Strategies for a Purpose

Examining Student Work: One approach

1. Have teachers work the problem themselves
2. Discuss prepared samples of student work
3. Analyze samples of their own students' work

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Strategies for a Purpose

Examining Student Work: An alternative

1. Examine samples of their own students' work
2. Have teachers work the problem themselves
3. If necessary, discuss selected prepared samples of student work
4. Analyze samples of their own students' work

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Ensuring Access to All

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- Much of what we know about learning theory is described in the National Research Council's volumes *How People Learn* (2003) and *How Students Learn: History, Mathematics, and Science in the Classroom* (2005).

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- These principles apply for adult learners as well as for K-12 student learners.

What do we know about how people learn?

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Learners need to be motivated

– People won’t learn unless they want to do so.

– What motivates individuals varies quite a bit.

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Learners are not empty vessels

- They have ideas and beliefs from their prior experiences that interconnect and form complex cognitive structures (Piaget, 1952).
- These ideas/beliefs may facilitate or impede learning (National Research Council, 2003).
- Learning involves building on, undoing, and/or reorganizing these cognitive structures.
- Instruction is more effective when it takes initial ideas into account.

Learners need opportunities to investigate meaningful questions and engage with appropriate phenomena/examples.

- Experiences don't necessarily have to be hands on; learners can engage with thought experiments, data generated from an activity, or examples they've experienced in the past.

Experiences do need to:

- Provide evidence for the concept or idea being addressed

- Be accessible to the learners.

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Learners need to use evidence/reasoning to support and critique claims about their experiences.

- Supporting and critiquing claims with evidence helps tie the new experiences and ideas into learners' existing cognitive frameworks

- When learners have hard-to-change ideas, the stronger the evidence for the new idea, the more likely they will be to restructure their cognitive framework and not revert back to their initial way of thinking.

Learners need support in drawing connections between what they experienced and what they were intended to learn.

- This process is often left up to the individual learner without appropriate support, leaving far too much of the possibility of learning to chance.

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Learners need opportunities to reflect on how their thinking has changed.

- This process is particularly important for the learning of concepts for which learners have strong naïve conceptions or flawed initial assumptions.

Monica Mitchell

Quality Education for Minorities (QEM) Network

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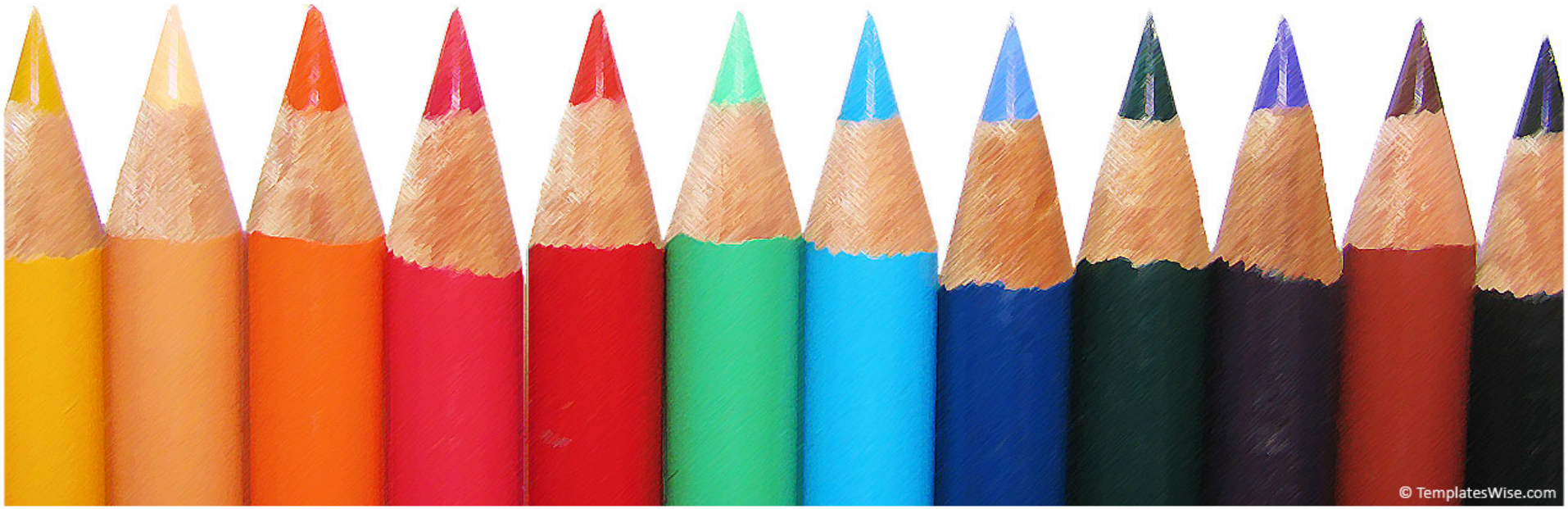
Ensuring Access And Success For All

Monica B. Mitchell, Ed.D.

MER*Associates*

May 24, 2010



Children of Color

- Growing diversity in public schools
- 30 percent of public school student population are racially, ethnically diverse
- More than 70 percent of total school enrollment in 20 largest school districts
- Number of school-aged children (5-17) who speak a language other than English in their home doubled between 1979-2006 from 9 to 20 percent of the population of this age group
  (Planty et al. 2008)

Source: Ladson-Billings (2009).

EQUITY

All students, regardless of their race, ethnicity, class, gender, or language proficiency, will learn and use mathematics and science.

- Allexsaht-Snider & Hart (2001)

Socio-cultural Theoretical Framework

Students' Learning of Mathematics

- Acquiring knowledge
- Practices
- Sense of belonging

A growing body of research makes it clear poverty and ethnicity are not the primary causal variables related to student achievement. Adult variables, including the professional practices of teachers and the decisions leaders make can be more important than demographic variables.

Source: Reeves (2006)

Each student needs to feel that she is

competent, important and talented.

- Jo Sanders

Research on Teacher Expectations

- Significantly influence the quality of learning opportunities
- Not based on fact and may persist even in the face of contrary evidence
- Assumptions about students' aptitude are difficult to change
- Particularly in math and science, teachers tend to believe that white students, some Asian American students, and male students are smarter
- Teachers with less confidence in their teaching abilities tend to have low expectations for students (Gay, 2000)

Source: Thompson (2004)

Necessary Educator Attitudes/Beliefs

- All children can learn.
- Parents of children from diverse backgrounds do care about their children and often assist them academically in ways that are invisible to teachers

Necessary Educator Attitude/Beliefs continued

- It is the teacher's job to do their best with all students not to judge students' community, culture, family, home life, and aptitude of students of color (Hale, 2001)
- Racial and cultural differences exist but colorblindness does not exist (teachers who claim to be colorblind are in denial) (Cattani, 2001)
- Most students regardless of background, ethnicity, race, or income level do want to learn, and when teachers seek the best in them that is usually what they find (Collins, 1992)

Additive Pedagogy

Boykin (2002)

- Poor social and economic statuses are political disadvantages not education deficits (Kristy, 2002)
- High Standards for all Students (Drew, 1996; Chval, 2001)
- Multiple determinants of students' success
- Build on assets that students bring to school
- Promotion of school as a caring community that focuses on students' academic and personal well-being
- Genuinely believe students are capable of advanced work in mathematics regardless (Khristy, 2002)

The role of Culture and a Culturally-relevant Instruction

- Mathematics and science education must be meaningful and relevant (NCSM, 2008)
- Beyond content-knowledge and classroom environment
- Instruction responsive to culture while ensuring engaging, rigorous, and accessible content

CULTURE

Culture is a meaning that is shared by a group of people who hold common values and beliefs.

- Malloy & Malloy 1998

Culturally-Relevant Teaching

A pedagogy that empowers students intellectually, socially, emotionally, and politically by using cultural referents to impart knowledge, skills, and attitudes.

- Ladson Billings, 1994

An Example

- Students take a field trip in their community with origin, destination and return to origin
- Students reconstruct the journey using a map which serves as a number line
- Key concepts are introduced including “how many,” “which direction,” (positive and negative integers), and equivalence
- “Trip line” activity of the algebra project

Source: Moses & Cobb (2001). Radical Equations: Civil Rights from Mississippi to the Algebra Project

Language

Kristy (2002). Mathematics Learning and the Latino Student: Suggestions from Research for Classroom Practice. *Teaching Children Mathematics*

- Central to teaching and learning with Latino students
- Two dimensions of language proficiency: social conversation and cognitive academic (not equivalent)
- Development of academic language takes 5 -7 years with deliberate instruction
- Most teachers provide 2 – 3 years to develop proficiency

Instructional Supports to learn *Both* the Language and the Content

- Multiple communication strategies of content
- Write words on an overhead projector or on the board, or point to the words in a prepared text as they are being delivered
- Always contextualize instruction through the use of models, real objects, drawings, and other visual aids
- Have students physically act out problems or concepts.

Other Useful Strategies: Echevarria, J., Vogt, M., Short, D.J. (2000). Making Content Comprehensible for English Language Learners: The SIOP Model.

Gender

- In elementary school, two-thirds of young girls and boys say they like science
- By middle school, gender differences in beliefs, interest, and perceptions surface
- Girls only 10% of students taking advanced AP computer science exam in high school (Sanders, 2005)
- Leaky pipeline – at higher levels of STEM education percentage of women continues to decline (Women are 59% workforce but 25% of STEM workforce)

Source: De Welde, K, Laursen S. & Thiry, H. (2008).

Gender Inequity

- Cultural Stereotypes

  (New Formulas for America's Workforce 2: Girls in Science and Engineering, NSF 06-60)

- Equity as user/consumer of technology – Inequity as creator/producer of technology
- Gender differences in educational achievement vary by race, ethnicity and family income level

  (AAAU, Where the Girls Are: The Facts about Gender Equity in Education, 2008)

Evidence-based Recommendations Gender Equity in Math and Science

- Foster development in girls' of strong beliefs about their abilities in math and science
  - Academic abilities expandable and improvable
  - Provide proscriptive, informational feedback
  - Choose activities in ways that do not reinforce existing gender stereotypes
  - Expose girls to female role models who have succeed in math and science
  - Teachers should provide opportunities for students to engage in spatial skills training

Source: IES Practice Guide – Encouraging Girls in Mathematics and Science

Instructional Practice -Jigsaw Grouping

- Form of flexible grouping and strategy for cooperative learning
- Promotes the use of multiple representations
- Begin lesson in home groups
- Separate into multiple expert groups
- Lessons' content split into pieces
- Each expert group receives material from lesson different from the other groups
- Once expert return to home group and share expertise on content learned

Examples of Mathematics Jigsaw Lessons

Expert Group Assignment	Home Group Assignment
Research a particular class of numbers (prime, composite, square, triangular, rational, irrational, and so on)	Classify a set of numbers
Develop an algorithm for a particular integer operation and defend using examples and manipulatives	Write a pamphlet on integer operations
Collect data using different experiments	Model data using functions
Summarize and explain a section of the current unit	Study for a unit test

Advantages

- Potential for producing positive results in student achievement (Johnson, Johnson, and Stanne, 2000)
- Ideal for differentiated instruction
- Multiple access points – expert grouping to focus on physical models or pictorial representations
- Accommodate multiple learning styles
- Encourage participation and engagement for students hesitant in whole-class discussions

Professional Development on Equity and Diversity

- Addressed directly and explicitly
- A central focus or key strand
- Sustained and ongoing process
- Experimentation
- Collaboration and Communication
- Reflection
- Tools and Resources

Implications for Providers

- Challenge own beliefs and perceptions
- Develop comfort-level with the subject and associated issues
- Model safe, accepting, respectful and trusting PD environment
- Provide opportunities for observation of practice (e.g., video, collegial)
- Conduct parallel PD for multiple stakeholders

Equity Leadership

NCSM PRIME Leadership Framework (2008)

To what extent does my leadership ensure:	I have no under-standing and have taken no action	I have a basic understanding	I have a deep under-standing	I use my under-standing to take action and model for others
Every teacher addresses gaps in achievement expectations	1	2	3	4
Every teacher provides access to meaningful experiences				
Every teacher works interdependently to erase inequities in student learning				

To what extent does my leadership ensure:	I develop awareness in others, but often inconsistently	I ensure collaborative discussion by teams	I follow up on discussion with collaborative action by teacher teams	I systematically and intentionally ensure complete implementation by teachers/teams
Every teacher addresses gaps in achievement expectations	1	2	3	4
Every teacher provides access to meaningful experiences				
Every teacher works interdependently to erase inequities in student learning				

Additional Resources

Framework to Address Equity in Mathematics Classrooms: Abbe H. Herzig, Goals for Diversity in Mathematics Classrooms, *Mathematics Teacher*, Nov. 2005

A PD approach to Equity:

Tonya G. Bartell and Margaret R. Meyer, *Addressing the Equity Principle in the Mathematics Classroom*, Mathematics Teacher, April 2008

Questions for Educators:

Julian Weissglass, Inequity in Mathematics Education: Questions for Educators, *The Mathematics Educator*, 2002

Resources

Gender Equity:

Guidelines for a Gender Equity Workshop, Jo Sanders

www.josanders.com/pdf/GE%20workshop.pdf

Resource List to Promote Self-Efficacy for Girls

University of Texas at Austin

www.utexas.edu/cola/centers/cwgs/publications/WGS-Reading/middleschool.php

Leadership Development

- The Prime Leadership Framework: Principles and Indicators for Mathematics Education Leaders, National Council of Supervisors of Mathematics (2008)

A few handouts

Thank you!

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MSP Example

*Nebraska*MATH

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Nebraska Algebra

Jim Lewis

University of Nebraska-Lincoln

Aaron Douglas Professor of Mathematics

The NebraskaMATH Partnership

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- University of Nebraska-Lincoln
  - Jim Lewis, Mathematics
  - Ruth Heaton, Teaching, Learning and Teacher Education
  - Carolyn Edwards, Psychology and Child, Youth and Family Studies
  - Walt Stroup, Statistics
  - Ira Papick, Mathematics
  - Tom McGowan, Teaching, Learning and Teacher Education
- Grand Island Public Schools
- Lincoln Public Schools
  - Barb Jacobson, Lincoln Public Schools
- Omaha Public Schools
- Papillion-La Vista Public Schools
- Nebraska's Educational Service Units
  - 101 school districts and 216 schools.

Nebraska Algebra

Nebraska MATH
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- 9 hours of graduate coursework
  - A two-week, 8 hour per day summer institute
    - Math 810T: Algebra for Algebra Teachers
    - EDPS 991: Cognition and Instruction for High School Algebra Teachers
  - A yearlong (on site and distance education) academic year course
    - TEAC 991: Field Studies in Mathematics
- Some districts are able to provide participants with an algebra coach
  - If a coach is not available, we provide a teacher mentor
- All teachers have a university mentor

Nebraska Algebra Teachers

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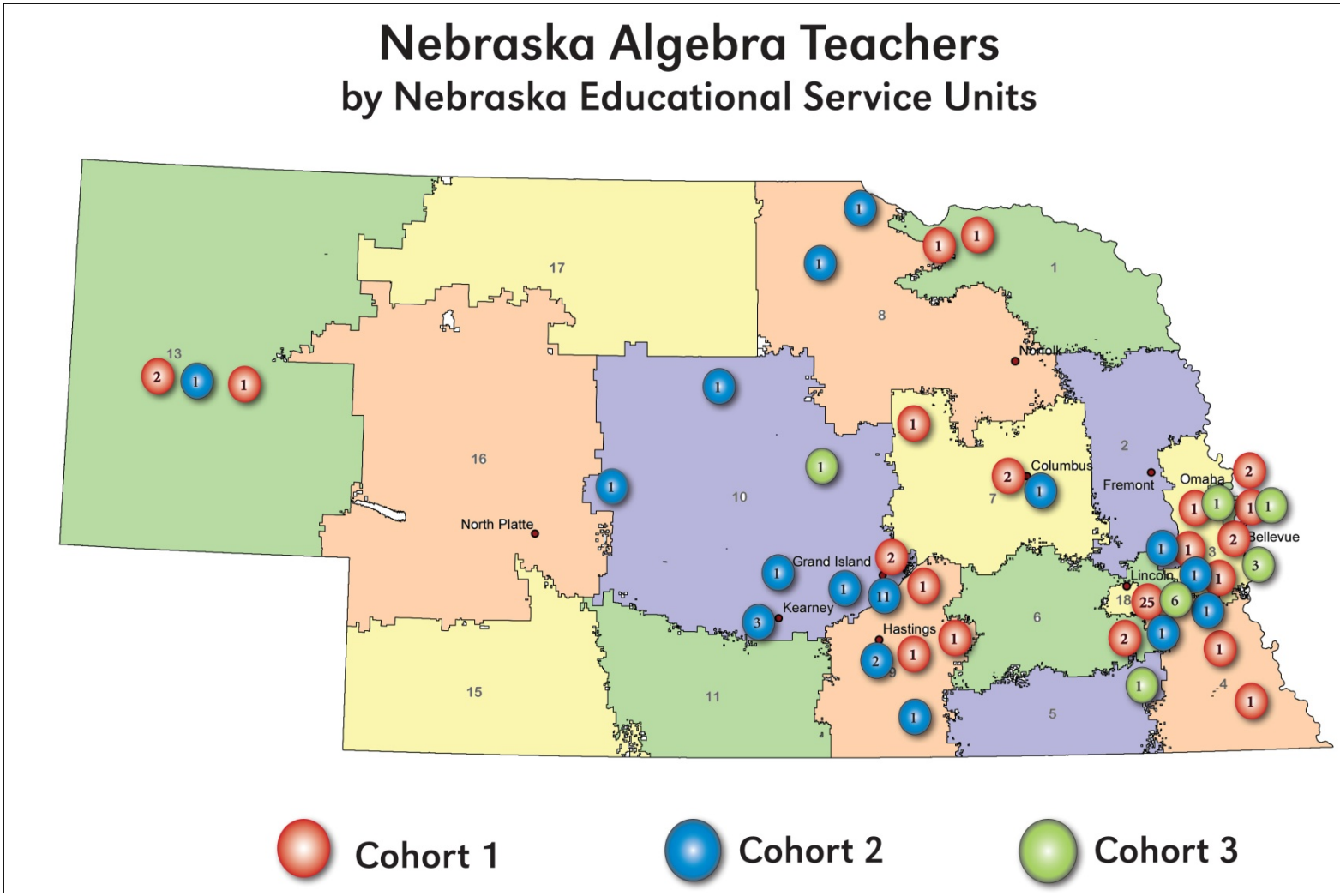

Algebra for Algebra Teachers

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- Objectives
  - To help teachers better understand conceptual underpinnings of school algebra
  - To leverage new understanding into improved classroom practice
- Pedagogy
  - Combines collaborative learning with direct instruction
  - Provide teachers with dynamic model for learning & teaching
- Assessment
  - Individual & group presentations, written & historical assignments, mathematical analyses of curricula, and an End-of-Course Problem Set

Mathematical Knowledge for Teaching

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- Teachers need specialized content knowledge:
  - Deep understanding of content
  - Representations and connections
  - Understand student thinking
  - Assess student learning
  - Make curricular decisions
  - Communicate learning goals to parents and principals
- This type of knowledge is not typically gained through most pre-service mathematics programs (Ball, Thames & Phelps, 2008; NCTM, 2000)

Algebra for Algebra Teachers – Day 1

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Do you believe the following statements? Can you offer a valid argument that any of them are true?

- If x is a natural number and x^2 is even, then x is even.
- If n is a natural number, then $1 + 2 + 3 + \ldots + n = n(n+1)/2$.
- If n is a natural number, then $1 + 3 + 5 + \ldots + (2n-1) = n^2$.
- The number $\sqrt{2}$ is irrational.
- The number Pi is irrational.

Algebra for Algebra Teachers content

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- The arithmetic and algebra of the integers, especially the (Euclidean) division algorithm, the Fundamental Theorem of Arithmetic and important school mathematics applications related to these results.
- The integers modulo *n* as a tool to broaden and deepen our knowledge of the integers.
- Defining polynomials, roots, polynomial functions, and polynomial rings;
- Special attention paid to linear and quadratic polynomials/functions in connection to their importance in school algebra (slope/rate of change, graphs, quadratic formula, etc);
- Comparing properties of $k[x]$, k a field with **Z**, the integers;
- In $k[x]$, Division algorithm, Euclidean algorithm and applications, unique factorization and applications;
- Irreducibility in $\mathbf{Q}[x]$, $\mathbf{R}[x]$ and $\mathbf{C}[x]$ (Irreducibility tests); (brief overview of properties of C).

Mathematical Knowledge for Teaching Algebra

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Teachers need knowledge of mathematics that enables them to address a wide range of mathematical ideas and questions. Here are some questions that school algebra teachers might be asked.

1) My teacher from last year told me that I whatever I do to one side of an equation, I must do the same thing to the other side to keep the equality true. What am I doing wrong when I add 1 to the numerator of both fractions in the equality 1/2 =2/4 and get 2/2 = 3/4?

2) My father (who is very smart) was helping me with my homework last night and he said the book is wrong. He said that $\sqrt{4}=2$ and $\sqrt{4}=-2$, because $2^2=4$ and $(-2)^2=4$, but the book says that $\sqrt{4}\neq-2$. He wants to know why we are using a book that has mistakes.

3) Why does the book say that a polynomial $a_n x^n + a_{n-1}x^{n-1}+\ldots+a_1 x + a_0 = 0$ if and only if each $a_i = 0$, and then later says that $2x^2 + 5x + 3 = 0$?

4) I don't understand why $(-3)\times(-5)=15$. Can you please explain it to me?

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Papillion-La Vista School District

Excellence...One Student at a Time

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