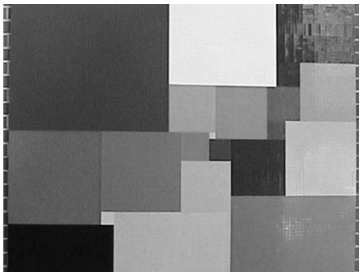


Preparing Secondary Students for STEM Fields: A Collaborative Model

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“Twenty One”
Lego Art Composition (1994)
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Outline

- Rationale for STEM education
- Review of literature
- Steps to STEM
- Promising practices
- Accessibility Issues
- Recommendations

Objectives

Theoretical: Gain an understanding of research-based interventions and recommendations

Practical: Gain a compendium of local, state and federal resources concerning SWD and STEM fields

Preparation for assisting students with disabilities to enter and graduate from STEM fields

STEM Fields

- Core of advanced society
- Information Age
- Vocational choice
- Low unemployment rates
- High starting salaries
- Rewarding, Satisfying, Pleasurable

Standard of Living

- MRIs
- GPS
- Semiconductor

- Microsoft
- Apple
- Google

Mathematics courses required for typical undergraduate majors.

Liberal Arts	Core Mathematics: Pre-Calculus or Finite Mathematics. (But some areas require calculus e.g. economics.)
Nursing	Pre-Calculus Algebra
Agriculture	Pre-Calculus Trigonometry, (some require calculus)
Elementary Ed Secondary Math Ed	Core + Three Mathematics for Elementary Education Essentially a degree in mathematics
Business	Business Calculus I and II (Two semesters.) Statistics
Engineering	Calculus I, II & III (three semesters), Differential Equations, Linear Algebra, Statistics (some require more)
Pre-Medicine; Pharmacy, etc.	Calculus I & II, Statistics
Science	Minimum: Calculus I & II, Statistics

Declining STEM Education

- BLS data
- Response:
1. Increase pool by improving K-12 science and math education
 2. Strengthen teacher skills with additional training in science, math, technology
 3. Enlarge college student pipeline

Barriers to STEM Education

- Disability
- Self-empowerment/exploration
- Academics
- Career/employment

Research: Elementary Ed.

- Challenges: Fact Mastery and fluency and problem-solving skills
 - 5 - 8% population identified with math LD
 - Strategic interventions most positively affected basic math skills (4 operations and automaticity)
 - Direct instruction used for b. skills remediation and automaticity
- (Swain, Bertini & Coffey, 2010)

Direct Instruction and Drill Tasks

- Drills = response and review (Burns, 2005)
- Acquisition of new skills (Burns)
- Better retention of skills (Singer-Dudek & Greer, 2005)
- Development of automaticity (Kroesbergen & VanLuit, 2003)
- Improved performance on higher level tasks (MacQuarrie, Tucker, Burns & Hartman, 2002)

Individual Instructional Level

- Math facts
 - Ratios of known and unknown items
 - Incremental rehearsal and drill sandwich
 - IR with a ratio of 90% known and 10% unknown effectively increased student's fluency with multiplication tables
- (Burns, 2004; Burns, 2005)

Early Math Success

- Conceptual understanding combined with fluency in basic math facts helps students develop more flexibility in approaching math problem-solving tasks (Varol & Farran, 2007)

Point to Ponder

“... some of the students with [number facts] difficulties may be remedial students during the elementary years when computational accuracy is heavily stressed, but can go on to join honors classes in higher math where their conceptual prowess is called for” (Garnett, 1998)

Math Difficulties

- Difficulty with multi-step problems
 - Borrowing (i.e., regrouping, renaming) errors
 - Cannot recall number facts automatically
 - Misspells number words
 - Reaches unreasonable answers
- (Bryant, Bryant & Hammill, 2000)

Math Difficulties Continued

- Calculates poorly when the order of digit presentation is altered
- Cannot copy numbers accurately
- Orders and spaces numbers inaccurately in multiplication and division
- Does not remember number words or signs

The Language of Math

- Math is conceptually dense
- Abstract symbols and vocabulary important

The Pythagorean Theorem:

$$a^2 + b^2 = c^2.$$

The quadratic equation: if

$$ax^2 + bx + c = 0,$$

then

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}.$$

Word Problems

- Area of great weakness for students with math disabilities from elementary to postsecondary grade levels
- Which behaviors interfere with finding solutions? Reading? Syntax? Computation? Multi-steps? Type of structure of word problem?

Multi-step Problems

- Whole number computation
- Fractions
- Word problem solving
- Algebra
- Sequenced, explicit, systematic teaching with practice and corrective feedback and activities that promote understanding of steps

Multistep Problems

Mr. Jones want to tile his den with tiles that are each a foot square. The den is 15 feet by 20 feet. If tiles cost \$1.50 each, then how much does it cost to tile the room?

Classic Multistep Problem: If Tom takes 3 hours to paint Mrs. Sawyer's fence and Huck takes 4 hours to paint the fence then how long will it take them to paint the fence together?

Solution to Tom and Huck problem.

Tom can paint $\frac{100}{3}$ percent of the fence in an hour; Huck can paint $\frac{100}{4}$ percent of the fence in an hour. So together they paint at a rate of $\frac{100}{3} + \frac{100}{4}$ percent of the fence per hour. This is $\frac{175}{3}$ percent per hour. So together it takes them $\frac{100}{\frac{175}{3}} = \frac{300}{175} = \frac{12}{7}$ hours to paint the fence.

Solution to Tom and Huck problem assuming the fence is 12 yards; I use 12 because 12 is divisible by both 3 and 4. (And like many students I like to avoid fractions.)

Tom can paint $\frac{12}{3} = 4$ yards of the fence in an hour; Huck can paint $\frac{12}{4}$ yards of the fence in an hour. So together they paint at a rate of $3 + 4 = 7$ yards per hour. So together it takes them $\frac{12}{7}$ hours to paint the fence.

Factors affecting STEM Participation

1. Intensity, quality of HS curriculum, test scores, class rank/GPA
2. Mathematics beyond Algebra II
3. Advanced math and science courses offered by schools, taken by students; teacher effectiveness, school resources, parental income, wealth, education
4. Out-of-school opportunities; pre-college programs for URM (GK-12)

Factors for STEM Retention

1. STEM academic support services and programs
2. Drop out rates attributed to: financial difficulties, poor high school preparation, poor college teaching, low faculty expectations

Graduate School Participation in STEM Fields

- Stem pre-graduate school bridges and undergraduate research programs for minorities and women increased STEM graduate school enrollment

Math Instruction for Students with Mathematics LD

- Explicit Instruction
 - Use of Heuristics (rules, algorithms)
 - Student Verbalizations
 - Visuals (for teacher and students)
 - Teacher feedback
 - Cross age tutoring (student from a higher grade helping a student in a lower grade)
- (Gersten, Chard, Jayanthi, Baker, Morphy, Flojo, 2009)

Instructional Differences

- Auditorium classes
- Computer assisted learning and computer-based quizzes and examinations
- International faculty or graduate students
- Instructors who are not versed in current optimal pedagogical methods
- Increased use of technology in instructional delivery

Transition to College: What to Pack

**Self
actualization**

Self regulation

Self accommodation



Self advocacy

Universal Design for Learning (UDL)

The brain and learning
Recognition networks receive and analyze information (what)
Strategic networks plan and execute actions (how)
Affective networks evaluate and set priorities (why)
(Rose, Meyer & Hitchcock, 2006)

Universal Design Initiative

- Working closely with STEM departments to make math and science courses more accessible to students with disabilities
- Exploring various ways to make math and sciences courses accessible to all students
- Testing accessibility of online software suites
 - Pearson's My MathLabs

My Math Lab: Findings

- Accessibility
- Flash and Frames
- Some controls do not update or change causing navigation to be difficult or awkward
- At times it is necessary to tab backwards through materials to access what did not show up previously

My Math Lab Continued

- Certain program buttons, such as the Help Me Solve This Button, will open an additional flash page that does not allow the screen reader to switch focus to the new flash page.
- These new pages are not considered frames; there appears to be no way to make the new window interact properly with a screen reader

My Math Lab Continued

- Many buttons within the lab often require mouse clicks and the drag function

Quizzes and Tests

- Mathematical equations are read correctly
- However when paired with images, such as finding the perimeter of a rectangle, nothing is read at all
- No selectable text-- users with learning disabilities using an external reading program will be unable to cut and paste text to be read back to them

Answers

- Correct answers are only visible by mousing over them; not useful at all to a screen reader user

E-book

- All folders are labeled as Graphic:Folder and documents are labeled Graphic:Document for each chapter of the ebook
- This is advised against as this is considered non-useful alternative text
- Video lecture player does not have control buttons labeled

E-book

- Captions are available through clicking the CC button
- No selectable texts in the questions for users with learning disabilities

E-book

- Accessibility page views for the ebook, however some are more difficult to navigate than others
- Accessibility pages are viewed in PDF format, because of Adobe's accessibility tool pages are not generated properly causing the reading order to be confused
- No selectable text for students with learning disabilities

Students in STEM Courses at Auburn University

- Meet with professor and/or Department Head before semester begins
- Work with the department to find the student a GTA/Assistant to work assist the student during class labs and quizzes, this is especially helpful for science courses

STEM Students

- Attempt to obtain access to textbooks and other materials during this meeting
- Option - Braille books in house or purchase textbook from outside source
- Etext book (if student does not know nemeth)
- Convert all notes, power points, handouts in both e-text and braille

Accessibility Products and Perspectives

- Software/Hardware Available to make Math Accessible
- Various products on the market
- The Design Science Line
 - - MathType
 - - MathDaisy
 - - MathPlayer

Accessibility Continued

- Others
- -Scientific Notebook
- -Kurzweil 3000 v.12

AU Programs Fostering Success Rates and Retention.

- Mathematics Placement Exam *New*
- MathExcel Program
- Tutoring Programs
- Midterm Evaluation and Intervention Program.
- Computer Assisted Classes

Computer Assisted Courses

- Students attend all their classes in computer labs
- Undergraduate Teaching Assistant
- Graduate Teaching Assistant
- Group learning is encouraged
- Students can go at their own pace
- Student can try problems as many times as they like
- Multiple means of content delivery (worked examples with hints, electronic textbook, mini-lecture videos)

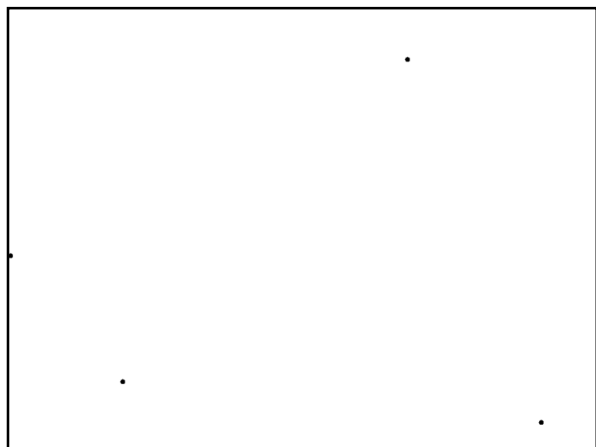
Department of Mathematics and Statistics
Mathematics for Elementary Education Program.

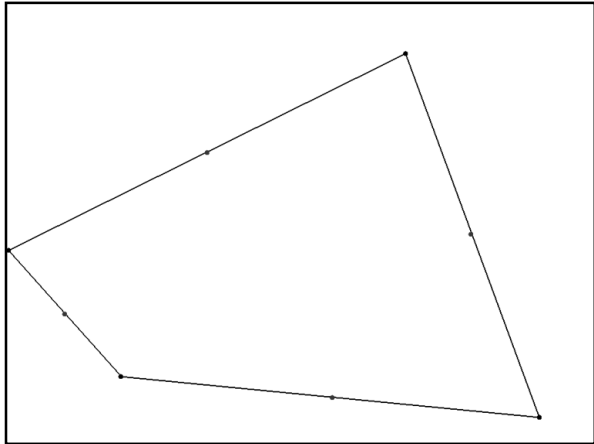
- Small Classes
- Use of research based pedagogical methods
- Group work and projects
- Careful selection of instructors
- Bi-weekly meetings with instructors
- Model the pedagogical methods that we wish the students to use in their classrooms when they become teachers

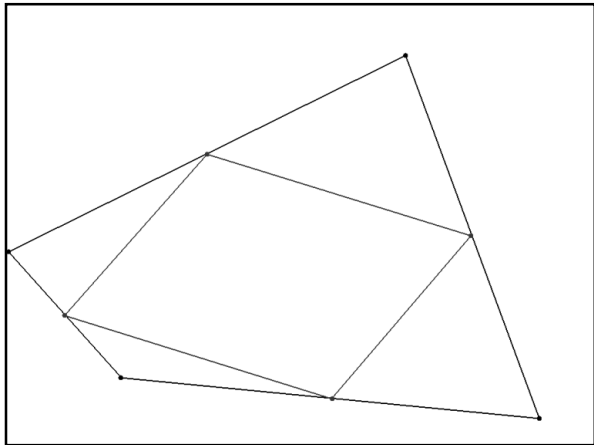
Inquiry Based Learning (IBL)

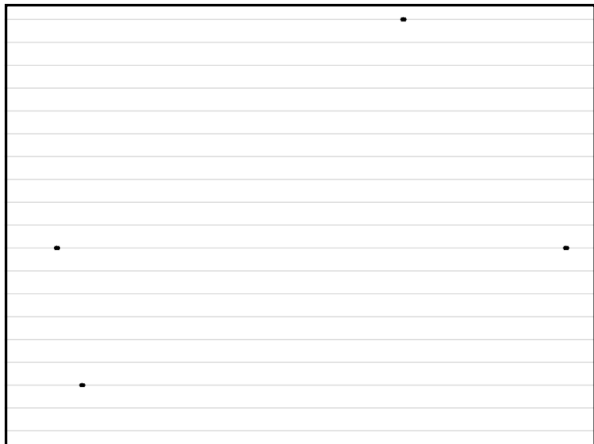
Guided Discovery Method (GDM)

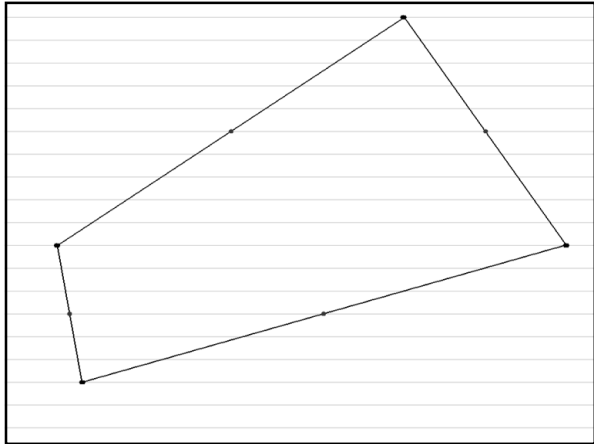
An exercise in the GDM/IBL type of pedagogy: A Geometry Lesson.

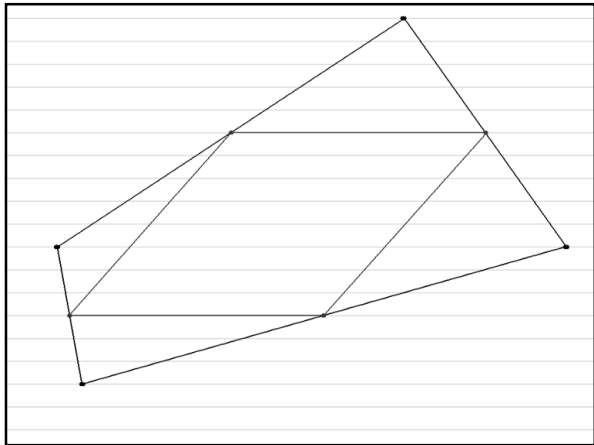


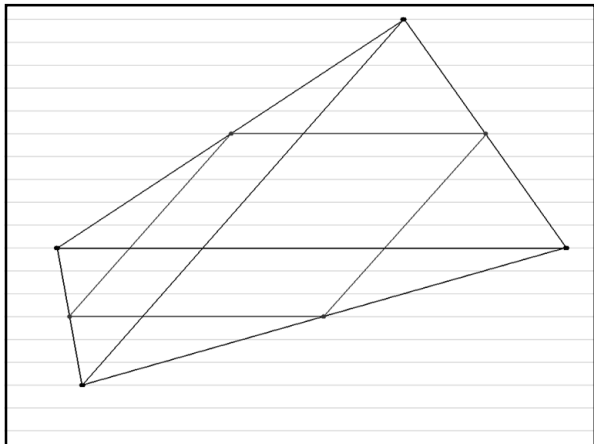


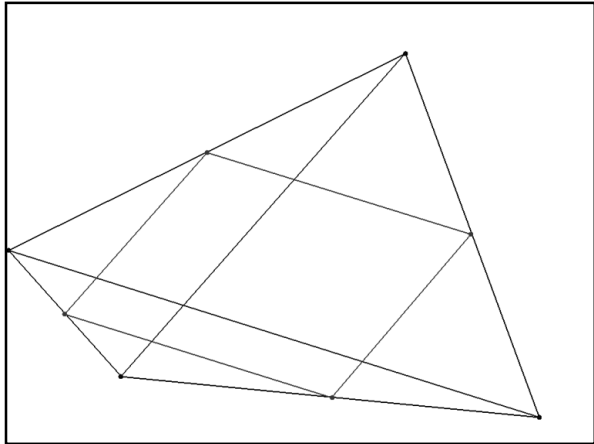


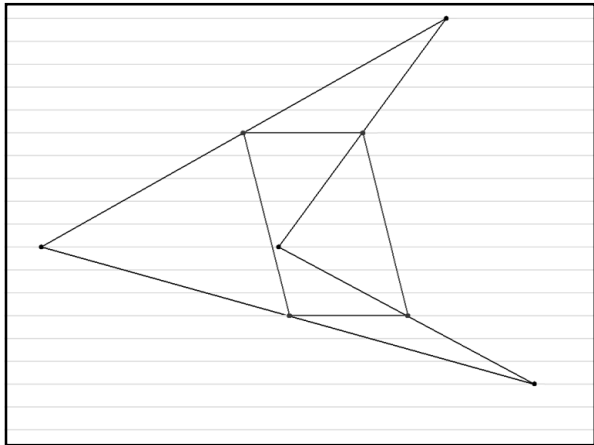


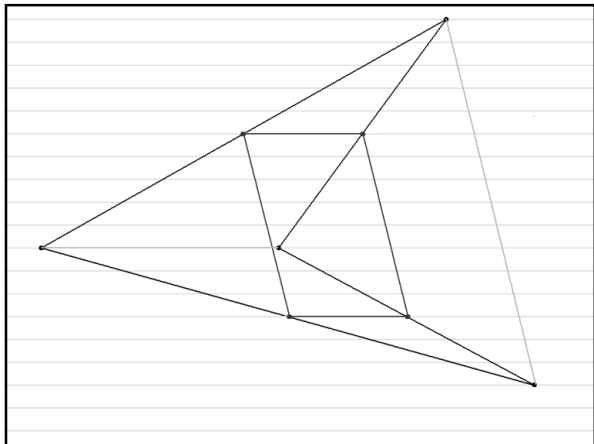


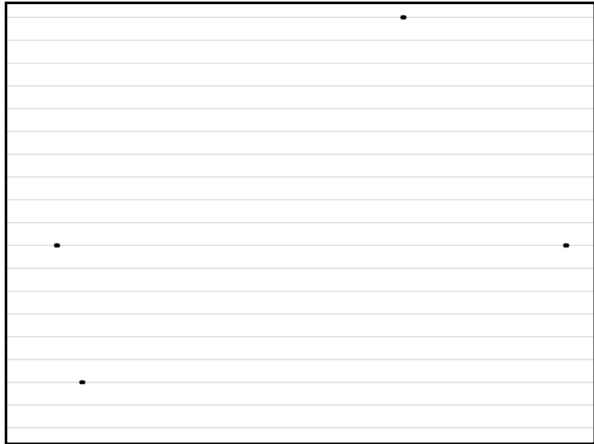


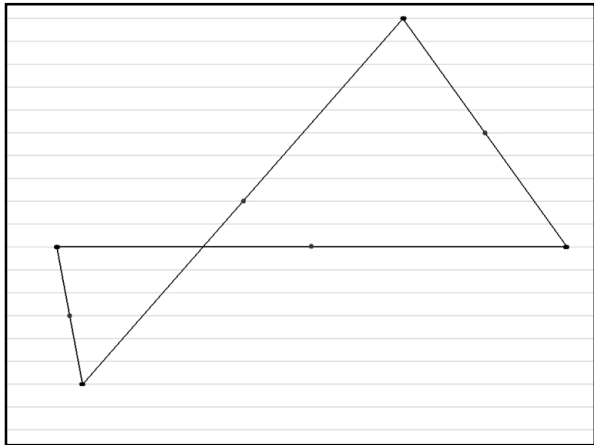


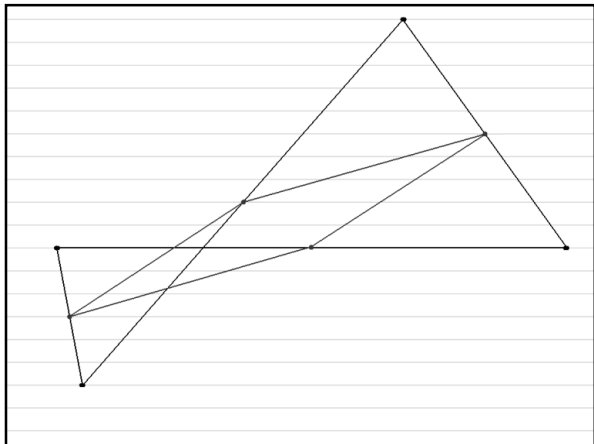


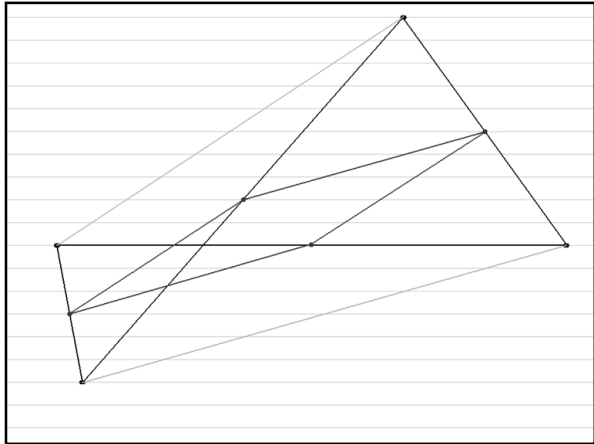















Community of Practice
Recruitment
Retention
Training
Capacity-building

NSF Alliances

- Alabama Alliance for Students with Disabilities in STEM (AASD-STEM):
<https://fp.auburn.edu/diversity/stem.aspx>

Access to STEM Fields

- A Community of Practice
- Pedagogical and methodological strategies and techniques
 - Universal Design for Instruction and access
- Assistive technology and accommodations
- Student engagement and self advocacy, self accommodations and self regulation

AccessSTEM

- <http://www.washington.edu/doi/Stem/>



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