DOWNLOAD PDF ABOUT TEACHING MATHEMATICS

Chapter 1 : About Teaching Mathematics by Marilyn Burns

Burns stresses big ideas in teaching conceptual math, not by providing a bunch of printable activities for kids to do that can fragment math skills and be just another worksheet, but by providing hands-on ideas using manipulatives and visuals to help kids see the meaning in math.

It is one of the most important branches of science in that it serves as a foundation for more advanced areas of biology, geology, astronomy and more. It stems from the periodic table of the elements: Chemistry students study the atom and atomic structure, learning how they fuse together to create compounds. Students are first introduced to overarching principles of chemistry such as the states of matter, conservation of matter and the composition of matter as collections of molecules and atoms. These topics are then explored through simple chemical reactions and everyday applications of chemistry. Introductory Chemistry is a required course at most high schools in the United States. High school chemistry instructors teach students the mathematical reasoning behind the principles of chemistry. Curricula for Introductory Chemistry focus on chemical bonds and compounds, as well as stoichiometry, the mathematical analysis of chemical reactions. Students establish familiarity with chemistry equations and the periodic table of the elements, preparing them for Advanced Placement Chemistry, which involves a more in-depth mathematical analysis of the concepts covered in Introductory Chemistry. Physics Physics encompasses the science of matter, motion and energy. A highly advanced and complex area of science, physics is not usually taught at the elementary and middle school levels. However, elements of physics are incorporated into the general science education that younger students receive. In elementary and middle school, students begin to learn about gravity, friction and kinetic energy all of which are basic principles of physics. Physics is often offered in high school after students have completed introductory levels of biology and chemistry. High school physics begins to incorporate mathematics through physics equations and formulas. A typical high school physics curriculum begins with general theories of motion, including force, kinetic energy, friction and acceleration. Classes then cover more advanced motion, such as tension. Math Students in the United States begin studying mathematics at around five or six years of age, continuing through secondary school and into higher education. Many schools will offer different levels of classes as students may show a greater or lesser aptitude for complex math courses. During elementary school, students are taught basic arithmetic: Many students will have completed some form of pre-algebra or even algebra 1 by the time they enter high school, although geometry is occasionally taught in eighth grade as an honors course. High school mathematics can continue with the study of algebra 3, otherwise known as trigonometry, around 11th grade. Students will complete their high school math courses senior year with either pre-calculus or calculus, although that is usually only offered at an honors level. Algebra Algebra is an area of mathematics that focuses on the rules of operations and relations, and the constructions and concepts that arise from them. Subjects within algebra include terms, polynomials, equations and algebraic structures. Algebra is a required mathematics class in all 50 states and is taught in several different stages. While stages may vary from school to school, the general stages include pre-algebra, algebra 1 and algebra 2. Pre-algebra is often taught at the middle school level, and introduces the basic concepts of polynomials and variables, thus bridging the gap between basic arithmetic and advanced algebra. Elementary algebra that is, the beginning levels of algebra introduces the concept of variables representing numbers. Some districts introduce algebra 1 to middle school students as an honors class, though for the most part, this stage is taught at the high school level. In high school, students must complete algebra 1 and algebra 2, followed by trigonometry or pre-calculus algebra 3. The complexity of these subjects increases as the grade level increases, but they all generally incorporate elements of powers, roots, polynomials, quadratic functions, coordinate geometry, exponential and logarithmic functions, probability, matrices and basic to advanced trigonometry. Geometry Geometry is an area of mathematics concerned with questions of size, shape, relative positions of figures and the properties of space. Geometry deals with measurements, such as volume, length, angles, proofs, area, circumferences, etc. It includes algebraic forms, such as Cartesian coordinates. Geometry also overlaps somewhat with trigonometry, serving as a foundation for a more specialized area of mathematics. The study of triangular shapes is introduced in geometry, which introduces students to the basic concepts of trigonometry. Elementary geometry builds off the general arithmetic students learn in elementary and middle school. It is most commonly taught beginning in tenth grade. Geometry lessons are often taught in the form of queries requiring step-by-step proofs which the student must develop. Trigonometry Trigonometry comprises what is sometimes known as algebra 3. Trigonometry focuses on the study of triangles, specifically the relationships between sides and angles, as well as trigonometric functions and the motion of waves. Calculus Calculus is one of the higher levels of mathematics and is only taught to secondary school students. The level of complexity in this area of mathematics is very advanced and incorporates concepts from all levels of algebra, trigonometry and pre-calculus. It focuses on limits, functions, derivatives, integrals and infinite series. Calculus requires a solid foundation in mathematics for students to grasp the various concepts. Following the completion of algebra and trigonometry, high school students, begin studying calculus in several stages. Pre-calculus is the most common and most widely taught form of calculus. Calculus is almost always an honors-level class, if it is even taught at all, because of its highly advanced content. It is usually not taught as part of a normal curriculum before 11th or 12th grade in high school. School curricula have been lacking in their math and science components, and in response to this decrease in STEM education, several initiatives have been started to reclaim the lead and produce literate, savvy, and driven young talent that will leave their indelible marks on STEM industries. The American Competitiveness Initiative: Bush in to address the shortfalls in federal support of STEM educational development. The initiative called for a significant increase in federal funding with the hopes of seeing an increase in college graduates with STEM degrees. It sought to double federal spending for advanced research in physical sciences, and to improve science and mathematics education in public schools. It also aimed to provide additional training for teachers in science, math, and technology. CGI America united over business, nonprofit, and governmental leaders to brainstorm initiatives for increasing economic growth in the United States. One of the leaders in innovative computer technology, Intel , has demonstrated their commitment to STEM. Their Education page seeks to help teachers enrich their STEM classes and inspire students to become future leaders in the industry. Through guidance for lesson plans , curriculum design , and interactive multimedia resources , Intel empowers teachers to create fun and exciting lessons that will engage with their students while also bringing STEM to the forefront of the classroom. Do you know of other great STEM programs or initiatives? Let us know by sending an email to info teach.

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Chapter 2 : About Teaching Mathematics: A K-8 Resource - Marilyn Burns - Google Books

About Teaching Mathematics is a book for K-8 educators that responds to the struggles that teachers wrestle with in the classroom when trying to balance procedural skills with developing deep conceptual understanding.

A Guide for Teachers This page report summarizes the findings of meta-research on effective practices for students with learning disabilities or difficulties learning mathematics. A Synthesis of the Intervention Research". This summary highlights the seven most effective strategies as determined by the research report. Each strategy is detailed, a discussion of how it is to be utilized is provided, and evidence from the report is given. Intensive Interventions for Students Struggling in Reading and Mathematics This page research-based guide provides the best practices for teaching students with learning difficulties in math and reading. The highlighted interventions include supporting cognitive processing, intensifying instructional delivery, increasing learning time, and reducing group size. The article also provides suggestions for further reading and three examples of how lessons can be modified to include these recommendations. Assisting Students Struggling with Mathematics: The guide identifies eight recommendations to help educators use response to intervention practices, provides a brief description of each, establishes the relative strength of the research base, and discusses difficulties that may occur in implementing these interventions. Teaching Mathematics This webpage contains the links to 5 short articles on strategies for teaching students with dyscalculia. The articles that are included are: Two Decades of Research and Development. Improving Mathematics Problem Solving Skills for English Language Learners with Learning Disabilities In this article the authors provide before, during, and after problem solving strategies and instructional suggestions for teachers. The focus of the article is to improve the ability of students with disabilities that are also English as a second language ESL learners to solve word problems. The authors provide multiple teaching strategies, questioning techniques, and links to lesson resources. Differentiation and Grouping in Mathematics This page resource pdf from Frederick County Public School System outlines their policy for hetrogeneous grouping in mathematics. This resource explains their decisions as a school system, the ways in which their teachers are expected to plan and implement their lessons, and provides recommendations for the differentiation of instruction to reach all learners. Teacher Collaboration In this group of three 5-minute videos for teachers of grades 3 through 8, three co-teaching teams describe how they work within the same classroom, collaborating on math instruction. Each pair, one classroom teacher and one special educator, talk of the benefits that collaborative teaching can offer and share their experiences of teaching mathematics in an inclusion classroom. Effective Strategies Brief In this research brief the authors detail effective teaching strategies for teaching students with difficulties in math. The brief summarizes the work of over fifty research studies and details the practices that were seen as consistently effective across many of them. The brief details six instructional strategies and presents data describing the effectiveness of each on special education students and low-achieving students. The brief can be viewed on the webpage or downloaded as a PDF. Adapting Reading and Math Materials in the Inclusive Classroom In this article eight guidelines are detailed for making adaptations to the general reading and math curriculum. Each principal is explained and a link is provided to a chart that lists these guidelines and questions to ask yourself before selecting the adaptation. A link to similar articles on adapting curriculum is also provided. Tips on Supporting All Students: The guidelines elaborate on the practices of individualizing instruction, providing a positive classroom climate, identifying biases, questioning and listening techniques, and the concept of equity in education. Differentiated Learning This reference webpage, provided by NCTM, lists various techniques that could be used to differentiate instruction. Since each activity and each group of students are different, it may be necessary to vary these strategies or use one more than another. Each strategy contains a brief description, and some offer links to more detailed information. Two Decades of Research and Development In this article researchers identify the three main areas of mathematics cognition and identify technology tools and programs that may benefit students with difficulties in mathematics. The article is structured to define and provide solutions for declarative math difficulties, procedural math difficulties, and conceptual math difficulties. Throughout the article links or suggestions about software or internet resources some free and some for purchase are provided. Improving Basic Mathematics Instruction: Promising Technology Resources for Students with Special Needs This 8-page article from Technology in Action provides suggestions for choosing and implementing web-based practice in the classroom. The article focuses on sites that provide specific benefits in building number sense, conceptual understanding, and problem solving for students with learning disabilities and visual impairments. Addressing the needs of their diverse students, in particular, English Language Learners and students with special needs, the authors discuss how a technology-rich learning environment influences critical features of the classroom. They use classroom examples to show how technology tools amplify opportunities for extending mathematical thinking. Planning Strategies for Students with Special Classroom teachers that serve students with special needs will benefit from the planning strategies highlighted in this article. The article illustrates its application using a lesson that emphasizes the five Process Standards highlighted in Principles and Standards for School Mathematics. Building Responsibility for Learning in The article includes practical classroom applications for teachers of special needs students. Learning-Disabled Students Make Sense of The authors, Janet B. Andreasen and Jessica H. Hunt, first discuss Process, Content, and Product differentiation; then using the lesson plan, Fun with Fractions from Illuminations they illustrate how to implement it using stations that "maximize learning for all while minimizing the need for or individual accommodations.

DOWNLOAD PDF ABOUT TEACHING MATHEMATICS

Chapter 3 : Teaching Mathematics and its Applications: An International Journal of the IMA | Oxford Acade

About Teaching Mathematics has ratings and 7 reviews. Sarah said: Marilyn Burns is considered THE guru in the mathematics field and for good r.

History[edit] Elementary mathematics was part of the education system in most ancient civilisations, including Ancient Greece , the Roman Empire , Vedic society and ancient Egypt. In most cases, a formal education was only available to male children with a sufficiently high status, wealth or caste. This structure was continued in the structure of classical education that was developed in medieval Europe. Apprentices to trades such as masons, merchants and money-lenders could expect to learn such practical mathematics as was relevant to their profession. In the Renaissance , the academic status of mathematics declined, because it was strongly associated with trade and commerce, and considered somewhat un-Christian. The first modern arithmetic curriculum starting with addition, then subtraction, multiplication, and division arose at reckoning schools in Italy in the s. They contrasted with Platonic math taught at universities, which was more philosophical and concerned numbers as concepts rather than calculating methods. For example, the division of a board into thirds can be accomplished with a piece of string, instead of measuring the length and using the arithmetic operation of division. However, there are many different writings on mathematics and mathematics methodology that date back to BCE. These were mostly located in Mesopotamia where the Sumerians were practicing multiplication and division. There are also artifacts demonstrating their own methodology for solving equations like the quadratic equation. After the Sumerians some of the most famous ancient works on mathematics come from Egypt in the form of the Rhind Mathematical Papyrus and the Moscow Mathematical Papyrus. The more famous Rhind Papyrus has been dated to approximately BCE but it is thought to be a copy of an even older scroll. This papyrus was essentially an early textbook for Egyptian students. The social status of mathematical study was improving by the seventeenth century, with the University of Aberdeen creating a Mathematics Chair in , followed by the Chair in Geometry being set up in University of Oxford in and the Lucasian Chair of Mathematics being established by the University of Cambridge in However, it was uncommon for mathematics to be taught outside of the universities. In the 18th and 19th centuries, the Industrial Revolution led to an enormous increase in urban populations. Basic numeracy skills, such as the ability to tell the time, count money and carry out simple arithmetic , became essential in this new urban lifestyle. Within the new public education systems, mathematics became a central part of the curriculum from an early age. By the twentieth century, mathematics was part of the core curriculum in all developed countries. During the twentieth century, mathematics education was established as an independent field of research. Here are some of the main events in this development: Schaaf published a classified index , sorting them into their various subjects. The second congress was in Exeter in , and after that it has been held every four years In the 20th century, the cultural impact of the " electronic age " McLuhan was also taken up by educational theory and the teaching of mathematics. Please help improve this section by adding citations to reliable sources. Unsourced material may be challenged and removed. December Learn how and when to remove this template message Boy doing sums, Guinea-Bissau, At different times and in different cultures and countries, mathematics education has attempted to achieve a variety of different objectives. These objectives have included: The teaching and learning of basic numeracy skills to all pupils The teaching of practical mathematics arithmetic , elementary algebra , plane and solid geometry , trigonometry to most pupils, to equip them to follow a trade or craft The teaching of abstract mathematical concepts such as set and function at an early age The teaching of selected areas of mathematics such as Euclidean geometry as an example of an axiomatic system and a model of deductive reasoning The teaching of selected areas of mathematics such as calculus as an example of the intellectual achievements of the modern world The teaching of advanced mathematics to those pupils who wish to follow a career in Science, Technology, Engineering, and Mathematics STEM fields. The teaching of heuristics and other problem-solving strategies to solve non-routine problems. Methods[edit] The method or methods used in any particular context are largely determined by the objectives that the relevant educational system is trying to achieve. Methods of teaching mathematics include the following: Games can motivate students to improve skills that are usually learned by rote. In "Number Bingo," players roll 3 dice, then perform basic mathematical operations on those numbers to get a new number, which they cover on the board trying to cover 4 squares in a row. Computer-based math an approach based around use of mathematical software as the primary tool of computation. Mobile applications have also been developed to help students learn mathematics. Starts with arithmetic and is followed by Euclidean geometry and elementary algebra taught concurrently. Requires the instructor to be well informed about elementary mathematics , since didactic and curriculum decisions are often dictated by the logic of the subject rather than pedagogical considerations. Other methods emerge by emphasizing some aspects of this approach. Provides more human interest than the conventional approach. Adopted in the US as a response to the challenge of early Soviet technical superiority in space, it began to be challenged in the late s. The problems can range from simple word problems to problems from international mathematics competitions such as the International Mathematical Olympiad. Mathematical problems that are fun can motivate students to learn mathematics and can increase enjoyment of mathematics. Uses class topics to solve everyday problems and relates the topic to current events. A derisory term is drill and kill. In traditional education , rote learning is used to teach multiplication tables , definitions, formulas, and other aspects of mathematics. Content and age levels[edit] Different levels of mathematics are taught at different ages and in somewhat different sequences in different countries. Sometimes a class may be taught at an earlier age than typical as a special or honors class. Elementary mathematics in most countries is taught in a similar fashion, though there are differences. In the United States fractions are typically taught starting from 1st grade, whereas in other countries they are usually taught later, since the metric system does not require young children to be familiar with them. In most of the U. Mathematics in most other countries and in a few U. Students in science-oriented curricula typically study differential calculus and trigonometry at age 16â€”17 and integral calculus , complex numbers , analytic geometry , exponential and logarithmic functions , and infinite series in their final year of secondary school. Probability and statistics may be taught in secondary education classes. Science and engineering students in colleges and universities may be required to take multivariable calculus , differential equations , linear algebra. Applied mathematics is also used in specific majors; for example, civil engineers may be required to study fluid mechanics , [12] while "math for computer science" might include graph theory , permutation , probability, and proofs. Standards[edit] Throughout most of history, standards for mathematics education were set locally, by individual schools or teachers, depending on the levels of achievement that were relevant to, realistic for, and considered socially appropriate for their pupils. In modern times, there has been a move towards regional or national standards, usually under the umbrella of a wider standard school curriculum. In England , for example, standards for mathematics education are set as part of the National Curriculum for England, [14] while Scotland maintains its own educational system. Ma summarised the research of others who found, based on nationwide data, that students with higher scores on standardised mathematics tests had taken more mathematics courses in high school. This led some states to require three years of mathematics instead of two. In , they released Curriculum Focal Points, which recommend the most important mathematical topics for each grade level through grade 8. However, these standards are enforced as American states and Canadian provinces choose. The MCTM also offers membership opportunities to teachers and future teachers so they can stay up to date on the changes in math educational standards. Please help rewrite this section from a descriptive, neutral point of view , and remove advice or instruction. April Learn how and when to remove this template message "Robust, useful theories of classroom teaching do not yet exist". The following results are examples of some of the current findings in the field of mathematics education: Important results [19] One of the strongest results in recent research is that the most important feature in effective teaching is giving students "opportunity to learn". This must involve both skill efficiency and conceptual understanding. Conceptual understanding [19] Two of the most important features of teaching in the promotion of conceptual understanding are attending explicitly to concepts and allowing students to struggle with important mathematics. Both of these features have been confirmed through a wide variety of studies. Explicit attention to concepts involves making connections between facts, procedures and ideas. This is often seen as one of the strong points in mathematics teaching in East Asian countries, where teachers typically devote about half of their time to making connections. At the other extreme is the U. Deliberate, productive struggle with mathematical ideas refers to the fact that when students exert effort with important mathematical ideas, even if this struggle initially involves confusion and errors, the end result is greater learning. This has been shown to be true whether the struggle is due to challenging, well-implemented teaching, or due to faulty teaching the students must struggle to make sense of. Formative assessment [21] Formative assessment is both the best and cheapest way to boost student achievement, student engagement and teacher professional satisfaction. Effective assessment is based on clarifying what students should know, creating appropriate activities to obtain the evidence needed, giving good feedback, encouraging students to take control of their learning and letting students be resources for one another. Students benefit from feedback. Students with learning disabilities or low motivation may profit from rewards. For younger children, homework helps simple skills, but not broader measures of achievement. Students with difficulties [22] Students with genuine difficulties unrelated to motivation or past instruction struggle with basic facts , answer impulsively, struggle with mental representations, have poor number sense and have poor short-term memory. Techniques that have been found productive for helping such students include peer-assisted learning, explicit teaching with visual aids, instruction informed by formative assessment and encouraging students to think aloud. Algebraic reasoning [22] It is important for elementary school children to spend a long time learning to express algebraic properties without symbols before learning algebraic notation. When learning symbols, many students believe letters always represent unknowns and struggle with the concept of variable. They prefer arithmetic reasoning to algebraic equations for solving word problems. It takes time to move from arithmetic to algebraic generalizations to describe patterns. Students often have trouble with the minus sign and understand the equals sign to mean "the answer is Quantitative research includes studies that use inferential statistics to answer specific questions, such as whether a certain teaching method gives significantly better results than the status quo. The best quantitative studies involve randomized trials where students or classes are randomly assigned different methods in order to test their effects. They depend on large samples to obtain statistically significant results. Qualitative research , such as case studies , action research , discourse analysis , and clinical interviews , depend on small but focused samples in an attempt to understand student learning and to look at how and why a given method gives the results it does. Such studies cannot conclusively establish that one method is better than another, as randomized trials can, but unless it is understood why treatment X is better than treatment Y, application of results of quantitative studies will often lead to "lethal mutations" [19] of the finding in actual classrooms. Exploratory qualitative research is also useful for suggesting new hypotheses, which can eventually be tested by randomized experiments. Both qualitative and quantitative studies therefore are considered essential in educationâ€”just as in the other social sciences. Randomized trials[edit] There has been some controversy over the relative strengths of different types of research. Some scholars have pushed for more random experiments in which teaching methods are randomly assigned to classes. His textbooks on basic arithmetics, algebra and geometry were the standard for Russian classrooms since well into the s, when Russian mathematics education got embroiled in the New Math reforms.

Chapter 4 : Strategies for Teaching Students Struggling With Mathematics | www.nxgvision.com

About Teaching Mathematics: A K-8 Resource, Third Edition With more than , copies of the first edition in print, About Teaching Mathematics, Second Edition presents information necessary for teachers to teach math through problem-solving.

Living and Loving Math Principle 1: Let It Make Sense Let us strive to teach for understanding of mathematical concepts and procedures, the "why" something works, and not only the "how". It may take even several years to grasp a concept. For example, place value is something children understand partially at first, and then that deepens over a few years. This is why many math curricula use spiraling: This can be very good if not done excessively for years is probably excessive. However, spiraling has pitfalls also: The "how" something works is often called procedural understanding: It is often possible to learn the "how" mechanically without understanding why something works. Procedures learned this way are often forgotten very easily. The relationship between the "how" and the "why" - or between procedures and concepts - is complex. And, conceptual and procedural understanding actually help each other: Try alternating the instruction: Then explain why it works. Go back to some practice. Remember the Goals What are the goals of your math teaching? Or do you have goals such as: My student can add, simplify, and multiply fractions My student can divide by 10, , and These are all just "subgoals". But what is the ultimate goal of learning school mathematics? Students need to be able to navigate their lives in this ever-so-complex modern world. This involves dealing with taxes, loans, credit cards, purchases, budgeting, and shopping. Our youngsters need to be able to handle money wisely. All that requires good understanding of parts, proportions, and percents. Another very important goal of mathematics education as a whole is to enable the students to understand information aroud us. Being able to read through it and make sense of it requires knowing big and small numbers, statistics, probability, and percents. And then one more. We need to prepare our students for further studies in math and science. Of course high school geometry is a good example of this, but when taught properly, other areas of school math can be as well. Then one more goal that I personally feel fairly strongly about: The more you can keep these big real goals in mind, the better you can connect your subgoals to them. And the more you can keep the goals and the subgoals in mind, the better teacher you will be. For example, adding, simplifying, and multiplying fractions all connect with the broader goal of understanding part-and-whole relationships. It will soon lead to ratios, proportions, and percent. Also, all fraction operations are a necessary basis for solving rational equations and for the operations with rational expressions in algebra. First of all of course comes a black or white board or paper â€" something to write on, then we have pencils, compass, protractor, ruler, eraser Then we have computer software, interactive activities, animated lessons and such. There are workbooks, fun books, worktexts, books, and online tutorials. Then we have manipulatives, abacus , measuring cups, scales, algebra tiles, and so on. And then there are games, games , games. Well, you just have to start somewhere, probably with the basics, and then add to your "toolbox" little by little as you have opportunity. Knowing a few "math tools" inside out is more beneficial than a mindless dashing to find the newest activity to spice up your math lessons. The book or curriculum. Choosing a math curriculum is often difficult for homeschoolers. Check our curriculum pages for some help. There are two things to keep in mind: You can skip pages, rearrange the order in which to teach the material, supplement it, and so on. You can quite likely sell it on homeschool swap boards, and buy some other one. Manipulatives are physical objects the student manipulates with his hands to get a better grasp of some concept. I once saw a question asked by a homeschooling parent, on the lines, "What manipulatives must I use and when? Manipulatives are definitely stressed in these days. The goal is to learn to do the math without them. Some very helpful manipulatives are: I made my daughter "ten-bags" by putting marbles into little plastic bags, and they worked perfectly for teaching place value. You can simply make pie models out of cardboard. Often, drawing pictures can take place of manipulatives, especially after the first elementary grades. Geometry and measuring tools, such as ruler, compass, protractor, scales, and measuring cups. These are of course essential teaching tools. Note though that dynamic geometry software can in these days replace compass and ruler constructions done on paper and actually be even better. The extras These are, obviously, too many to even start listing. A game or games are good for drilling basic facts. In fact, games are nice for reinforcing just about any math topic. I played "10 Out" card game with my daughter, and she seemed to learn the sums that add to 10 just by playing that game. Of course the internet is full of online math games. I would definitely use graphing software when teaching algebra and calculus. Living and Loving Math You are the teacher. You show the way - also with your attitudes, your way of life. Do you use math often in your daily life? Is using mathematical reasoning, numbers, measurements, etc. Are you happy to teach it? Math is not a drudgery, nor something just confined to math lessons. Let it make sense. This alone can usually make quite a difference and students will stay interested. Read through some fun math books, such as Theoni Pappas books or puzzle books. Get to know some interesting math topics besides just schoolbook arithmetic. There are lots of story books math readers that teach math concepts - see a list here. Consider including some math history if you have the time. Figure it out together. I hope these ideas will help you in your math teaching!

Chapter 5 : Mathematics | Oklahoma State Department of Education

Burns is a nationally known mathematics educator whose messages about math have reached teachers throught her many books, videotapes, talks, and extensive program of Math Solutions Courses.

Dave" Moursund What is Mathematics? Mathematics is an old, broad, and deep discipline field of study. People working to improve math education need to understand "What is Mathematics? They did this at the same time as they developed reading and writing. However, the roots of mathematics go back much more than 5, years. Throughout their history, humans have faced the need to measure and communicate about time, quantity, and distance. The Ishango Bone see ahttp: Figure 1 The picture given below shows Sumerian clay tokens whose use began about 11, years ago see http: Such clay tokens were a predecessor to reading, writing, and mathematics. Figure 2 The development of reading, writing, and formal mathematics 5, years ago allowed the codification of math knowledge, formal instruction in mathematics, and began a steady accumulation of mathematical knowledge. Mathematics as a Discipline A discipline a organized, formal field of study such as mathematics tends to be defined by the types of problems it addresses, the methods it uses to address these problems, and the results it has achieved. One way to organize this set of information is to divide it into the following three categories of course, they overlap each other: Mathematics as a human endeavor. For example, consider the math of measurement of time such as years, seasons, months, weeks, days, and so on. Or, consider the measurement of distance, and the different systems of distance measurement that developed throughout the world. Or, think about math in art, dance, and music. There is a rich history of human development of mathematics and mathematical uses in our modern society. Mathematics as a discipline. You are familiar with lots of academic disciplines such as archeology, biology, chemistry, economics, history, psychology, sociology, and so on. Mathematics is a broad and deep discipline that is continuing to grow in breadth and depth. Mathematics as an interdisciplinary language and tool. Mathematics is such a useful language and tool that it is considered one of the "basics" in our formal educational system. To a large extent, students and many of their teachers tend to define mathematics in terms of what they learn in math courses, and these courses tend to focus on 3. The instructional and assessment focus tends to be on basic skills and on solving relatively simple problems using these basic skills. As the three-component discussion given above indicates, this is only part of mathematics. Even within the third component, it is not clear what should be emphasized in curriculum, instruction, and assessment. The issue of basic skills versus higher-order skills is particularly important in math education. How much of the math education time should be spent in helping students gain a high level of accuracy and automaticity in basic computational and procedural skills? How much time should be spent on higher-order skills such as problem posing, problem representation, solving complex problems, and transferring math knowledge and skills to problems in non-math disciplines? Beauty in Mathematics Relatively few K teachers study enough mathematics so that they understand and appreciate the breadth, depth, complexity, and beauty of the discipline. Mathematicians often talk about the beauty of a particular proof or mathematical result. Do you remember any of your K math teachers ever talking about the beauty of mathematics? He discusses two examples of beautiful pure math problems. These are problems that some middle school and high school students might well solve, but are quite different than the types of mathematics addressed in our current K curriculum. Both of these problems were solved more than 2, years ago and are representative of what mathematicians do. A rational number is one that can be expressed as a fraction of two integers. Prove that the square root of 2 is not a rational number. Note that the square root of 2 arises in a natural manner as one uses land-surveying and carpentering techniques. A prime number is a positive integer greater than 1 whose only positive integer divisors are itself and 1. Prove that there are an infinite number of prime numbers. In recent years, very large prime numbers have emerged as being quite useful in encryption of electronic messages. Problem Solving The following diagram can be used to discuss representing and solving applied math problems at the K level. This diagram is especially useful in discussions of the current K mathematics curriculum. Figure 3 The six steps illustrated are 1 Problem posing; 2 Mathematical modeling; 3 Using a computational or algorithmic procedure to solve a computational or algorithmic math problem; 4 Mathematical "unmodeling"; 5 Thinking about the results to see if the Clearly-defined Problem has been solved,; and 6 Thinking about whether the original Problem Situation has been resolved. Steps 5 and 6 also involve thinking about related problems and problem situations that one might want to address or that are created by the process or attempting to solve the original Clearly-defined Problem or resolve the original Problem Situation. Click here for more information about problem solving. Final Remarks Here are four very important points that emerge from consideration of the diagram in Figure 3 and earlier material presented in this section: Mathematics is an aid to representing and attempting to resolve problem situations in all disciplines. It is an interdisciplinary tool and language. Computers and calculators are exceedingly fast, accurate, and capable at doing Step 3. Our current K math curriculum spends the majority of its time teaching students to do Step 3 using the mental and physical tools such as pencil and paper that have been used for hundreds of year. We can think of this as teaching students to compete with machines, rather than to work with machines. Our current mathematics education system at the PreK levels is unbalanced between lower-order knowledge and skills with way to much emphasis on Step 3 in the diagram and higher-order knowledge and skills all of the other steps in the diagram. It is weak in mathematics as a human endeavor and as a discipline of study. There are three powerful change agents that will eventually facilitate and force major changes in our math education system. Brain Science, which is being greatly aided by brain scanning equipment and computer mapping and modeling of brain activities, is adding significantly to our understanding of how the brain learns math and uses its mathematical knowledge and skills. Computer and Information Technology is providing powerful aids to many different research areas such as Brain Science , to the teaching of math for example, through the use of highly Interactive Intelligent Computer-Assisted Learning, perhaps delivered over the Internet , to the content of math for example, Computational Mathematics , and to representing and automating the "procedures" part of doing math. The steady growth of the totality of mathematical knowledge and its applications to representing and helping to solving problems in all academic disciplines.

Chapter 6 : Teaching math - four principles of deeply effective math teaching

Teaching Children Mathematics (TCM) is an official journal of the National Council of Teachers of Mathematics and is intended as a resource for elementary school students, teachers, and teacher educators.

For the last year or so, my nine-year-old daughter and I have been trying to develop a meditation practice. This guy, Andy, who leads us daily through meditation sessions facilitated by a phone app, has become a familiar name between my daughter and me. Even my five-year-old occasionally mentions Andy when going to bed at night; sleepy-time Andy tells us to lie on our backs and close our eyes and start by saying good night to our toes. One day my daughter posed me a question. We had just completed our ten-minute session for the day. She was not willing to move on yet, it seemed, so I waited. If Andy is human, he is not perfect. Yet none of his flaws are really my business, because he is effectively teaching us to be better. He is consistently, with kindness, in good humor, and with no sign of condescension, telling us how we can do better. In every session, or let me be honest, in most sessions, we learn from him. I am not as capable. I am not as kind. I am not as forgiving. I am not as insightful. I am not as brave. Now let me rephrase that for you so as to be clear. All of the above are ways of saying the same thing: And for some, an alternative may not even exist. Do they ever falter? It is not my story to tell. Again, like Andy, any of their possible faltering is none of my business. What is my business is what I learn from them.

Chapter 7 : Top 20 Math Teacher Blogs For Math Learners And Teachers

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We now turn our attention to what it takes to develop proficiency in teaching mathematics. Proficiency in teaching is related to effectiveness: Proficiency also entails versatility: Teaching in the ways portrayed in chapter 9 is a complex practice that draws on a broad range of resources. Despite the common myth that teaching is little more than common sense or that some people are just born teachers, effective teaching practice can be learned. In this chapter, we consider what teachers need to learn and how they can learn it. First, what does it take to be proficient at mathematics teaching? If their students are to develop mathematical proficiency, teachers must have a clear vision of the goals of instruction and what proficiency means for the specific mathematical content they are teaching. They need to know the mathematics they teach as well as the horizons of that mathematicsâ€”where it can lead and where their students are headed with it. They need to be able to use their knowledge flexibly in practice to appraise and adapt instructional materials, to represent the content in honest and accessible ways, to plan and conduct instruction, and to assess what students are learning. Helping Children Learn Mathematics. The National Academies Press. If you can interweave the two things together nicely, you will succeedâ€¦. Believe me, it seems to be simple when I talk about it, but when you really do it, it is very complicated, subtle, and takes a lot of time. It is easy to be an elementary school teacher, but it is difficult to be a good elementary school teacher. Used by permission from Lawrence Erlbaum Associates. Teaching requires the ability to see the mathematical possibilities in a task, sizing it up and adapting it for a specific group of students. In short, teachers need to muster and deploy a wide range of resources to support the acquisition of mathematical proficiency. In the next two sections, we first discuss the knowledge base needed for teaching mathematics and then offer a framework for looking at proficient teaching of mathematics. In the last two sections, we discuss four programs for developing proficient teaching and then consider how teachers might develop communities of practice. The Knowledge Base for Teaching Mathematics Three kinds of knowledge are crucial for teaching school mathematics: Page Share Cite Suggested Citation: In our use of the term, knowledge of mathematics includes consideration of the goals of mathematics instruction and provides a basis for discriminating and prioritizing those goals. Knowing mathematics for teaching also entails more than knowing mathematics for oneself. Teachers certainly need to be able to understand concepts correctly and perform procedures accurately, but they also must be able to understand the conceptual foundations of that knowledge. In the course of their work as teachers, they must understand mathematics in ways that allow them to explain and unpack ideas in ways not needed in ordinary adult life. Knowledge of students and how they learn mathematics includes general knowledge of how various mathematical ideas develop in children over time as well as specific knowledge of how to determine where in a developmental trajectory a child might be. Knowledge of instructional practice includes knowledge of curriculum, knowledge of tasks and tools for teaching important mathematical ideas, knowledge of how to design and manage classroom discourse, and knowledge of classroom norms that support the development of mathematical proficiency. Teaching entails more than knowledge, however. Teachers need to do as well as to know. For example, knowledge of what makes a good instructional task is one thing; being able to use a task effectively in class with a group of sixth graders is another. Understanding norms that support productive classroom activity is different from being able to develop and use such norms with a diverse class. Knowledge of Mathematics Because knowledge of the content to be taught is the cornerstone of teaching for proficiency, we begin with it. Many recent studies have revealed that U. The mathematical education they received, both as K students and in teacher preparation, has not provided them with appropriate or sufficient opportunities to learn mathematics. As a result of that education, teachers may know the facts and procedures that they teach but often have a relatively weak understanding of the conceptual basis for that knowledge. Many have difficulty clarifying mathematical ideas or solving problems that involve more than routine calculations. Many have little appreciation of the ways in which mathematical knowledge is generated or justified. Preservice teachers, for example, have repeatedly been shown to be quite willing to accept a series of instances as proving a mathematical generalization. Although teachers may understand the mathematics they teach in only a superficial way, simply taking more of the standard college mathematics courses does not appear to help matters. The evidence on this score has been consistent, although the reasons have not been adequately explored. For example, a study of prospective secondary mathematics teachers at three major institutions showed that, although they had completed the upper-division college mathematics courses required for the mathematics major, they had only a cursory understanding of the concepts underlying elementary mathematics. For the most part, the results have been disappointing: Most studies have failed to find a strong relationship between the two. Many studies, however, have relied on crude measures of these variables. The measure of teacher knowledge, for example, has often been the number of mathematics courses taken or other easily documented data from college Page Share Cite Suggested Citation: Such measures do not provide an accurate index of the specific mathematics that teachers know or of how they hold that knowledge. Teachers may have completed their courses successfully without achieving mathematical proficiency. Or they may have learned the mathematics but not know how to use it in their teaching to help students learn. They may have learned mathematics that is not well connected to what they teach or may not know how to connect it. The empirical literature suggests that this belief needs drastic modification and in fact suggests that once a teacher reaches a certain level of understanding of the subject matter, then further understanding contributes nothing to student achievement. Fourth graders taught by teachers who majored in mathematics education or in education tended to outperform those whose teachers majored in a field other than education. That crude measures of teacher knowledge, such as the number of mathematics courses taken, do not correlate positively with student performance data, supports the need to study more closely the nature of the mathematical knowledge needed to teach and to measure it more sensitively. The research, however, does suggest that proposals to improve mathematics instruction by simply increasing the number of mathematics courses required of teachers are not likely to be successful. As we discuss in the sections that follow, courses that reflect a serious examination of the nature of the mathematics that teachers use in the practice of teaching do have some promise of improving student performance. Teachers need to know mathematics in ways that enable them to help students learn. The specialized knowledge of mathematics that they need is different from the mathematical content contained in most college mathematics courses, which are principally designed for those whose professional uses of mathematics will be in mathematics, science, and other technical fields. Why does this difference matter in considering the mathematical education of teachers? First, the topics taught in upper-level mathematics courses are often remote from the core content of the K curriculum. Although the abstract mathematical ideas are connected, of course, basic algebraic concepts or elementary geometry are not what prospective teachers study in a course in advanced calculus or linear algebra. Second, college mathematics courses do not provide students with opportunities to learn either multiple representations of mathematical ideas or the ways in which different representations relate to one another. Advanced courses do not emphasize the conceptual underpinnings of ideas needed by teachers whose uses of mathematics are to help others learn mathematics. While this approach is important for the education of mathematicians and scientists, it is at odds with the kind of mathematical study needed by teachers. Consider the proficiency teachers need with algorithms. The power of computational algorithms is that they allow learners to calculate without having to think deeply about the steps in the calculation or why the calculations work. Over time, people tend to forget the reasons a procedure works or what is entailed in understanding or justifying a particular algorithm. Because the algorithm has become so automatic, it is difficult to step back and consider what is needed to explain it to someone who does not understand. Most advanced mathematics classes engage students in taking ideas they have already learned and using them to construct increasingly powerful and abstract concepts and methods. Once theorems have been proved, they can be used to prove other theorems. It is not necessary to go back to foundational concepts to learn more advanced ideas. Teaching, however, entails reversing the direction followed in learning advanced mathematics. In helping students learn, teachers must take abstract ideas and unpack them in ways that make the basic underlying concepts visible. For adults, division is an operation on numbers. She wants to put 6 cookies on each plate. How many plates will she need? He wants to put all the cookies on 6 plates. If he puts the same number of cookies on each plate, how many cookies will he put on each plate? These two problems correspond to the measurement and sharing models of division, respectively, that were discussed in chapter 3. Young children using counters solve the first problem by putting 24 counters in piles of 6 counters each. They solve the second by partitioning the 24 counters into 6 groups. In the first case the answer is the number of groups; in the second, it is the number in each group. Until the children are much older, they are not aware that, abstractly, the two solutions are equivalent. Teachers need to see that equivalence so that they can understand and anticipate the difficulties children may have with division. To understand the sense that children are making of arithmetic problems, teachers must understand the distinctions children are making among those problems and how the distinctions might be reflected in how the children think about the problems. The different semantic contexts for each of the operations of arithmetic is not a common topic in college mathematics courses, yet it is essential for teachers to know those contexts and be able to use their knowledge in instruction. The division example illustrates a different way of thinking about the content of courses for teachersâ€”a way that can make those courses more relevant to the teaching of school mathematics. Teachers are unlikely to be able to provide an adequate explanation of concepts they do not understand, and they can hardly engage their students in productive conversations about multiple ways to solve a problem if they themselves can only solve it in a single way. Most of the investigations have been case studies, almost all involving fewer than 10 teachers, and most only one to three teachers. Not surprisingly, these teachers gave the students little assistance in developing an understanding of what they were doing. The teacher also needs to be sensitive to the unique ways of learning, thinking about, and doing mathematics that the student has developed. Each student can be seen as located on a path through school mathematics, equipped with strengths and weaknesses, having developed his or her own approaches to mathematical tasks, and capable of contributing to and profiting from each lesson in a distinctive way. Teachers also need a general knowledge of how students thinkâ€”the approaches that are typical for students of a given age and background, their common conceptions and misconceptions, and the likely sources of those ideas. We have described some of those progressions in chapters 6 through 8. From the many examples of misconceptions to which teachers need to be sensitive, we have chosen one: Children can develop this impression because that is how the notation is often described in the elementary school curriculum and most of their practice exercises fit that pattern. Knowledge of Classroom Practice Knowing classroom practice means knowing what is to be taught and how to plan, conduct, and assess effective lessons on that mathematical content. We have discussed these matters in chapter 9. In the sections that follow, we consider how to develop an integrated corpus of knowledge of the types discussed in this section. First, however, we need to clarify our stance on the relation between knowledge and practice.

Chapter 8 : What is Mathematics?

Excellent resource for K-8 math teachers and pre-service teachers. I use this book at the college level as the foundation for my elementary math methods class, but it would be equally as valuable to an elementary teacher.

Chapter 9 : Marilyn Burns | Math Solutions

teaching. 33 The implications for teacher education and professional development is that teachers engage not only in learning methods of teaching but also in reflecting on them and justifying and explaining them in relation to such matters as the mathematics being taught, the goals for students, the conceptions and misconceptions that students.