.amatyc.org

2) Team-taught with Chemistry, English, EAP, and Art History; was a "math mentor" with Art, Political Science, & Business

3) Taught math at a community college for 13 years.

MAC^3 Courses & Projects - WWW.MAC3.AMATYC.ORG

Projects from past MAC^3 Institutes

Accounting
Anthropology
Art
Art History
Biology
Business
Campus-Wide Initiatives
Chemistry
Career & Technical
Computer Information Systems
Computer Science
Criminal Justice
Culinary/Hospitality Management
Economics
Education
English
Environmental Science
Ethnic Studies
Ethnomathematics
Geology
Health
Health & Human Services
History
Humanities
Labor Studies
Marketing
Mathematics
Nursing
Physics
Policy Studies Political Science
Psychology
Reading
Sociology
Spanish
Speech
Special Education
Statistics and Data Analysis
Study Skills
Sustainability
Urban Planning

Why YOU?

- Introduce yourself, including
  - your name,
  - discipline, and
  - what you hope to get out of being here today.

Revisit Agenda?

12:15 – 12:45	What is MAC³ and how can it help with Quantitative Literacy, Critical Thinking and Problem Solving
12:45 – 1:15	Implementing mathematics across disciplines: strategies & examples
1:15 – 2:15	Brainstorming & designing
2:15 – 2:30	Break with refreshments
2:30 – 2:45	Resources & Assessment
2:45 – 3:45	Time to work (individually or in teams)
3:45 – 4:00	Discussion & Wrap-up

QUIZ:

1. *Do your students know the math and have the critical thinking skills they need for your class?*

2. *Do students know the math and have the critical thinking skills they need for the workplace or university?*

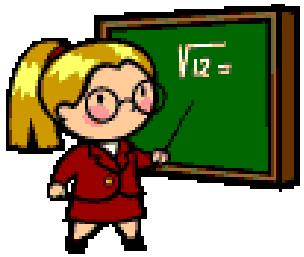
3. *Given the level of critical thinking and math skills that student bring with them, and given the set curriculum, what can do about it?*

QUIZ ANSWERS:

1. *Probably not!*

2. *Probably not!*

3. *Math Across the Curriculum (or Critical Thinking in Context, Math-in-CTE, Quantitative Literacy Across Disciplines, …)*



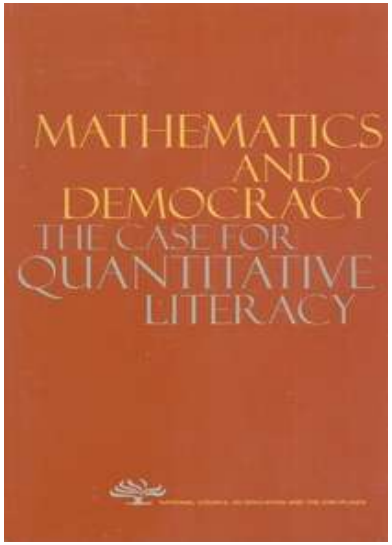
A Note on wording…

- One definition of "Critical Thinking" is:
  - "The positive habits of mind … including a desire to follow reason and evidence wherever they may lead, open-mindedness, foresight attention to the possible consequences of choices, a systematic approach to problem solving, inquisitiveness, fair-mindedness and maturity of judgment, and confidence in reasoning."
- Thus, from here on…

Mathematics + Critical Thinking = Quantitative Reasoning

A Note on wording…

- "The capacity to deal effectively with quantitative aspects of life is referred to by many different names, among them quantitative literacy, numeracy, mathematical literacy, quantitative reasoning, or sometimes just plain 'mathematics'."



Mathematics and Democracy

Again…Why are we here?

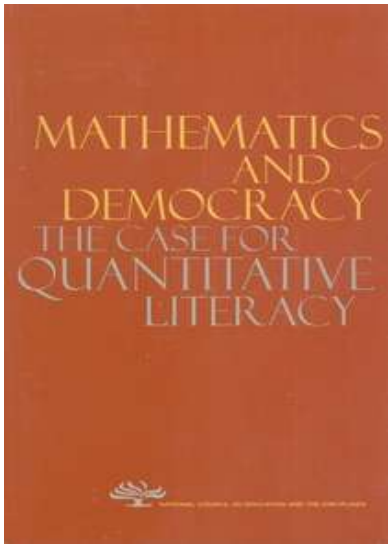
- From a 2006 Report from the National Research Center for CTE:

"… students, particularly those enrolled in career and technical education (CTE) courses, do not have the math skills necessary for today's jobs… Math is found in all areas of CTE, but is largely implicit to both teachers and students."

- In 2000, the National Council of Teachers of Mathematics (NCTM) issued a report that emphasized math as one of the *new basic skills* for industry.
- Mathematics is no longer a requirement only for prospective scientists and engineers. Instead, some degree of mathematical literacy is required of anyone entering a workplace or seeking advancement in a career (National Research Council, Mathematical Sciences Education Board, 1995).
- Research by Levy and Murnane (2004) has shown that higher wages depend on the ability to think mathematically.

From *Mathematics and Democracy*

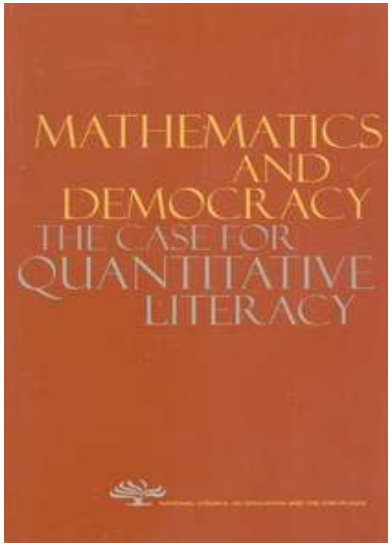
- "Quantitative literacy empowers people by giving them tools to think for themselves… These are the skills required to thrive in the modern world."



Mathematics and Democracy

What is Quantitative Literacy (QL)?

- "…quantitative literacy involves mathematics acting in the world. Typical numeracy challenges involve real data and uncertain procedures but requires primarily elementary mathematics."

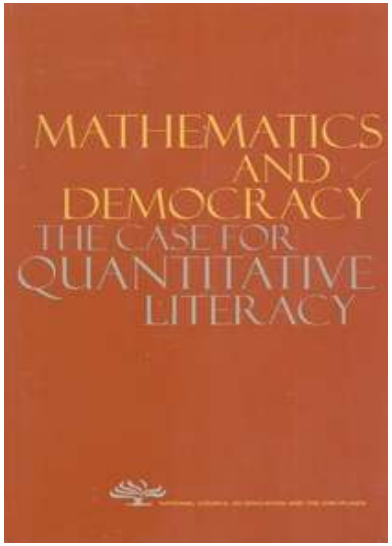


Mathematics and Democracy

What is Quantitative Literacy (QL)?

- "Numeracy is not the same as mathematics, nor is it an alternative to mathematics."

  Mathematics and Democracy



Whose Responsibility?

Bernard Madison:

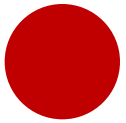
- “Quantitative Literacy (QL), the ability to use numbers and data analysis in everyday life, is everybody's orphan. Despite every person's need for QL, in the discipline-dominated K-16 education system in the United States, there is neither an academic home nor an administrative promoter for this critical competency."

Quantitative Literacy

How Can This Be Done?

Modes of Integration:

1) Enhancing an existing course with projects and assignments
2) Adding a credit of math onto an existing course
3) Adding online support for math topics
4) Linking courses or combining courses
5) Other ideas?



What can MAC look like?

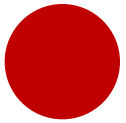
- **Examples of projects:**
  - Health
  - Art – Ceramics
  - Biology
  - English Composition
  - Anthropology
  - Nursing
  - Automotive Technology

Health

- Lessons on Survey Design, Graphing, and Statistics
  - Learn to effectively assess the statistics in current media by developing critical thinking skills with the data.
  - Learn how to perform simple statistical analyses. The data used will be on drugs, alcohol and sexual health for potential adolescent behavior modification.
  - Improve survey designs and graphs.

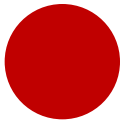
Biology with Math-Aid

- Combined Biology 201 (5-credits) with Topics in Math (2-credits).
  - Biology 201 is the first-quarter of the 3-quarter biology majors series
  - Class met 1 extra hour a day for 5 weeks
  - Knowledge of math content used in assignments and labs



Biology with Math-Aid

Math topic	Biology examples
Graphing	Photosynthesis Enzymatic reactions
Units & Scientific Notation	liter, ml, μl, meter, mm, μm …
Logarithms & exponential functions	pH, electrophoresis, bacterial growth
Probability	Mendelian genetics
"DNA math"	restriction maps, standard curves



Biology with Math-Aid

- Math Instructor also gained…
  - The math instructor better understood which mathematical skills are used in biology courses and how they are used.
  - The math instructor can now incorporate more appropriate examples into the mathematical courses that are prerequisites for biology.

Biology with Math-Aid

- Course now offered as:

BIOL 210 - Problem Solving for Majors Cellular Biology

1.0 Credits
Designed specifically to improve student success in BIOL& 211 (was BIOL 201). Provides practice for solving quantitative problems with improved overall understanding of principles. MANDATORY participation S/U grading (was BIOL 211). Prerequisite: ENGL 100, MATH 090 and CHEM& 121 (was CHEM 101) or CHEM& 143 (was CHEM 133) or equivalent each with a grade of 2.0 or higher. Concurrent enrollment in BIOL& 211 (was BIOL 201) is also required.

Art: Ceramics

- Started as a non-credit integration when they developed ceramics projects in Geometry course for future teachers
  - Ceramic vase project
  - Tiles

Art: Ceramics

- Combined Ceramics & 1 CR Math – Fall 2006
  - **Measurement activities**
  - **Ratio/proportion**
  - Scavenger hunt
  - Symmetry patterns
  - Ethnomathematics
  - Unique surfaces

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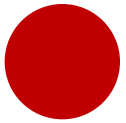
Algebra the Write Way

- Coordinated studies course – integrated course
  - 5 CR *Elementary Algebra* course & 5 CR *Intro to Essay Writing* course
- Common ground/focus areas:
  - Writing to explain the mathematical algorithms and deepen understanding of concepts
  - Readings related to mathematics / Quantitative Reasoning
- Key Integrated Parts of the Course
  - Math Homework writing questions
  - Journal (writing & math prompts, reading responses)
  - Essays



Anthropology –
MAC^3 and Service Learning

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- Learn-n-serve Environmental Anthropology Field (LEAF) School
  - AmeriCorps scholarship, 15 credits in Human Ecology

Anthropology – MAC^3 and Service Learning

SSAC2007.WY159.JZ1.1

Computing Dosage for Infants and Children

Calculation of Dosage Using the Body Weight Method

Calculate pediatric dosage using the child's weight in kilograms and the manufacturer's recommended daily dose based on the weight in kilograms.

Core Quantitative Issue
Ratio and proportion

Supporting Quantitative Skill
Unit conversions

Prepared for SSAC by
JIAN ZOU – SOUTH SEATTLE COMMUNITY COLLEGE

Overview of Module

According to *Math and Meds* (1998, p. 207), "Even minor mistakes in administering medication to an infant or child can be extremely serious because of differences in their ability to absorb, distribute, metabolize, and excrete substances such as drugs." This module is designed to show you how to calculate the amount of medication to be administered to an infant or a child according to the physician's prescription, the manufacturer's recommended daily dose per kilograms of body weight, and the body weight of the child.

Slides 4-6 Build the pound-to-kilogram conversion spreadsheets.

Slide 7 Gives the formulas to use to calculate the dosage in mg.

Slides 8-9 Build the spreadsheets to calculate the dosages.

Slide 10 Calculates the dosage in mL.

Slides11-12 Build the spreadsheet to calculate the dosages in ml

Slides 13 End of module assignment

Automotive Technology

Math-in-CTE Lesson Plan

Lesson title: Manipulating the variable to change compression ratios	**Lesson no.: 10**

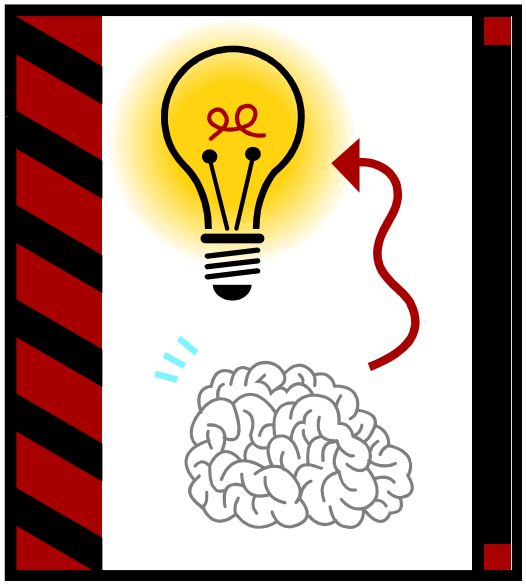
Occupational area: Automotive Technology
CTE concept(s): Compression ratio
Math concept(s): Direct/indirect variation; exponents.

Lesson objective:	Students will demonstrate a working knowledge of how to use direct and indirect variation and its application in automotive technology, while recognizing it in other contexts.
Supplies needed:	*HP Books Auto Math Handbook* by John Lawlor Copyright 1972, ISBN 1-55788-020-4

Automotive Program Curriculum Map				
Course	**Unit**	**CTE Concepts**	**Math Concepts**	**NCTM Reference**
Electrical	Voltage, Current, Resistance and Ohm's Law	Voltage, current, resistance and Ohm's Law	Whole numbers; decimals and fractions (adding, subtracting, multiplying, and dividing); solving linear equations; ratio proportion; system of equations; metric to metric conversions; metric prefixes; reading and writing percents	N8, N9, A2, M0, M1, P15, P16
	Series and Parallel Circuits	Series and parallel circuits	Decimals and fractions (adding, subtracting, multiplying, and dividing); solving linear equations; ratio proportion; system of equations; metric to metric conversions; substituting data into formulas; working with reciprocals	N8, N9, A7, A8, A9, A11, P2, P15
	Electrical Components	Electrical components	Solving linear equations; percents; temperature; comparing numbers; linear measurement	N8, N9, A2, M0, M1, P2, P15
	Automotive Wiring	Automotive wiring	Whole numbers	N8, N9, P15
	Multimeter and Scopes	Multimeter and scopes	Whole numbers; reading and writing percents; ratios; reading dials, gauges and meters	N8, N9, M0, M1, P15, P16
Engine Performance	On-Board Diagnostic and Scan Tools	On-board diagnostic and scan Tools	Whole numbers; binary math basics; charts and graphs; reading and writing percents; comparing numbers; angles; degrees of rotation; temperature measurement; ratios	N8, N9, M0, M1, P15, P16
	Sensors	Sensors	Whole numbers; charts and graphs; reading and writing percents; comparing numbers; temperature measurement	N8, N9, M0, M1, P15, P16

What can NDSCS do?

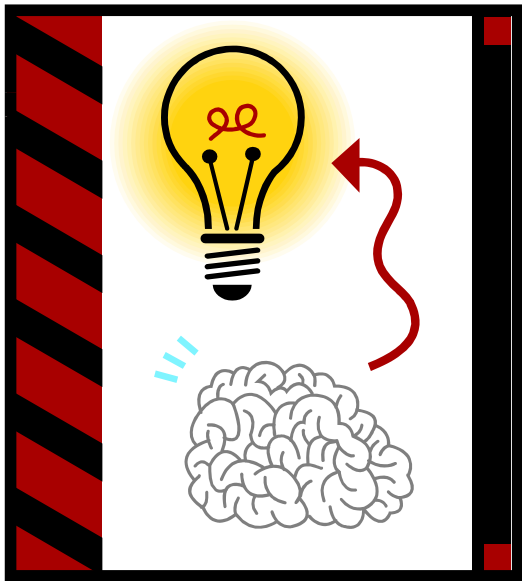
- BRAINSTORMING & ARTICULATION OF GOALS WORKSHEET
- Break into groups by discipline as possible



What can NDSCS do?

- At the end of the hour, each person or team will share their answer to #5 (a brief idea for a project)

- Refreshment Break 2:15

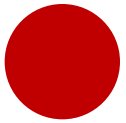


What can we learn from others?

General MAC/QL Resources & Web sites

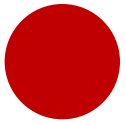
Web Resources Handout:

- MAC³ Projects and Courses
  - http://www.mac3.amatyc.org/projects.htm
- Statistical Literacy
  - http://www.statlit.org/
- Social Science Data Analysis Network
  - http://www.ssdan.net/chip/exercises.shtml
- **Math-in-CTE (NRC for CTE)**
  - **http://136.165.122.102/mambo/content/view/43/56/**
- **Spreadsheets Across the Curriculum**
  - **http://serc.carleton.edu/sp/ssac/index.html**



What we learn from ourselves? When can NDSCS get started?

- Together, you will think about this with the "Implementation & Assessment Details" Worksheet.
- Work on this until about 3:45.
- At that point we'll discuss "challenges" and any remaining questions.



Collaboration is Key:
Ways to "Open the Door":

- **Bridge the divide between math department and other departments**
  - Buy a lot of lunches
  - In-service days or non-instructional day
  - Borrow textbooks

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- **Support each other**
  - MAC - Math "servants"
  - MOD Squad

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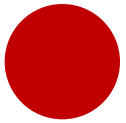
- **Use AQIP as your excuse**

What's in it for Faculty?

In interviews, MAC^3 faculty participants responded that they -

- created a wide variety of new ways of incorporating mathematics into their curricula;
- gained valuable insights into their team member's disciplines;
- realized new ways of looking at their own discipline;
- discovered strong connections in terms of linking skill-building and critical thinking development from one discipline to another;



What's in it for Faculty?

Faculty responded that they -

- generated new pedagogical approaches that would carry over to the other classes they taught;
- were stimulated by their work with colleagues;
- non-math faculty described a significant diminishing of their own math-phobia and an increased willingness to incorporate mathematical concepts into non-math classes.

What's in it for Students?

Our data show-

- "After completing a MAC^3 course, surveyed students showed statistically significant gains in their interest and confidence in mathematics, their awareness of math in their lives, and their appreciation for interdisciplinary learning."

What's in it for Students?

What will your data show???

THANK YOU!
YOU CAN CONTACT ME AT:

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