

# Maths Paper 1 Study Guide Grade 12

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**The Catholic School Journal** -  
1967

*Resources in Education* - 1998

*Canadian Books in Print* - 2001

*Catalog of Copyright Entries.  
Third Series* - Library of  
Congress. Copyright Office 1976

*Business Math Handbook and  
Study Guide to Accompany  
Practical Business Math  
Procedures, Eighth Edition* -  
Jeffrey Slater 2006

Eureka Math Grade 5 Study  
Guide - Great Minds 2015-11-09  
Eureka Math is a comprehensive,  
content-rich PreK–12

curriculum that follows the focus and coherence of the Common Core State Standards in Mathematics (CCSSM) and carefully sequences the mathematical progressions into expertly crafted instructional modules. The companion Study Guides to Eureka Math gather the key components of the curriculum for each grade into a single location, unpacking the standards in detail so that both users and non-users of Eureka Math can benefit equally from the content presented. Each of the Eureka Math Curriculum Study Guides includes narratives that provide educators with an overview of what students should be learning throughout the year, information on alignment to the instructional shifts and the standards, design of curricular components, approaches to differentiated instruction, and descriptions of mathematical models. The Study Guides can serve as either a self-

study professional development resource or as the basis for a deep group study of the standards for a particular grade. For teachers who are new to the classroom or the standards, the Study Guides introduce them not only to Eureka Math but also to the content of the grade level in a way they will find manageable and useful. Teachers familiar with the Eureka Math curriculum will also find this resource valuable as it allows for a meaningful study of the grade level content in a way that highlights the coherence between modules and topics. The Study Guides allow teachers to obtain a firm grasp on what it is that students should master during the year. The Eureka Math Curriculum Study Guide, Grade 5 provides an overview of all of the Grade 5 modules, including Place Value and Decimal Fractions; Multi-Digit Whole Number and Decimal Fraction Operations; Addition and

Subtraction of Fractions;  
Multiplication and Division of  
Fractions and Decimal Fractions;  
Addition and Multiplication with  
Volume and Area; Problem  
Solving with the Coordinate  
Plane.

**MEGA Study Guide for NTSE  
2021 (SAT & MAT) Class 10  
Stage 1 & 2 - 12th Edition** - Disha  
Experts 2020-05-13

**The Publishers' Trade List  
Annual** - 1980

**NYSTCE Mathematics (004) Test  
Secrets Study Guide** - Nystce  
Exam Secrets Test Prep  
2018-04-12

\*\*\*Includes Practice Test  
Questions\*\*\* NYSTCE Students  
with Disabilities (060) Test  
Secrets helps you ace the New  
York State Teacher Certification  
Examinations, without weeks  
and months of endless studying.  
Our comprehensive NYSTCE  
Students with Disabilities (060)  
Test Secrets study guide is

written by our exam experts,  
who painstakingly researched  
every topic and concept that you  
need to know to ace your test.  
Our original research reveals  
specific weaknesses that you can  
exploit to increase your exam  
score more than you've ever  
imagined. NYSTCE Students  
with Disabilities (060) Test  
Secrets includes: The 5 Secret  
Keys to NYSTCE Success: Time  
is Your Greatest Enemy,  
Guessing is Not Guesswork,  
Practice Smarter, Not Harder,  
Prepare, Don't Procrastinate, Test  
Yourself; Introduction to the  
NYSTCE Series including:  
NYSTCE Assessment  
Explanation, Two Kinds of  
NYSTCE Assessments; A  
comprehensive General Strategy  
review including: Make  
Predictions, Answer the  
Question, Benchmark, Valid  
Information, Avoid Fact Traps,  
Milk the Question, The Trap of  
Familiarity, Eliminate Answers,  
Tough Questions, Brainstorm,

Read Carefully, Face Value, Prefixes, Hedge Phrases, Switchback Words, New Information, Time Management, Contextual Clues, Don't Panic, Pace Yourself, Answer Selection, Check Your Work, Beware of Directly Quoted Answers, Slang, Extreme Statements, Answer Choice Families; Along with a complete, in-depth study guide for your specific NYSTCE exam, and much more...

Mathematics - 2014

*Study and Master Mathematics Grade 12 CAPS Study Guide* - Noleen Jakins 2013-10-31

**Canadian Books in Print** - Marian Butler 2002-02

*Glencoe Mathematics* - Jack H. Stocker 1998-02

**Trade and Industrial Education** - 1972

**The Theory of Flight** - Siphwe

Gloria Ndlovu 2021-01-12

"On the third of September, not so long ago, something truly wondrous happened on the Beauford Farm and Estate. At the moment of her death, Imogen Zula Nyoni - Genie - was seen to fly away on a giant pair of silver wings ..."

**Report** - International Clearinghouse on Science and Mathematics Curricular Developments 1966

Library of Congress Catalog: Motion Pictures and Filmstrips - Library of Congress 1968

6th Grade Math - Jessica Corriere Robert Richards 2012-11-25

The best 6th grade study guide to prepare your middle school student for mathematic exams. The book teaches children to understand basic math concepts, skills, and strategies of the Common Core Curriculum Standards and the Regents Mathematics exam with detailed

step by step explanations to solving typical exam problems. It's like studying with your own private tutor! This book features a user friendly format perfect for browsing, research, and review. Three practice test and answer keys included; covering review topics: Number Sense, Algebra, Geometry, Measurement, Probability and Statistics. All content aligned to state and national standards.

Drum - 2002

Eureka Math Curriculum Study Guide - Common Core 2015-03-23  
Eureka Math is a comprehensive, content-rich PreK–12 curriculum that follows the focus and coherence of the Common Core State Standards in Mathematics (CCSSM) and carefully sequences the mathematical progressions into expertly crafted instructional modules. The companion Study Guides to Eureka Math gather the key components of the

curriculum for each grade into a single location, unpacking the standards in detail so that both users and non-users of Eureka Math can benefit equally from the content presented. Each of the Eureka Math Curriculum Study Guides includes narratives that provide educators with an overview of what students should be learning throughout the year, information on alignment to the instructional shifts and the standards, design of curricular components, approaches to differentiated instruction, and descriptions of mathematical models. The Study Guides can serve as either a self-study professional development resource or as the basis for a deep group study of the standards for a particular grade. For teachers who are new to the classroom or the standards, the Study Guides introduce them not only to Eureka Math but also to the content of the grade level in a way they will find manageable

and useful. Teachers familiar with the Eureka Math curriculum will also find this resource valuable as it allows for a meaningful study of the grade level content in a way that highlights the coherence between modules and topics. The Study Guides allow teachers to obtain a firm grasp on what it is that students should master during the year. The Eureka Math Curriculum Study Guide, Grade K provides an overview of all of the Kindergarten modules, including Numbers to 10; Two-Dimensional and Three-Dimensional Shapes; Comparison of Length, Weight, Capacity, and Numbers to 10; Number Pairs, Addition and Subtraction to 10; Numbers 10–20 and Counting to 10; and Analyzing Comparing and Composing Shapes.

Mathematics - 2014

*El-Hi Textbooks in Print* - 1984

Study Guide for CTET Paper 2

(Class 6 - 8 Teachers)

Mathematics/ Science with Past Questions - Disha Experts  
2020-02-04

**PSAT 8/9 Math Study Guide** -  
Reza Nazari

Are you preparing for your PSAT 8/9 Math test? Do you want to give yourself the best possible chance of succeeding? Are you looking for assistance from a study guide designed by a top PSAT Math expert?

Succeeding on any test means study and lots of it. Poring over books for hours every day is one way of achieving your goals, but there are other things that can assist you, such as the PSAT 8/9 Math Study Guide, which reflects the 2021 test guidelines and is a great tool for helping students to attain outstanding results. With this PSAT 8/9 Math Study Guide you will find a comprehensive book that is tailored to your exact needs and provides you with extensive

assistance with: ✓ Math lessons ✓ Exercises ✓ Sample math questions ✓ Quizzes with answers ✓ Two complete math tests ✓ Content 100% aligned with the 2021 PSAT 8/9 test ✓ And lots more... Written by a PSAT Math instructor and test expert and covering everything you will need this is a book that has been designed specifically to help you hone your math skills, overcome exam anxiety, boost your confidence – and do your best to ace the PSAT Math on test day. So if you want to give yourself the best possible chance of success, scroll up, click Add to Cart and get your copy now! Ideal for self-study and classroom usage! Visit [www.EffortlessMath.com](http://www.EffortlessMath.com) for Online Math Practice

**Bibliographic Guide to Education**  
- 1990

*x-kit exam 2004 mathematics* - Bryony Poulter 2005

Report of the International Clearinghouse on Science and Mathematics Curricular Developments - International Clearinghouse on Science and Mathematics Curricular Developments 1966

*Building Thinking Classrooms in Mathematics, Grades K-12* - Peter Liljedahl 2020-09-28

A thinking student is an engaged student Teachers often find it difficult to implement lessons that help students go beyond rote memorization and repetitive calculations. In fact, institutional norms and habits that permeate all classrooms can actually be enabling "non-thinking" student behavior. Sparked by observing teachers struggle to implement rich mathematics tasks to engage students in deep thinking, Peter Liljedahl has translated his 15 years of research into this practical guide on how to move toward a thinking classroom.

Building Thinking Classrooms in

Mathematics, Grades K–12 helps teachers implement 14 optimal practices for thinking that create an ideal setting for deep mathematics learning to occur. This guide Provides the what, why, and how of each practice and answers teachers' most frequently asked questions Includes firsthand accounts of how these practices foster thinking through teacher and student interviews and student work samples Offers a plethora of macro moves, micro moves, and rich tasks to get started Organizes the 14 practices into four toolkits that can be implemented in order and built on throughout the year When combined, these unique research-based practices create the optimal conditions for learner-centered, student-owned deep mathematical thinking and learning, and have the power to transform mathematics classrooms like never before.

Harcourt Math, Grade 1 - HSP  
2002

Mathematics program for grades K-6 provides focused instruction on key skills, comprehensive assessment, targeted intervention and practice for mastery and retention.

**Study and Master Mathematical Literacy Grade 12 CAPS Learner's Book** - Karen Morrison  
2014-05-01

**Eureka Math Grade 2 Study Guide** - Great Minds 2015-09-18  
Eureka Math is a comprehensive, content-rich PreK–12 curriculum that follows the focus and coherence of the Common Core State Standards in Mathematics (CCSSM) and carefully sequences the mathematical progressions into expertly crafted instructional modules. The companion Study Guides to Eureka Math gather the key components of the curriculum for each grade into a single location, unpacking the standards in detail so that both users and non-users of Eureka



Math can benefit equally from the content presented. Each of the Eureka Math Curriculum Study Guides includes narratives that provide educators with an overview of what students should be learning throughout the year, information on alignment to the instructional shifts and the standards, design of curricular components, approaches to differentiated instruction, and descriptions of mathematical models. The Study Guides can serve as either a self-study professional development resource or as the basis for a deep group study of the standards for a particular grade. For teachers who are new to the classroom or the standards, the Study Guides introduce them not only to Eureka Math but also to the content of the grade level in a way they will find manageable and useful. Teachers familiar with the Eureka Math curriculum will also find this resource valuable as it allows for

a meaningful study of the grade level content in a way that highlights the coherence between modules and topics. The Study Guides allow teachers to obtain a firm grasp on what it is that students should master during the year. The Eureka Math Curriculum Study Guide, Grade 2 provides an overview of all of the Grade 2 modules, including Sums and Differences to 20; Addition and Subtraction of Length Units; Place Value, Counting, and Comparison of Numbers to 1,000; Addition and Subtraction Within 200 with Word Problems to 100; Addition and Subtraction Within 1,000 with Word Problems to 100; Foundations of Multiplication and Division; Problem Solving with Length, Money, and Data; and Time, Shapes, and Fractions as Equal Parts of Shapes.

**Canadian Books in Print. Author and Title Index - 1975**

*Everything You Need to Ace*

*Math in One Big Fat Notebook* - Workman Publishing 2018-02-06

It's the revolutionary math study guide just for middle school students from the brains behind Brain Quest. Everything You Need to Ace Math . . . covers everything to get a student over any math hump: fractions, decimals, and how to multiply and divide them; ratios, proportions, and percentages; geometry; statistics and probability; expressions and equations; and the coordinate plane and functions. The BIG FAT NOTEBOOK™ series is built on a simple and irresistible conceit—borrowing the notes from the smartest kid in class. There are five books in all, and each is the only book you need for each main subject taught in middle school: Math, Science, American History, English Language Arts, and World History. Inside the reader will find every subject's key concepts, easily digested and summarized:

Critical ideas highlighted in neon colors. Definitions explained. Doodles that illuminate tricky concepts in marker. Mnemonics for memorable shortcuts. And quizzes to recap it all. The BIG FAT NOTEBOOKS meet Common Core State Standards, Next Generation Science Standards, and state history standards, and are vetted by National and State Teacher of the Year Award–winning teachers. They make learning fun and are the perfect next step for every kid who grew up on Brain Quest.

**Geometry Part 1** - BarCharts, Inc 2017-05

Guaranteed to boost test scores and grades. The essentials of this branch of mathematics are an important foundation that future more advanced math is built upon. Using this as a review and reinforcement tool is quick and easy to do daily or weekly, keeping all concepts fresh once you move deeper into the

subject. For complete coverage, get the Geometry Part 2 QuickStudy guide and use the two guides to study, reference, review and ace the grade. 6-page laminated guide includes: Geometric Formulas Undefined Terms Defined Terms Space Shapes Lines Planes Line Segments Rays Angles Suggested uses: Quick Reference - instead of digging into the textbook to find a core answer you need while studying, use the guide to reinforce quickly and repeatedly Memory - refreshing your memory repeatedly is a foundation of studying, have the core answers handy so you can focus on understanding the concepts Test Prep - no student should be cramming, but if you are, there is no better tool for that final review

Building on the Past to Prepare for the Future - Janina Morska 2022-09-01

Abstract of Book This volume contains the papers presented at

the International Conference Building on the Past to Prepare for the Future held from August 8-13, 2022, in King's College, Cambridge, UK. It was the 16th conference organised by The Mathematics Education for the Future Project - an international educational and philanthropic project founded in 1986 and dedicated to innovation in mathematics, statistics, science and computer education world wide. Contents List of Papers and Workshop Summaries Fouze Abu Qouder & Miriam Amit The Ethnomathematics of the Bedouin - An Innovative Approach of Integrating Socio Cultural Elements into Mathematics Education <https://doi.org/10.37626/GA9783959872188.0.001> First page: 1 Last page: 6 Abstract Our study attempted to address young Bedouin (desert tribes) students' persistent difficulties with mathematics by integrating ethnomathematics into a

standard curriculum. First, we conducted extensive interviews w 35 Bedouin elders and women to identify: 1. The mathematical elements of their daily lives- particularly traditional units of length and weight, 2. The geometrical shapes in Bedouin women’s traditional dress embroidery. Then we combined these with the standard curriculum to make an integrated 90 hours 7-8th grade teaching units that were implemented in Bedouin schools and in the Kidumatica Math Club for Excellent Students.

Comparisons between the experimental groups (186) and the control group (62) showed that studying by the integrated curriculum improved:1.The cognitive aspects of the students 2.The affective aspects.

Keywords: Bedouin Cultures, ethnomathematics.

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===== Nadine Adams &

Clinton Hayes Why Everyone should know Statistics!

<https://doi.org/10.37626/GA97839>

59872188.0.002 First page: 7 Last

page: 11 Abstract “Decision is the

central intellectual activity in our

everyday lives” and statistics is

central to these activities

(Longford, 2021, p. xi). The

ability to manipulate and

interpret data is an important

component in decision making. A

misunderstanding or poor grasp

of data distributions and statistical

methods can lead to assumptions

that are not accurate. When these

inaccurate assumptions are

presented as factual to decision

makers also possessing little or no

statistical knowledge, poor

decisions can be made. This paper

investigates how an

interpretation of statistics played

a role the decision to remove

multiple-choice questions from

invigilated examinations at a

regional Australian university.

The case is further argued that it

is important for everyone to have



analysis of the geometric concepts. With a case study design of 15 pupils through interviews and observations, the findings show that pupils can apply baskets to learn geometric tessellations. It was there recommended that baskets be used to extend learning as they play, game and fun.

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===== Nurten Alpaslan & Emre Alpaslan Mathematics for Everybody  
<https://doi.org/10.37626/GA9783959872188.0.005> First page: 24 Last page: 25

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===== Cynthia Oropesa Anhalt, Ricardo Cortez, Brynja Kohler & Will Tidwell Interrogation of Social Justice Contexts in Mathematical Modeling: The Use of Simulations of Practice in the Mathematical Preparation of Teachers

<https://doi.org/10.37626/GA9783959872188.0.006> First page: 26 Last page: 31 Abstract Research in prospective teachers' development of mathematical modeling knowledge for teaching is gaining momentum. The Mathematics of Doing, Understanding, Learning, and Educating for Secondary Students [MODULE(S2)]\* project developed a curriculum in modeling for teacher education that includes simulations of practice, in which prospective teachers reflect on and plan a discussion around student thinking, their models, and the contextualization of their results. We present an analysis of prospective teachers' modeling work on the decreasing area of Indigenous reservation land in the U.S., and a simulation of practice which explores different methods for finding the area of land in connection to the injustice deeply rooted in the treatment of Indigenous people. This problem

explores a critical social issue and calls for explicit attention to pedagogical knowledge in structuring discussions around the contextualization of the mathematical results.

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===== Takako Aoki & Shin Watanabe Find out Mathematics on a Football: Making a football with paper  
<https://doi.org/10.37626/GA9783959872188.0.007> First page: 32 Last page: 34 Abstract We are aiming for a workshop method as a way to teach mathematics in future school education. It is important to cooperate with each other and understand mathematics. In this workshop, we aim to discover the mathematics hidden in the footballs we handle every day. As an aid to thinking, I would like to make football by paper first and learn mathematics while looking at concrete things. You need 20 equilateral triangles. A regular hexagon is made from

this equilateral triangle, and a regular pentagon uses the method of making a hole. In particular, pay attention to the four-color problem in mathematics, make sure that the colours of adjacent regular hexagons are different, and use three colours (red, green, yellow). For example, in a football, how many equilateral triangles of each colour are used is one of the issues. I am looking forward to holding a workshop to see what kind of problems there are. Key words: football Introduction with paper, the truncated icosahedron, the color coding of the three colors, Euler's polyhedral formula

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===== Sarah Bansilal Analysing the Demands of an Assessment in a Geometry Pedagogic Content Knowledge Module  
<https://doi.org/10.37626/GA9783959872188.0.008> First page: 35 Last

page: 40 Abstract With the onset of the pandemic, universities were forced to move to online platforms for teaching and for assessments. In this paper, I reflect on the use of multiple-choice questions in a geometry PCK module for pre-service mathematics teachers. The study involves a secondary analysis of the data generated by the responses of 92 students to an assessment consisting of 25 items. The aim of the study was to distinguish between, and if possible, characterise possible levels of demands of the test items. The results suggested that there are four distinct groups of items relating to common content knowledge of early and late high school respectively, PCK related to deductive reasoning skills and critical thinking in an open book setting.

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===== Mike Bedwell Three or Four numbers: A Teacher's

Tale

<https://doi.org/10.37626/GA9783959872188.0.009> First page: 41 Last page: 43

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===== Esther Billings & Lisa Kasmer Learning Experiences that Support Primary Teacher Candidates' Understanding and Enactment of Core Mathematics Teaching Practices

<https://doi.org/10.37626/GA9783959872188.0.010> First page: 44 Last page: 49 Abstract In many

teacher preparation programs, instruction focuses on learning about strategies and practices for teaching rather than directly enacting and honing these skills (Grossman, Hammerness, & McDonald, 2009): a corepractice approach in teacher education necessitates organizing coursework and fieldwork around practices of the teaching profession while simultaneously providing teacher candidates (TCs) ample opportunities to



“practise” by enacting these teaching practices. In this paper, we share our corepractice instructional strategies, along with TC work used in our teacher preparation mathematics education courses (prior to student teaching) to engage TCs’ understanding and development of their ability to enact core practices, specifically the mathematics teaching practices outlined in National Council of Teachers of Mathematics (NCTM) (2014).

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===== Victoria Bonaccorso,  
Joseph DiNapoli & Eileen Murray Promoting Meaningful Conversations among Prospective Mathematics Teachers  
<https://doi.org/10.37626/GA9783959872188.0.011> First page: 50 Last page: 55 Abstract Recent circumstances due to the COVID-19 pandemic and restrictions on entering public schools have created barriers for

prospective teachers (PT) to gain valuable exposure to real classrooms. As a result, we have transitioned some teacher preparation from in person experiences to video case study analysis. Our research seeks to determine how this transition can foster development of critical teaching skills by infusing a model of powerful teaching with video of real classrooms. Our findings suggest that with online video case analysis PTs were able to advance their discursive conversations to strategic conversations by building on and transforming each other’s articulation of proposed teacher moves. This model for PT preparation has the potential to foster more meaningful discourse among participants by providing a space to build on and refine their understanding of mathematics teaching.

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===== Primo Brandi, Rita

Ceppitelli & Anna Salvadori  
Elementary Dynamic Models: A  
Strategic Bridge Connecting  
School and University  
<https://doi.org/10.37626/GA9783959872188.0.012> First page: 56 Last  
page: 62 Abstract We present an  
innovative educational path  
thought as a link between High  
School and University studies.  
The topic is the introduction to  
dynamic models (both discrete  
and continuous) which represent  
a key tool in a wide range of  
disciplines: sciences, techniques,  
economics, life sciences and more.

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===== Simone Brasili &  
Riccardo Piergallini Introducing  
Symmetry and Invariance with  
Magic Squares

<https://doi.org/10.37626/GA9783959872188.0.013> First page: 63 Last  
page: 68 Abstract Magic squares  
are key tools in mathematics  
teaching. They favor reasoning  
and creativity in problem-  
solving. As well, they bring

students closer to the history of  
mathematics. Our work presents  
the magic squares in a learning  
progression introducing the  
symmetry linked with the idea  
of invariance “sameness in  
change” early at primary school  
in Montegranaro (Italy). Using  
the 3x3 magic square and  
manipulation games, a sample of  
101 pupils (8 years) internalizes  
symmetries, reflections, and  
rotations associated with the  
square. The proposed activities  
provide tools and experience for  
geometric cognitive processes  
transferable from magic squares  
to main geometric shapes. The  
findings confirm that symmetry  
linked to the search for  
invariance is appropriate and  
accessible for primary school  
pupils through manipulation  
games.

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===== Angela Broaddus &  
Matthew Broaddus Assessing  
Mathematical Reasoning: Test

Less – Explain More  
<https://doi.org/10.37626/GA9783959872188.0.014> First page: 69 Last page: 74 Abstract Mathematics educational researchers have long offered recommendations for effective mathematics teaching, learning, and assessment, yet educators still struggle to implement fair and practical assessments that promote engagement and inspire students. This study describes assessments that (1) reduced anxiety, frustration, and rote imitation of procedures; (2) increased accessibility, motivation, and psychological resilience; and (3) improved engagement, strategic competence, self-assessment, and depth of understanding. Writing assignments prompted students to explain their reasoning about problems or their understanding of main ideas. Students revisited assignments in response to feedback and resubmitted them later in the course, which motivated students to deepen

their understanding over time. Sample assignments, responses, and lessons learned will be shared.

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===== Irena Budínová & Jitka Panáčová Children with Reduced Cognitive Effectivity, their Problems and Optimal Way of Education

<https://doi.org/10.37626/GA9783959872188.0.015> First page: 75 Last page: 80 Abstract The contribution deals with children with reduced cognitive efficiency, their specific, and frequent difficulties in learning mathematics in the first years of education. Two examples of children with reduced cognitive efficiency will illustrate the specific ways in which reduced cognitive efficiency can manifest itself in mathematics, how children can be helped to overcome the mathematics curriculum. Problems in learning two basic arithmetic operations

will be presented. The differentiation of teaching will be briefly introduced as an effective opportunity to work with these children.

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===== Gail Burrill Data  
Science and Mathematical  
Modeling: Connecting  
Mathematics to the World in  
which Students Live  
<https://doi.org/10.37626/GA9783959872188.0.016> First page: 81 Last  
page: 89 Abstract The increasing  
need for statistical and  
quantitative thinking and  
reasoning makes it more  
important than ever that using  
mathematics and statistics to  
make sense of the world should  
be a central component of  
schooling. Data have transformed  
the way we look at the world.  
Shouldn't this emphasis on data  
also impact what we teach both  
in mathematics and statistics?  
Research suggests that engaging  
with real data can motivate

students, encourage them to take  
an interest in STEM fields, and  
allows the interests of diverse  
communities to be used as  
opportunities for learning. This  
paper summarizes the research  
looking at why connecting  
mathematics to the world is  
important for student learning,  
describes the role of data science  
and modeling in doing so, and  
provides examples of  
opportunities for students to  
interact with the world in which  
they live and work. "The  
development of mathematics is  
intimately interwoven with the  
progress of civilization,.."  
(Ebrahim, 2010)

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===== Gail Burrill & Thomas  
Dick Connecting Mathematics to  
the World: Engaging Students  
with Data Science  
<https://doi.org/10.37626/GA9783959872188.0.017> First page: 90 Last  
page: 94 Abstract Mathematics  
and statistics can be used to

describe, explore, and understand this complicated world in which we live. The workshop focus is on several potentially messy, real-world problems from predicting herd immunity, to exploring the quality of life across countries to modeling the change in CO2 levels. Each situation begins with a question and a set of data. The activities are open ended with multiple ways students might develop mathematical and statistical models, use technology to analyze the data, and make sense of terms such as herd immunity or vaccine efficacy or to investigate situations such as optimizing resources during a flood.

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===== Elizabeth A. Burroughs & Mary Alice Carlson Fostering Empathy in Mathematics through Mathematical Modeling <https://doi.org/10.37626/GA9783959872188.0.018> First page: 95 Last

page: 100 Abstract Modeling, a cyclic process by which mathematicians develop and use mathematical tools to represent, understand, and solve problems, provides learning opportunities for school students. Mathematical modeling situates mathematical problem solving squarely in the middle of everyday experiences. Modeling engenders the habits and dispositions of problem solving and empowers students to identify critical issues important to them, use their mathematical tools to address these problems, and view mathematics as a force for societal good.

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===== Bernardo Camou The Adventure of Learning Mathematics and Lakatos's Legacy <https://doi.org/10.37626/GA9783959872188.0.019> First page: 101 Last page: 104 Abstract Mathematics is normally

described as abstract, exact, general and perfect. However, mathematics is a human creation and thus we can ask: How can humans with flaws and defects are able to create something perfect and infallible? Mathematics have its foundations in concrete problems, trials and errors approximations and representations. Learning mathematics is a fascinating trip, back and forth between concrete and abstract, between approximations and accuracy, between particular and general. Our poor representations are the road to conceptualize mathematical objects that then, seem to become perfect. In this workshop we will handle polyhedral and work with Euler's Formula, with angular defects and its relation with surface's curvature. In Lakato's book Proofs and Refutations the author might have committed a mistake, though his book gives us a brilliant insight about the logic

of mathematical discovery.  
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===== Carrie Chiappetta,  
Christopher Walsh, Annie Smith  
& Javier Perez K-12 Schools after  
the Global Pandemic: How a  
Regional School District in the  
United States Accelerated  
Learning for Students, Teachers  
& Administrators  
<https://doi.org/10.37626/GA9783959872188.0.020> First page: 105  
Last page: 110 Abstract After the  
global pandemic, Regional School  
District 15 will start the  
2021-2022 school year by  
accelerating learning for students,  
teachers, and administrators. For  
teachers, the focus will be on  
“purposeful planning,”  
“differentiation,” and “formative  
assessment” to ensure that all  
students learn grade level  
content. For administrators, the  
focus would be on supporting  
teachers in these three areas of  
focus. The Assistant  
Superintendent, the

Mathematics/Science Department Chair, and the elementary and middle school mathematics instructional coaches will share the plan that they have implemented to work with K-12 teachers and administrators to ensure that students were able to learn grade level content even after the interrupted education that occurred during the global pandemic.

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===== Kathleen Cotter Clayton Fractions of the Future <https://doi.org/10.37626/GA9783959872188.0.021> First page: 111 Last page: 116 Abstract Explore the simplicity and beauty of fractions of the future with a linear model, not with circle sets. When fractions are approached with this linear perspective, fractions can be easily taught, explored, and applied in daily life. Learn how to ask the right questions to guide your pupils to a solid understanding. Children as

young as five can see that  $1/3$  is less than  $1/2$  and more than  $1/4$ . They can also see why  $9/8$  is more than 1, why  $1/4$  plus  $1/8$  is  $3/8$ , and why  $1/2 \times 1/2$  is  $1/4$ . Fractions are a delight when they are taught the right way. Allow the children to explore the whole picture and relationships within the whole using the linear fraction model. Learn about activities and games to build confidence and develop a deep understanding of fractions. Uncover the joy of fractions!

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===== Joan A. Cotter Teaching Primary Mathematics without Counting and Place Value with Transparent Number Naming <https://doi.org/10.37626/GA9783959872188.0.022> First page: 117 Last page: 122 Abstract Counting - memorizing the sequence and coordinating pointing with recitation - is problematic for many children. Children with

poor counting skills often struggle to learn their beginning math with various approaches. Yet, counting is unnecessary. Babies are born with the ability to subitize; that is, to detect quantities at a glance, up to three. By age 3, they can subitize up to five; by age 4 they can subitize up to 10 by grouping in fives, similar to their fingers. After children know the names for quantities 1 to 10, their next step should be place-value starting with temporary transparent number naming. For example, 11 is “ten-1”, 12 is “ten-2”, and 24 is “2-ten-4.” The counting words in Far Asian languages reflect this transparency, enhancing their pupils’ mathematics achievement. Place-value knowledge combined with subitizing gives pupils a way to master number combinations.

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M.A.T.H. = Making Algebraic

## Thinking Holistic

<https://doi.org/10.37626/GA97839>

59872188.0.023 First page: 123

Last page: 127 Abstract Students in mathematics often need more than just definitions and examples. The first step is leaving their anxiety at the door. Hands-on work engages students by utilizing group learning, discovery, and active learning both with and without technology lessening the fears of math. Faculty members will be given sample activities, rubrics, and sample student work. Special focus on creating Spirolaterals and quilting teach geometric movement and pattern recognition. Puzzles are created with mathematical problems in linear equations, linear inequalities, and compound inequalities bringing the focus on skills and historical facts. Faculty members will work in teams to recreate the materials themselves to see where issues in understanding come from. There



will be time for both questions and answers.

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===== Scott A. Courtney The Impact of Remote Instruction on Mathematics Teachers' Practices

<https://doi.org/10.37626/GA9783959872188.0.024> First page: 128

Last page: 133 Abstract The coronavirus pandemic has impacted all aspects of society. As the virus spread across the globe, countries and local communities closed workplaces, moved schools to remote instruction, limited in-person contact, cancelled public gatherings, and restricted travel.

At one stage, over 91.3% of students worldwide, from pre-primary through tertiary education, were impacted by school closures. In the United States, many institutions continue to provide remote and hybrid learning options throughout the 2021-2022 academic year.

Attempts to mitigate Covid-19 through mass remote instruction

has provided unique opportunities for researchers to examine the resources teachers utilize to drive and supplement their practices. In this report, I describe remote instruction's ongoing impact on grades 6-12 mathematics teachers and their students in rural area and small-town schools in the Midwestern United States.

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===== Mili Das Building on the Past to Prepare for the Future - Impact of Teaching Skills and Professionalism to Reduce Mathematics Phobia

<https://doi.org/10.37626/GA9783959872188.0.025> First page: 134

Last page: 138 Abstract In India mathematics is a compulsory subject for the primary, upper primary and secondary classes. In secondary school curriculum among the compulsory subjects MATHEMATICS is the most vital subject and at the same time it is the most difficult one as per

the learners' opinion as well as the parents. So, the subject is neglected by many students and as a consequence Mathematics Phobia is often developed in the students' mind. There are many more factors which are connected to this growing distaste in learning mathematics like in appropriate curriculum organization, methodology of teaching, teachers' knowledge, assessment techniques [Das,M.2010] and management of classroom environment. The said problem is not a new one but in present teachers' training course special attention is given on it. In this paper author will discuss that how the teaching skills and teachers' professionalism can create a positive environment to motivate students. Keywords: Mathematics Teacher, Learners, Curriculum, Professionalism  
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===== Thomas P. Dick  
Combining Dynamic Computer

Algebra and Geometry to Illustrate "the most marvelous theorem in mathematics"  
<https://doi.org/10.37626/GA9783959872188.0.026> First page: 139  
Last page: 144 Abstract Dynamic geometry software (DGS) allows for constructions and measurements that instantly update when a virtual geometric figure is manipulated. Likewise, dynamic computer algebra systems (CAS) enable symbolic calculations that instantly update when an expression or equation is altered. Linking geometric objects to symbolic parameters combines these two powerful tools together. We will illustrate a unique feature of "locked" measurement in a special DGS to create a Steiner ellipse. We then illustrate the use of a dynamic CAS to create dynamic first and second derivative zeroes of a cubic function whose zeroes can be graphically manipulated. Finally, we will link a dynamic geometric construction based on

these zeroes to illustrate the Siebeck-Marden Theorem, an astounding result that has been justifiably called “the most marvelous theorem in mathematics.”

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===== Hamide Dogan, Angel Garcia Contreras & Edith Shear  
Geometry, Imagery, and Cognition in Linear Algebra  
<https://doi.org/10.37626/GA9783959872188.0.027> First page: 145  
Last page: 150 Abstract This paper discusses features of five college-level linear algebra students’ geometric reasoning, revealed on their interview responses to a set of predetermined questions from topics relevant to linear independence ideas. Our qualitative analysis identified three main themes (Topics). Each theme, furthermore, revealed similarities and differences, providing insight into technology’s potential effect.

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===== Ann Dowker, Olivia Cheriton & Rachel Horton  
Age Differences in Pupils’ Attitudes to Mathematics  
<https://doi.org/10.37626/GA9783959872188.0.028> First page: 151  
Last page: 156 This study investigated children’s and adolescents’ attitudes to mathematics, with a particular focus on whether and how these are affected by age and gender. 216 pupils from Years 2, 6, 9 and 12 participated in the study. They were given (1) the Mathematics Attitude and Anxiety’ questionnaire (Thomas & Dowker, 2000), which assesses levels of maths anxiety; unhappiness at failure in maths; liking for maths, and self-rating in maths; and (2) the British Abilities Scales Number Skills Test to establish actual mathematics performance. Age had a significant effect on both liking for maths and selfrating in

maths: older children were lower than younger children in both. Gender had a significant effect on self-rating: boys rated themselves higher than girls, though there was no significant gender difference in mathematical performance. Self-rating, but not anxiety, predicted mathematics performance.

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===== Alden J. Edson & Elizabeth Difanis Phillips The Potential of Digital Collaborative Environments for Problem-Based Mathematics Curriculum <https://doi.org/10.37626/GA9783959872188.0.029> First page: 157 Last page: 162 Abstract In this paper, we present an overview of the design research used to develop a digital collaborative environment with an embedded problembased curriculum. We then discuss the student and teacher features of the environment that promote inquiry-based learning and

teaching.

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===== Belinda P. Edwards Learning to Teach Mathematics using Virtual Reality Simulations <https://doi.org/10.37626/GA9783959872188.0.030> First page: 163 Last page: 168 Abstract Researchers (Lampert, et al., 2013; Zeichner, 2010; Grossman, et al., 2009a) recommend the use of rehearsals in teacher education classrooms to help preservice teachers (PST) bridge theory to practice. Rehearsals enable PSTs to practice teacher moves, such as asking purposeful questioning and engaging students in mathematical discourse during an episode of teaching a lesson (NCTM, 2014). During a rehearsal, the PST's teacher education instructor provides coaching that helps the PST make flexible adjustments to their instruction. Using a phenomenological approach, this research investigates the use of

Virtual Reality (VR) simulations to support PSTs learning to teach mathematics through rehearsals. The presentation will include samples of PSTs' mathematics teaching episodes with attention to successes, challenges, and lessons learned from the use of VR simulations in teacher education classrooms.

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===== Allison Elowson,  
Kristen Fye, Gregory Wickliff,  
Christopher Gordon, Alisa  
Wickliff, Paul Hunter & David  
Pugalee Student Research in a  
Mathematics Enrichment  
Program  
<https://doi.org/10.37626/GA9783959872188.0.031> First page: 169  
Last page: 174 Abstract Increasing  
emphasis is placed on the  
development of research skills for  
students in STEM content areas.  
As part of a four-week summer  
enrichment program, 24 high  
school students participated in a  
mathematics course highlighting

the historical development of mathematics through the lens of history and culture. Each student designed and conducted their own research study under the mentorship of instructors with expertise in mathematics, writing and technical communication, and student research. This paper presents a case study of one project selected on the basis of strong performance in meeting course goals. Data demonstrates the mathematical understanding of the student researcher, their scientific literacy and research skills, and their mathematical communication. The student prepared both a paper and a poster to report their research study.

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===== Antonella Fatai  
Improving Relational and  
Disciplinary Competences by  
Rondine Method  
<https://doi.org/10.37626/GA97839>



Opportunities in the Home

<https://doi.org/10.37626/GA9783959872188.0.034>

First page: 186

Last page: 191 Abstract Home to school engagement has often been a one-way path, with teachers seen as facilitators only.

When schools were forced to rapidly switch to virtual instruction, teachers were suddenly entering kitchens, living rooms and other spaces to deliver virtual instruction.

Findings from this qualitative study of eleven practicing teachers showed new teaching opportunities through virtual home visits. Doors were literally and figuratively opened as teachers became beneficiaries of cultural and academic practices in the home. Math instruction took on a real-world quality, as teachers were privy to home environments for authentic teaching materials. As schools open and teacher, parent, and caregiver relationships return to a more distant space, these

participants described small but significant changes in the way they continued to engage parents and caregivers after the experiences of the virtual home visits.

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===== Grant A. Fraser

Mathematics for Living: A

Course that Focuses on Solving

Problems in Today's World

<https://doi.org/10.37626/GA9783959872188.0.035>

First page: 192

Last page: 195 Abstract The author has developed and taught a course for University students who are not specializing in mathematics, science, or engineering. In contrast to traditional courses of this type, this course focuses on topics from the real world that students will encounter in later life. The aim of the course is to provide students with mathematical tools that they can use to create meaningful, practical solutions to problems that arise in these

topics. Students work individually on projects and present their solutions in class. Other students then critique these solutions. With practice, students develop the skills necessary to analyze more complicated kinds of problems. A final project enables students to use their newly acquired techniques to deal with more realistic problems. The author discusses the content of the course and the impact it has had on students.

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===== Toshiakira Fujii Roles of Quasi-variables in the Process of Discovering Mathematical Propositions

<https://doi.org/10.37626/GA9783959872188.0.036> First page: 196

Last page: 201 Abstract The purpose of this paper is to clarify roles of quasi-variables by focusing on the process of discovering mathematical propositions. For this purpose, the

author analyzed the assignment reports of third-year undergraduate students. As a result, the author found that "looking back" is important in the generalization-oriented inquiry process, but it is not enough. It is important to "re-examine" the found matter and its form of expression from the perspective of a new concept. In the process of "looking back" and "re-examine", it was confirmed from the description of the metacognitive part of the students that the use of quasi-variables clarified the object of consideration and made it easier to clarify which numbers contributed to the generalization and expansion in what sense.

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===== Ben Galluzzo, Katie Kavanagh, Karen Bliss, Michelle Montgomery & Christopher Musco Math Modelling: Common Pitfalls and Paths for Student Success



<https://doi.org/10.37626/GA9783959872188.0.037> First page: 202

Last page: 207 Abstract

Mathematical modelling refers to the process of creating a mathematical representation of a real-world scenario to make a prediction or provide insight.

There is a distinction between applying a formula and the actual creation of a mathematical relationship. Approaching open-ended problems can be challenging for students. In this two part workshop, we first share examples of how students can get off-track while creating models, in particular making choices or assumptions that undermine the solution quality.

In the second part, we demonstrate how to facilitate authentic math modelling so that students can be creative and innovative in the modelling process while having ownership over their solution. Participants will assess real student modelling solutions from Mathworks Math

Modeling Challenge (M3 Challenge), a program of Society for Industrial and Applied Mathematics (SIAM), and discuss ways that they would advise teams towards improvement.

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===== Parker Glynn-Adey & Ami Mamolo Modelling Beauty: Hands-on Experiences in Group Theory

<https://doi.org/10.37626/GA9783959872188.0.038> First page: 208

Last page: 213 Abstract In the 19th century, geometric models were valued as tools for exploring complex mathematics. Quartic surfaces and hyperboloids elaborately modelled with plaster gave access to powerful ideas and brought alive wonderful new mathematics. In this workshop, we explore a diverse set of geometric models that capture mathematical beauty and we showcase how they can be used to bring alive wonderful new-for-students mathematics. We

discuss the value of these experiences for fostering mathematical ways of being that can help disrupt preconceived notions about a homely, rote and rigid nature of mathematics, and capture some of the visual richness of older mathematical models.

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===== Gerald A. Goldin, Lisa B. Warner, Roberta Y. Schorr & Daniel Colaneri Exploring Prospective Mathematics Teachers' Motivating Desires during Group Problem Solving Activity

<https://doi.org/10.37626/GA9783959872188.0.039> First page: 214 Last page: 219 Abstract Earlier research has characterized recurrent patterns of cognition, affect, and behavior during in-the-moment mathematical activity. Each pattern, termed an "engagement structure," is named by a specific motivating desire that evokes it: e.g., Get

The Job Done, I'm Really Into This, Value My Culture, etc. This study explores prospective teachers' motivating desires as they engage in small-group problem solving sessions.

Participants were enrolled in courses required for teaching certification at two eastern U.S. state universities. Based on survey, individual interview, and focus group data, we identify the most frequently occurring desires, their perceived importance and accompanying emotional feelings. We present and discuss some findings briefly, including the motivating desire to Carry My Weight with a team of peers.

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===== John Gordon & Kehinde Emmanuel Adenegan Are Abstract Mathematical Thinkers Born or Can They Be Trained?

<https://doi.org/10.37626/GA9783959872188.0.040> First page: 220

Last page: 224 Abstract Abstract mathematical thinkers in the fields of pure Mathematics and theoretical computer science have contributed significantly to the body of knowledge that has fundamentally altered the course of human civilization and technological advances. This paper explores whether these thinkers are naturally gifted or if there are pedagogical strategies that can be implemented that will bring about the same outcomes. Keywords: Abstract, critical, thinkers, Mathematics

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===== John Gordon  
Reuniting Exponents and Logarithms: Teaching Exponents, Inverse functions, and Logarithms, as one Cohesive Pedagogical Unit

<https://doi.org/10.37626/GA9783959872188.0.041> First page: 225  
Last page: 230 Abstract Exponents, inverse functions, and logarithms are fundamentally

important concepts in almost every branch of technical science. However, they are not taught together as a cohesive, comprehensive, pedagogical unit in many instances. As a result, students lose deep insight into their meaning and applicability. Additionally, particularly in the concept of the inverse function, the richness, and beauty inherent in the concept are reduced to a purely mechanical process. This paper seeks to remedy this situation by outlining a pedagogical strategy that links exponents, inverses, and logarithms together in such a manner as to preserve their natural dependence, coherency, and logic. Keywords: Exponents, inverse, functions, logarithms.

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===== Debra Hydorn  
Infographics to Develop Graphical Literacy  
<https://doi.org/10.37626/GA9783959872188.0.042> First page: 231



understood from the variable-parts perspective. They then worked with piecewise linear functions and step functions to derive key calculus results. A first strand involved division, proportional relationships, slopes of lines, function composition, and the chain rule. A second strand involved multiplication, areas, inversely proportional relationships, and integration by substitution.

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===== Brian L. Johnson & Ioannis Gkigkitzis Interesting Facts about Terminating Decimals

<https://doi.org/10.37626/GA9783959872188.0.044> First page: 243 Last page: 248 Abstract The set of rationals is dense in  $\mathbb{R}$ . In fact, this is even true for the smaller family of terminating decimals. Unlike density ratios in the physical world, this is an absolute property implying that infinitely many such decimals exist in

even the "smallest" intervals we can imagine. However, it is possible to construct this infinite density in an increasing sequence of finite "densities"--starting with the discrete set of integers. While the terminating decimals do not seem to receive as much formal discussion as  $\mathbb{Z}$ ,  $\mathbb{Q}$  and  $\mathbb{R}$ , they are an essential part of the mathematics curriculum, from elementary school through college. Keywords: integers, rational numbers, algebra, density.

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===== Iris DeLoach Johnson Exploring a Collection of Approachable, Stimulating and Thought-Provoking Problems: Face-to-Face or Virtual? Related or not?

<https://doi.org/10.37626/GA9783959872188.0.045> First page: 249 Last page: 253 Abstract Students thrive when engaged in solving problems that they find to be approachable, stimulating, and



observed variables.  
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===== Anna Khalemsky &  
Yelena Stukalin Combining  
Various Data Mining Techniques  
in Binary Classification Teaching  
<https://doi.org/10.37626/GA9783959872188.0.047> First page: 256  
Last page: 260 Abstract Binary  
classification is one of the most  
common data analytics tasks. It  
appears in a wide range of  
applications including finance,  
sociology, psychology, education,  
medicine, and public health. In  
statistical and analytics courses,  
binary classification is usually  
handled by logistic regression.  
Other alternatives, such as  
decision trees, neural networks,  
and Naïve Bayes are not  
commonly taught in traditional  
undergraduate programs. We  
suggest making these  
methodologies accessible as  
alternatives or complementary  
approaches to binary classification.  
We treat the teaching of the

subject as a dynamic process that  
involves the understanding of  
the analytical task, understanding  
terms and concepts, visualizing,  
analyzing, interpreting the  
results, and decision making.  
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===== Richard Kitchen  
Leveraging Pólya’s Heuristic to  
Support Mathematical Reasoning  
and Language Development  
<https://doi.org/10.37626/GA9783959872188.0.048> First page: 261  
Last page: 266 Abstract An  
iteration of an instructional  
framework designed to provide  
emergent bilinguals (EBs) with  
opportunities to simultaneously  
engage in mathematical  
reasoning and learn the language  
of mathematics is illustrated in  
this paper. The “Discursive  
Mathematics Framework” (DMF)  
builds on Pólya’s iconic problem-  
solving heuristic by integrating  
research-based “language  
practices” and essential teaching  
practices. Videotapes and student

work from problem solving lessons were examined using grounded theory methodology to illustrate the development of the DMF. Theoretically, this study contributes to the literature by providing explicit examples of how practices that promote mathematical reasoning and the learning of the language of mathematics can be taught concurrently during problem solving lessons.

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===== Sergiy Klymchuk An Innovative Way of Teaching and Assessing Critical Thinking in Mathematics

<https://doi.org/10.37626/GA9783959872188.0.049> First page: 267 Last page: 272 Abstract This paper deals with the use of deliberately misleading mathematics questions in teaching and assessment as an innovative pedagogical strategy. The intention of using such questions is to enhance students'

critical thinking. Critical thinking is understood here as "examining, questioning, evaluating, and challenging taken-for-granted assumptions about issues and practices" as defined by the New Zealand Ministry of Education. The study is based on a survey of 82 secondary school mathematics teachers who attended introductory workshops on the suggested pedagogical strategy at their regional conferences.

Although the vast majority of the participants (96%) agreed to use such strategy in teaching, only 63% percent of the participants were willing to use it in assesment. Teachers' attitudes are analysed in the paper. Key words: critical thinking, assesment, school mathematics teachers.

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===== Allison M. Kroesch & Albert Otto Magic Throughout the Years

<https://doi.org/10.37626/GA97839>



59872188.0.050 First page: 273  
Last page: 276 Abstract Too often teachers use the word “trick” in their mathematics lessons. There are no tricks in mathematics, but there are explanations for what appears to be a trick. Throughout this paper, we will address this history of magic, including the history of playing cards.

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===== Aradhana Kumari Do not Teach the Symbols in Mathematics, Teach the Meaning of the Symbols

<https://doi.org/10.37626/GA97839>

59872188.0.051 First page: 277  
Last page: 282 Abstract Unnecessary use of symbols in introducing ideas in mathematics makes it difficult to learn. From a student's perspective, these symbols are the hurdle for them to understand the concepts/ideas in mathematics. One example is when we ask students the following: What is the meaning of the square root of a number,

often their reply is the symbol  $\sqrt{\quad}$ . This shows that they did not understand the actual meaning of the square root of a number, which is the number raised to power one-half. I will present many examples and show how we can avoid using unnecessary symbols and teach the ideas and concepts in mathematics.

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===== Sebastian Kuntze, Marita Friesen, Jens Krummenauer, Karen Skilling, Ceneida Fernandez, Pere Ivars, Salvador Llinares, Libuše Samkova & Lulu Healy Support for Mathematics Teachers through Representations of Practice - Vignette-based Approaches in the Project

[coReflect@maths](https://doi.org/10.37626/GA97839)

<https://doi.org/10.37626/GA97839>

59872188.0.052 First page: 283  
Last page: 288 Abstract Teachers' analysis of vignettes can be a key for connecting specific classroom situations with mathematics

education theories. As vignettes are representations of practice with relevance for professional requirements of the mathematics classroom, vignettes also represent or portray meaningful theoretical elements. The use of vignettes in pre-service and in-service teacher professional development needs, however, conceptual and evidencebased exploration. Building on prior work with video, text, and cartoon vignettes, the project coReflect@maths aims at exploring the potentials of vignette-based work both for supporting professional learning and for research into aspects of mathematics teachers' expertise. Key aspects of the project work will be presented.

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Barbara H. Leitherer,  
Pankaj R. Dwarka, Entela K.  
Khane & Jignasa R. Rami  
Undergraduate Research in a 2-  
Year College: Climate Change,

Global Learning, Process and  
Observations  
<https://doi.org/10.37626/GA9783959872188.0.053> First page: 289  
Last page: 294 Abstract In order to thrive and be successful in an increasingly interconnected world, 21st century students require multiple opportunities to engage with global learning (Landorf et al., 2019).

Mathematics faculty guided 2-year college honors students in the US through an independent study analyzing real-world global climate change data supplied by the World Wildlife Fund (WWF). This proposal will elaborate in depth about the undergraduate research process, lessons learned, and observations made. Presenters will reflect on strategies used to support both collaborative and independent learning; how students increased their awareness of climate change as a global problem; how this contributed to students' ownership, success and

enhancement in undergraduate research leading to preparedness for further education and a successful career in science, technology, engineering, and mathematics.

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===== Hadas Levi Gamlieli,  
Alon Pinto & Boris Koichu  
Secondary-Tertiary Transition  
and Effective Ways of Coping  
with it: A Perspective of  
Lecturers

<https://doi.org/10.37626/GA9783959872188.0054> First page: 295

Last page: 300 Abstract The secondary-tertiary transition (STT) in mathematics education is a longstanding concern. This study explores university mathematics lecturers' perspectives on the challenges underlying STT and on the effectiveness of university-level coping measures currently employed. The analysis of 311 responses to an international survey suggests that there is

considerable variability regarding the prevalent perspectives on STT among university lecturers. While most respondents recognized school-related factors, the coping measures they recommended were mainly university-related. The findings stress the need to improve communication, both between university mathematics lecturers and the school mathematics education community, and across universities, for promoting comprehensive initiatives to address STT.

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===== Sigal Levy & Yelena Stukalin  
Introducing Main Statistical Concepts to Non-statisticians

<https://doi.org/10.37626/GA9783959872188.0055> First page: 301

Last page: 303 Abstract In this paper we present and discuss the results of an academic open-end mid-term statistics exam given to high-school teachers qualifying to

teach Mathematics at a matriculation-exam level. The exam focused mainly on defining and understanding key terms and concepts in statistical inference. The purpose of this study is to identify what questions would be good predictors of the overall score, thus indicating a good understanding of statistics. Item analysis showed that the ability to properly define a parameter, state research hypotheses and interpret the findings were more inclined to do well in the exam.

Keywords: Statistical concepts, teaching statistics, non-statisticians

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===== Nicole Lewis, Ryan Andrew Nivens, Jamie Price, Jennifer Price & Anant Godbole  
Pandemic-Driven Mathematical Initiatives within the East Tennessee State University Center of STEM Education

<https://doi.org/10.37626/GA9783959872188.0.056> First page: 304

Last page: 309 Abstract We describe three Mathematics Education initiatives launched as a result of the global pandemic. (i) The Eastman-funded MathElites professional development (PD) program for K-8 teachers was offered online. Teachers were vastly more involved due to their greater autonomy. Old outcomes and those from 2020 will be compared. (ii) ETSU's Governor's School, which offers high school students Statistics and Biology college courses, went online too, and we used Columbia University Virology lessons and Covid19 data sets to make the courses more engaging to students. Student projects were assessed to be of a higher quality than in years past. (iii) With Niswonger Foundation support, we have launched a PD thrust for teachers in 2021, in the new areas of Epidemiology, Artificial Intelligence, and Statistics-with-R.

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===== Po-Hung Liu Students'  
Perceptions of Paradoxes of the  
Infinity  
<https://doi.org/10.37626/GA9783959872188.0.057> First page: 310  
Last page: 315 Abstract Infinity is a significant element for understanding calculus, yet studies consistently suggest that its counter-intuitive nature confused college students. The purpose of this study was to investigate Taiwanese college students' perceptions of paradoxes of the infinity and observe how their perspectives shifted back and forth while facing contradictory facts. It was found the 1-1 correspondence was the most used criterion for comparing the cardinality of infinite sets, which is somewhat different from previous studies, and students' reasoning on Zeno's paradoxes was feeble. The study suggests future research of this line should pay attention to the dialectical process of students'

discourse to detect their core beliefs about the infinity.  
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===== Hong Lu & Xin Chen  
The Relationship between  
Teacher-student Relationship,  
Interest, Self-efficacy and  
Mathematics Achievement –  
Does Gender Play a Role in it?  
<https://doi.org/10.37626/GA9783959872188.0.058> First page: 316  
Last page: 321 Abstract This study compared the mechanism by which the teacher-student relationship (TSR) affects mathematics achievement in different gender groups through interest and self-efficacy in mathematics. The results suggest that (1) in both samples, TSR positively predicted interest and self-efficacy, interest positively predicted self-efficacy, and self-efficacy in turn positively predicted mathematics achievement; (2) Gender differences were also detected; The positive relationships of TSR



Mathematics from the Real Application of Mathematics in our World?  
<https://doi.org/10.37626/GA9783959872188.0.060> First page: 325 Last page: 330 Abstract lessons, more motivation and a more sustainable learning success. Professional mathematical modelling is an important foundation for modern, technology-based societies. We are all significantly influenced by the results of mathematical modelling. The decisions for lock down, masks and travel restrictions in connection with Corona are a current example. This article drafts what we as teachers & researchers can learn about successful mathematical modelling from professional working mathematicians who are using & applying mathematics in the natural sciences, technology development, medicine, economics, social and humanities research & practice, consultancy for politics, the financial world &

other economic sectors). The background for this article is my research on mathematics as a technology, its acceptance as a concept and ways of technology transfer, as well as decades of experience with colleagues from industrial mathematics (<https://www.indmath.uni-linz.ac.at/>) and the RISC (<https://www.jku.at/institut fuer symbolisches rechnen risc/anwendungen/risc-software-gmbh/>) who started their work here in Linz a long time ago. As a co-founder and co-organizer, I organized and enjoyed many lectures on mathematics and society, industrial mathematics, etc. at the Johannes Kepler Symposium (<https://www.numa.unilinz.ac.at/JKS/2020/>)  
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===== Jodelle S. W. Magner & Susan McMillen Making Word Problems Accessible to All: Innovating through Meaningful

Models

<https://doi.org/10.37626/GA9783959872188.0.061> First page: 331  
 Last page: 332 Abstract Working with a large urban district over 14 years of Mathematics Science Partnership [MSP] grants, over 500 teachers of mathematics, special education teachers, mathematics coaches and administrators have come together to create engaging mathematics within grade 3 through 12 classrooms. Workshop participants will engage with an innovative use of a mathematical model and learn how it makes mathematics more accessible to students at all levels, especially to English Language Learners. Workshop participants will experience the use of the model in a variety of problem-solving contexts. Obstacles to teachers adopting these materials to use within their instruction and strategies used to overcome these challenges will be discussed.

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===== Rafael Alberto Méndez-Romero & María Angélica Suavita-Ramírez The mINNGa Labs: an Initiative of the Universidad del Rosario to Strengthen STEM Skills, Social Sensitivity and Youth Empowerment in Colombia  
<https://doi.org/10.37626/GA9783959872188.0.062> First page: 333  
 Last page: 337 Abstract The challenge of educating the generation of the digital age leads us to resort to pedagogical innovations that are sensitive, empathetic, analytical and multidisciplinary in nature. Additionally, these new student communities are characterized by appropriating causes, mobilize, manifest and are genuinely curious, which confronts us as educators with a greater and fascinating challenge. On the other hand, the historical moment of Colombia forces us to seek the unity of the country and generate a sum of forces from the



specific talents of the people in the regions, to solve, as a body, the emerging needs of the moment. In this article we show a technological pedagogical innovation designed at the Universidad del Rosario, which is based on strengthening STEM skills and youth empowerment through the use of our mINNGa labs, a version of a living laboratory as a social an open innovation.

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===== Jennifer Missen A

Process for Updating  
Mathematics Teaching for 21st  
Century Students

<https://doi.org/10.37626/GA9783959872188.0.063> First page: 338

Last page: 343 Abstract It is inevitable and necessary that the curriculum, pedagogy, and school and classroom structures for the teaching of Mathematics will continue to change over the next 30 years. However, teachers are time poor, there are more and

more who are teaching Mathematics when it is not their primary content area, and who may have knowledge of Mathematics but not the current pedagogical knowledge. Early career teachers need support in building a portfolio of tools and resources that work for them and their students. Experienced, traditional teachers are more comfortable with direct teaching and mastery practice and, understandably, are resistant to change. Inquiry based teaching and collaborative strategies, differentiated and tailored for the class and its individuals, combined with direct teaching and mastery practice, allow for greater equity and increased preparation of students for the ever-changing workforce. This two part workshop has participants work through the process of transitioning existing, traditional or textbook units of work to flexible, differentiated units with enough detail and

resources to support any teacher to walk into the classroom knowing that they will serve all the students well.

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===== Shelby Morge & Christopher Gordon Using Squeak Etoys to Model Mathematical Ideas

<https://doi.org/10.37626/GA9783959872188.0.064> First page: 344

Last page: 349 Abstract Effective mathematics instruction involves students in making sense of mathematical ideas and reasoning mathematically (NCTM, 2014).

Unfortunately for many US students in grades 6-8 (ages 10-14), mathematics is a repeat of topics learned in elementary school with an emphasis on computation. For this reason, students start to see mathematics as something that is hard to understand and not enjoyable. In this workshop, we share how a technology tool, Squeak Etoys, was used in a lesson to engage

grade 6-8 students in discovering the relationship between the number of sides and the angle measure in regular polygons. We describe a lesson implementation and engage participants in the development of a Squeak Etoys computer model. In addition, conclusions related to mathematics instructional practices are shared. Key words: Squeak Etoys, modeling, problem solving, lesson, geometry, polygons

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===== Janina Morska New Methods and Forms of Work during Online Maths Lessons <https://doi.org/10.37626/GA9783959872188.0.065>

First page: 350 Last page: 353 Abstract In more than 38 years as a mathematics teacher, I have always tried to look for interesting methods and new forms of work. I wondered how to explain the new material to students so that they would understand and be able to use the

information in the future. The previous school year has been a huge challenge in the field of distance learning. From October 2020 to May 2021, all teachers in Poland conducted Online lessons. As a result, we had to switch from traditional classroom teaching to online teaching. So I decided to look for appropriate tools and solutions of how to conduct such lessons. Keywords: online learning, distance learning, applications, computer programs, teaching materials, virtual notes, IT tools, online mathematics.

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===== Patricia S. Moyer-  
Packenham Relationships among  
Semiotic Representational  
Transformations and Math  
Outcomes in Digital Games  
<https://doi.org/10.37626/GA9783959872188.0.066> First page: 354  
Last page: 354

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===== Svenja Müller & Anna  
Fath-Streb Risk Literacy in the  
Context of Stochastics and  
Mathematical Education  
<https://doi.org/10.37626/GA9783959872188.0.067> First page: 355  
Last page: 360 Abstract The  
purpose of this risk literacy study  
was to explore the ways of  
integrating examples of global  
challenges into mathematics  
education. The examples follow  
an approach to introduce risk  
literacy in teacher education  
along with a curriculum analysis  
for secondary education in  
Germany to include risk literacy  
within the given requirements  
and constraints. Two main  
examples, microplastic pollution  
and extreme events due to  
climate change, are analysed in  
the interdisciplinary context of  
global challenges and their  
understanding of mathematical  
knowledge for teaching and  
learning stochastics.

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M. Estela Navarro  
Robles Elementary Teachers  
Reaching a Quasi-complete  
Knowledge of Rational Numbers  
through an Online Course  
<https://doi.org/10.37626/GA9783959872188.0.068> First page: 361  
Last page: 366 Abstract There is  
evidence that most of the  
Elementary Teachers in Mexico  
have various conceptual  
deficiencies in their knowledge  
about rational numbers; however,  
the deficiencies were not the  
same in all the cases. So, we  
decided to design a non-  
traditional-personalized online  
course, constructed as an  
adaptative system, in which it  
was identified if the participant  
covered each one of the different  
conceptual approaches in various  
contexts. When it was identified  
that a conceptual approach was  
not covered, interactive materials  
and videos were presented to  
them that allowed them to  
understand what they had not  
covered. The aim of the course is

to enable teachers to reach a  
quasicomplete conceptualization,  
whose meaning for us it is to  
understand the topic from  
different conceptual approaches  
in a deep way. This paper  
presents the structure of one  
module of the course, one  
detailed example, and results of  
the pilot test of this module.  
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Benita P. Nel Noticing  
through Self-reflection by  
Mathematics Teachers using  
Video Stimulated Recall  
<https://doi.org/10.37626/GA9783959872188.0.069> First page: 367  
Last page: 372 Abstract  
Continuous professional  
development should be navigated  
in a teacher's own context,  
addressing their particular needs  
where timeous feedback can be  
of great benefit. However, the  
major teachers' union in South  
Africa hindered government  
officials to enter the classroom,  
limiting support. Most

professional development (PD) initiatives are thus off-site and not always customised to the needs of the individual teacher. In this study, the use of Video-stimulated recall (VSR) was used as a PD tool where self-reflection is foregrounded, reporting on one teacher. The research question was: What did the teachers notice and act upon when VSR was incorporated as a PD amongst mathematics teachers? Through Mason's discipline of noticing the teacher's noticing was investigated. Key Words: Video-stimulated recall, Mathematics education; continuous professional development; teacher noticing; in-house setting

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===== Zanele Ngcobo  
Evoking School Mathematical Knowledge among Preservice Secondary Mathematics Teachers through Error Analysis  
<https://doi.org/10.37626/GA9783959872188.0.070> First page: 373

Last page: 373 Abstract This article explores how attention to Specialised Content Knowledge (SCK) could evoke the development of school mathematics concepts among pre-service mathematics teachers (PSMTs). At the heart of the repeated debate about the delivery of professional mathematics teacher education curricula has been the reported lack of development of PSMTs knowledge for teaching. However, discussion of what mathematical knowledge for teaching is needed by PSMTs and how it should be developed had been uneven. In South Africa, attention to improving the status quo of learners' poor performances in mathematics has been directed toward improving in-service teachers' mathematical knowledge for teaching. However, research has shown that the problem does not only emerge when teachers become practitioners. The problem of low

levels performance and of understanding of school mathematics by pre-service teachers has been identified by many studies but is often not addressed during teacher training. This article explores an under-examined strategy for addressing the repeated concerns about the quality of pre-service mathematics teachers' education. It examines how attention to specialised content knowledge (SCK) within a preservice teacher education curriculum could potentially influence deeper quality mathematical knowledge to pre-service mathematics teachers' professionalism. This is a qualitative study conducted in 2018 and 2019. Data was generated from (n=61) PSMTs that were enrolled for Bachelor of Education majoring in mathematics. Data was conducted using written task, open ended questionnaires and focus group interviews. The findings from

this small-scale study showed that error analysis has the potential to influence the development of SMK. Furthermore, findings suggest that attention to SCK has the potential to evoke school mathematics concepts and the evolution of subject matter knowledge. Based on the findings it is recommended that future research should be conducted to determine the veracity of these conclusions and their generalization to other mathematical topics. Considering the suggestions made by in literature that the description of knowledge is only valid at the time of the investigation, there is a need of large scale to ascertain the effect of error analysis toward the development of PSMTs' SMK of other school mathematics topics. Keywords: Error analysis, Pre-service mathematics teachers, Specialised Content Knowledge.

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Jenna O'Dell & Todd  
Frauenholtz Recruiting  
Mathematics and Mathematics  
Education Majors to a University  
<https://doi.org/10.37626/GA9783959872188.0.071> First page: 374  
Last page: 377 Abstract This  
paper will present strategies used  
to recruit students to a four-year  
university to complete a double  
major in mathematics and  
mathematics education, then  
enter the teaching field. The  
recruiters are two professors who  
work in both the Mathematics  
and Education departments at a  
university in the United States.  
The mathematics department has  
been especially supportive of the  
initiative as it will double the  
number of mathematics majors in  
their programs for two years  
from four to nine students. The  
recruiting included contacting  
community colleges, professional  
organizations, word of mouth, the  
university marketing  
department, and visits to  
collegiate mathematics classrooms

at the level of calculus and above.  
This project was supported by  
The National Science Foundation  
(NSF) as a Noyce project and will  
support students financially with  
full cost of attendance for the  
final two years of the four-year  
program.

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Elizabeth Oldham &  
Aibhín Bray Undergraduate  
Mathematics Students'  
Reflections on School  
Mathematics Curricula after a  
Major Curriculum Change in  
Ireland  
<https://doi.org/10.37626/GA9783959872188.0.072> First page: 378  
Last page: 383 Abstract After  
decades in which the Irish post-  
primary (grades 7-12)  
mathematics curriculum changed  
incrementally, a major  
innovation project was approved  
in 2008, and a "reform"-type  
curriculum was phased in over  
several years. The project was  
controversial, and some students







been tested with the new screening, one month after starting school.

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===== Maria Piccione & Francesca Ricci The Importance of Early Developing Symbol-sense

<https://doi.org/10.37626/GA9783959872188.0.076> First page: 401

Last page: 406 Abstract In this paper we deal with the mathematical-objects symbolic representation, as a relevant educational problem. In particular, we refer to the semiotic approach, a teaching model caring the distinction among sign-meaning-sense, proposing its adoption since the very beginning of the school experience. Focusing on the development of symbol-sense means sharing relational learning principles, reconsidering usual instrumental learning ways. We aim at promoting students' awareness in managing

mathematical language, taking into account its widespread weakness, also shown by our investigation. Awareness is a powerful mental attitude which enables facing difficulties and generating a proper conception of what mathematics and doing mathematics really are, then enhancing affect.

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===== Maria Piccione & Francesca Ricci Activities and tools for Early Developing Symbol-sense

<https://doi.org/10.37626/GA9783959872188.0.077> First page: 407

Last page: 412 Abstract This work deals with practical aspects of semiotic and relational approaches in teaching/learning. It is based on the Early Algebra principle by which mental models of algebraic thought can be constructed starting with Primary School, by teaching Arithmetic "algebraically". Here, the problem of the symbolic

representation of mathematical objects is tackled. The aim is to allow students to clearly distinguish between the two worlds - the one of signs and the one of meanings - and to use signs of mathematical language with full awareness rather than just manipulating them. We present activities and tools which take into consideration different semiotic fields (gestural, iconic, natural, ...) to achieve the mathematical field.

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===== Shelley B. Poole The  
"Yes, and..." Approach to  
Teaching Mathematical  
Modelling

<https://doi.org/10.37626/GA9783959872188.0.078> First page: 413

Last page: 417 Abstract  
Mathematical modelling can be a particularly creative tool when students are asked to solve open-ended problems. As instructors, when implementing mathematical modelling in the

classroom, we can build on the ideas of our students. Utilizing the concept of "yes, and..." from improvisational theatre, we can foster students' creativity and empower them to take ownership of the mathematics when solving open-ended problems. Using this approach allows us an opportunity to let go of the structure of old and embrace new approaches and ideas in the classroom.

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===== Jordan T. Register &  
Christian H. Andersson  
Analysing PSTs Ethical  
Reasoning in a Data Driven  
World

<https://doi.org/10.37626/GA9783959872188.0.079> First page: 418

Last page: 423 Abstract The prevalence of Big Data Analytics as a proxy for human decision-making processes in globalized society, has catalyzed a call for the modernization of the mathematics curriculum to

promote data literacy and ethical reasoning. To support this initiative, ten preservice mathematics teachers (PSTs) in Sweden (SWE) and the United States (US) were interviewed to identify what ethical considerations preservice teachers (PSTs) make in their mathematical analyses of data science contexts. Preliminary results indicate that teachers make a myriad of ethical considerations in their mathematical work that are tied to their critical mathematics consciousness (CMC), conceptions of data literacy, and experiences. As a result, it is imperative that educators simultaneously design educational curricula to foster students' CMC and work to transform teacher held definitions of data literacy to reflect changes brought on by globalization.

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===== Sarah A. Roberts,

Cameron Dexter Torti & Julie A. Bianchini A Mathematics Specialist Supporting District Shifts in Instruction for Multilingual Learners through Studio Days  
<https://doi.org/10.37626/GA9783959872188.0.080> First page: 424 Last page: 428 Abstract  
Mathematics specialists fill a gap in providing individualized professional learning for classroom teachers, including furnishing much needed professional learning related to multilingual learners. This qualitative study examines the role a secondary district mathematics specialist in the United States played in supporting shifts in instruction for multilingual learners through the enactment of studio days professional learning. Interviews across two years with a mathematics specialist were examined. Using a framework of multilingual learner principles and adaptive reasoning, we share



classes being taught by early adopters. Overall, students rated the quality of classes using project materials to be high. However, underrepresented ethnic minority students were somewhat less positive than other students and all students were less positive about the alignment of course content with course assessments than they were about other aspects of the course design.

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Ann-Sofi Røj-Lindberg  
Trends in Mathematics Education  
in Finland

<https://doi.org/10.37626/GA9783959872188.0.083> First page: 439

Last page: 444 Abstract Since PISA 2000 there has been a huge international interest towards education in Finland. Are there particular explanations to the PISA-success, a philosophers' stone, to be found? Is it possible to export innovative components found in Finnish schools to other countries and what exactly are

these components? Is it about accessibility? Can the successful components be noticed and described? And why has the Finnish PISA-results in mathematics dropped lately? Questions like these have been asked over the years. In the paper I discuss trends in the Finnish public schooling that I find to be of particular importance and highlight changes in the curriculum and trends in mathematics education generally. I connect my arguments to research findings as well as to anecdotal stories.

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Sheena Rughubar-Reddy & Emma Engers Video Tutorials and Quick Response Codes to Assist Mathematical Literacy Students in a Non-classroom Environment

<https://doi.org/10.37626/GA9783959872188.0.084> First page: 445

Last page: 450 Abstract This paper discusses effectiveness of

video tutorials, accessed via Quick Response codes, on Grade 10 mathematical literacy students' ability to complete their homework. To assist them outside of the classroom, an intervention involving video tutorials explaining specific sections of work and how to go about solving problems, was devised. Students could access the relevant tutorials on a mobile device via the scanning of barcodes provided on the worksheets. The effectiveness of the intervention was assessed both quantitatively and qualitatively, through analysis of the participating students' homework submissions and interviews with the students after the intervention had ended. Feedback from students via focus group interviews and questionnaires revealed that they found the tutorials helpful. This would indicate that the intervention was potentially beneficial. Keywords: Quick

Response codes, video tutorials, homework.  
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===== Sheryl J. Rushton,  
Melina Alexander & Shirley Dawson Mathematics to Teacher Education Persistence  
<https://doi.org/10.37626/GA9783959872188.0.085> First page: 451  
Last page: 456 Abstract In 2017, a university in Northern Utah's Teacher Education and Mathematics Departments moved from a two-course mathematics requirement to incorporate a three-course mathematics requirement for Elementary and Special Education Teacher Education majors to satisfy university and Utah State Board of Education Quantitative Literacy graduation requirements. The proposed research seeks to determine how persistence rates differ from the original two-course math series to the new three-course destination series.

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===== Robyn Ruttenberg-  
Rozen In-the-Moment  
Narratives: Interventions with  
Learners Experiencing  
Mathematics Difficulties  
<https://doi.org/10.37626/GA9783959872188.0.086> First page: 457  
Last page: 462 Abstract Despite a  
significant amount of planning, so  
much of what occurs in  
mathematics teaching and  
learning intervention  
interactions, for both teacher and  
learner, are based on fleeting in-  
the-moment decisions and  
responses. At the root of these in-  
the-moment interactions are  
narratives that position the  
learner, teacher, and  
mathematics. In this paper I  
explore the interplay between  
in-the-moment decisions and  
responses, narratives, and  
positioning within a  
mathematical intervention for a  
learner experiencing  
mathematics difficulties. I use

data from a mathematics  
intervention study of learners  
experiencing mathematics  
difficulties to show that  
interventions in mathematics can  
be a reciprocal and partnered  
activity. Importantly, since these  
narratives emerge in the  
reciprocal space of an  
intervention, narratives also  
evolve through the interaction.

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===== Tanishq Kumar Sah  
Extension of Theories  
<https://doi.org/10.37626/GA9783959872188.0.087> First page: 463  
Last page: 465 Abstract From an  
atom to this universe, from a  
bowl of water to the cosmic ocean  
this constant is present  
everywhere. This constant is  $\pi$  (  
periodicity of the tangent  
function). For tangent function  
we know that  $\tan(\tan^{-1}(x))=x$ ,  
but the expression  $\tan(n\tan^{-1}(x))$   
looks very complicated but is  
actually an expression of the type  
polynomial divided by another



polynomial. The sine function is very important not only for graphs but for geometry too. There are some inputs whose behavior is very strange from the usual ones. Geometrical shapes and their relations are very important for many thing such as for vectors and many more but the triangle is very special because it is the least sided polygon. Riemann zeta function is very crucial for prime numbers. Infinite series related to them may be a game changer for it. Wallis's integral formula is a boon but its domain is very constrained and needs another solution to it.

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Ishola A. Salami & Temitope O. Ajani Mathematics Songs to Hip-hop Music: Power to Engage Pupils and Improve Learning Outcomes in Primary Mathematics

<https://doi.org/10.37626/GA9783959872188.0.088> First page: 466

Last page: 471 Abstract Song-based strategy has been one of the most effective approaches of making learners remembering rule-governed educational contents like that of Mathematics. But the extent to which learners enjoy Mathematics songs and get engaged in it within and outside the school system is limited. Besides, many of the available Mathematics songs are for preschool while research studies have shown that learners' scores in Mathematics started to decline from Primary IV class. One of the music types children love most is hip-hop and they easily memorize the lyrics. This led to the production of Mathematics hip-hop music with its lyrics being Mathematics principles, ideas, formulae and procedures for upper primary classes. This study determines the effectiveness of Mathematics Hip-hop music on improved Mathematics learning outcomes. Keywords: Hip-hop music,

MATMUSIC, Upper primary  
Mathematics.

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S R Santhanam  
Teaching Mathematics using  
Storytelling and Technology  
<https://doi.org/10.37626/GA9783959872188.0089> First page: 472

Last page: 475 Abstract  
Storytelling coupled with  
technology is an attractive  
method to teach geometry. The  
following story was told to a set  
of students of the age group 14 –  
16 years, who are familiar with  
the GeoGebra software. A pirate  
hid his treasures in an island and  
left a note for the treasure hunt  
to his son. The instructions are as  
follows. “Find two palm trees in  
the island with markings of a  
heart (♥) on them. There will be  
a very small pond near them.  
From the pond go to one palm  
tree and turn 90 degrees and  
proceed equal distance to mark a  
point P on the ground. Do the  
same for the second palm tree to

get another point Q. The treasure  
is hidden at the midpoint of PQ”.

When his son went there, he  
could find the two palm trees but  
there was no pond nearby. But  
with his geometric knowledge,  
he could find the treasure. How?  
The students tried and some  
found the solution. In this short  
paper, this is discussed.

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Ipek Saralar-Aras &  
Betul Esen Designing Lessons for  
the 5th Graders through a Design  
Study on Teaching Polygons  
<https://doi.org/10.37626/GA9783959872188.0090> First page: 476

Last page: 481 Abstract It has  
been argued by researchers that  
learning about polygons is  
important. Student performance  
on polygons, particularly at the  
middle school level, was found to  
be lower than expected. Thus,  
this paper presents brief  
summaries of RETA-based lesson  
plans on polygons. The RETA is  
a maths model, which supports

realistic, exploratory, technology-enhanced and active lessons. The participants of the study were 60 middle school students. Data was collected through lesson recordings of 5 lessons, pre-tests and post-tests to measure students' performance on polygons, lesson evaluation forms and interviews. The findings show that students found the RETA-based lessons engaging but some of the parts were difficult for them. The lesson plans presented in this paper were the 2nd version of the plans, amended after the 1st cycle of designbased research. It is hoped that the lesson plans set an example for teachers and teacher candidates.

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Stephanie Sheehan-Braine & Irina Lyublinskaya A Framework for Online Problem-Based Learning for Mathematics Educators

<https://doi.org/10.37626/GA97839>

59872188.0091 First page: 482  
Last page: 487 Abstract Research shows that problem-based learning (PBL) has the capacity to make mathematics culturally relevant, so there is a need to adapt this successful learning model to virtual environments.

This study proposes the Framework for Online Problem-Based Learning for Educators (OnPBL-E) to add this challenge. The content components of the OnPBL-E framework were developed by unpacking PBL instructional principles and identifying interactions between the essential elements of PBL: the context, the educator, and the learner. Then, the Multimodal Model for Online Education was used to identify online modules for these interactions. This study also describes an example of implementing PBL in an online mathematics modeling course.

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M. Vali Siadat

Keystone Model of Teaching and Learning in Mathematics

<https://doi.org/10.37626/GA9783959872188.0.092> First page: 488

Last page: 493 Introduction

Keystone model presents a holistic approach to math education at the college. It is a dynamic system of frequently assessing student learning and adjusting teaching practices. Its philosophy is based on the belief that all students can learn mathematics provided they are engaged in the learning process. Keystone views classroom as a learning community where through peer-to peer interaction and cooperation, all students achieve. Contrary to other programs that put the students in competition with one another, essentially pitting them against each other for grades, our program challenges students to cooperate so that all attain the standards of excellence. Keystone is an alternative model to traditional educational practices

and its basic principles should be applicable to all disciplines.

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===== Parmjit Singh, Nurul

Akma Md Nasir & Teoh Sian

Hoon The Dearth of

Development in Mathematical

Thinking Among High School

Leavers

<https://doi.org/10.37626/GA9783959872188.0.093> First page: 494

Last page: 499 Abstract The

prime rationale of the high school

math curriculum is to develop

the intellectual mind of learners

who can think and apply learnt

content into solving problems of

different areas of learning. Thus,

to assess this context, a

mixedmethod approach was

undertaken to assess the levels of

the 640 High school leavers’

mathematical thinking acumen

in the context of their

preparation in facing the

challenges of tertiary level. The

findings depict low-level

mathematical thinking

attainment regarding their dearth in critical thinking and creative thinking to solve higher-order thinking tasks. They lack a heuristics repertoire to use their contextual knowledge in solving fundamental nonroutine problems. This then begs the question: how are these students to face the upcoming hurdles and challenges bound to be thrown their way at the tertiary level?

Keywords: Mathematical thinking, problem solving, non-routine, heuristics

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===== Praneetha Singh  
Mathovation- Creativity and Innovation in the Mathematics Classroom

<https://doi.org/10.37626/GA9783959872188.0.094> First page: 500

Last page: 505 Abstract The 21st century is predicted as the century of rapid development in all aspects of life. People are creative, but the degree of

creativity is different (Solso, 1995). The perspective of mathematical creative thinking expressed by experts such as Gotoh (2004) and Krulik and Rudnick (1999) refer to a combination of logical and divergent thinking, which is based on intuition but has a conscious aim and process. This thinking is based on flexibility, fluency and the uniqueness of mathematical problem solving. This paper will aim to assist the readers to find out the competencies that are required to assess the creative thinking ability and characteristic of mathematical problems that can be used in creative thinking.

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===== Charles Raymond Smith & Cyril Julie Towards Understanding Integrating Digital Technologies in the Mathematics Classroom  
<https://doi.org/10.37626/GA9783959872188.0.095> First page: 506

Last page: 511 Abstract In the context of ICT integration, a presentation by a teacher during a continuing professional development session is analyzed from the instrumental orchestration as well as the Technological Pedagogical (And) Content Knowledge (TPACK) perspective. The results indicate that some of the components of instrumental orchestration were used by the teacher during the presentation. In realising these orchestrations, the teacher had to delve into the different knowledge components that constitute TPACK. It is concluded that CPD providers need to take such complexities into account when delivering training programs. Keywords: GeoGebra, ICT integration, instrumental orchestration, TPACK, mathematics teacher practices

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===== Panagiotis Stefanides

“Generator Polyhedron”, Icosahedron Non-Regular, Discovered Invention <https://doi.org/10.37626/GA9783959872188.0.096> First page: 512 Last page: 517 Abstract The Invented [2017] Polyhedron, is a Non-Regular Icosahedron, it has 12 Isosceli triangles and 8 Equilateral ones. Its Skeleton Structure consists of 3 Parallelogramme Planes Orthogonal to each other, with sides’ ratios based on the Square Root of the Golden Number [ratios of  $4/\pi$  specially for  $\pi = 4/T = 3.14460551\dots$ , where T is the Square Root of the Golden Number ( $\sqrt{\Phi}$ ) equal to 1.27201965..] and related directly to the Icosahedron, whose structure is based on the Golden Number and to the Dodecahedron, whose structure is based on the Square of the Golden Number. Its geometry relates to Plato’s Timaeus “Most Beautiful Triangle”, a proposed theorization by the author

[“contra” the standard usual International interpretations], presented to various national and international conferences [the Magirus/ Kepler one is a constituent part of this triangle, similar to it, but not the same with it].

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===== Michelle Stephan & David Pugalee The Future of Mathematics Education in the Digital Age  
<https://doi.org/10.37626/GA9783959872188.0.097> First page: 518 Last page: 521 Abstract How do the mathematics content and processes taught in school today need to change in order to prepare students for participation in the digital and information age? We propose to stimulate a discussion about what mathematics education should aim for in preparing students for employment and local/global citizenship in this ever-changing technological world. Our group

will develop a forward-minded agenda on implementation of mathematics content and practices. This will include detailing 1) what content/practices should be kept, changed or deleted from the curriculum, 2) potential impediments to teachers implementing them and possible strategies to address these, and 3) necessary research projects to study implementations in order to make ongoing recommendations. We will aim to start with middle school (ages 12-15) with a vision to continue this working group through multiple conferences.

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===== Yelena Stukalin & Sigal Levy Introducing Probability Theory to Ultra-Orthodox Jewish Students by Examples from the Bible and Ancient Scripts  
<https://doi.org/10.37626/GA9783959872188.0.098> First page: 522

Last page: 525 Abstract Cultural diversity in the classroom may motivate teachers to seek examples that reflect their students' cultural backgrounds, thus making the course material more appealing and understandable. In this context, the Holy Bible is a source of many stories and anecdotes that may be included in teaching probability theory to even ultra-Orthodox Jews. This paper aims to demonstrate the use of stories from the Bible to introduce some concepts in probability. We believe that this approach will make learning probability and statistics more understandable to the Ultra-Orthodox students and increase their motivation to engage in their studies.

Keywords: cultural diversity, biblical examples, non-statisticians

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===== Emily K. Suh, Lisa Hoffman & Alan Zollman  
STEM SMART: Five Essential Life

Skills Students Need for their Future  
<https://doi.org/10.37626/GA9783959872188.0.099> First page: 526  
Last page: 530 Abstract To be successful in a future STEM-focused world, students need to know more than content: students need to be STEM SMART. A STEM SMART student has the mindset of an intellectual risk taker, the tenacity to tackle tough problems while learning from mistakes, and the critical thinking skills to separate scientific information from opinions and beliefs. We use the SMART acronym (Struggle, Mistakes, All, Risk, Think) to introduce five essential life skills not obviously related to STEM (Science, Technology, Engineering, and Mathematics) disciplines but necessary for success in STEM. For each of our five essential skills, we provide an explanation of its importance, connections to relevant educational research, and real-





statistics on students. On the other hand, statistics for the academic staff reveal that the department is clearly male dominated, thus stirring the discussion of gender preferences and systemic gender bias. Our findings support the notion that the institutional change currently taking place across departments and academic communities worldwide is yet to come to fruition and considerable effort is needed in order to bridge the gender gap in science, technology, engineering and mathematics (STEM) courses.

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===== Ching-Yu Tseng, Paul Foster, Jake Klinkert, Elizabeth Adams, Corey Clark, Eric C. Larson & Leanne Ketterlin-Geller Using Cognitive Walkthroughs to Evaluate the Students' Computational Thinking during Gameplay <https://doi.org/10.37626/GA9783959872188.0.102> First page: 542

Last page: 547 Abstract In this paper, we describe how a team of multidisciplinary researchers, including game designers, computer scientists, and learning scientists, created a learning environment focused on computational thinking using a commercial video game Minecraft. The learning environment includes a Minecraft mod, a custom companion application, and a learning management system integration. The team designed the learning environment for students in Grades 6-8. Working with a group of educators, the researchers identified eleven high-priority Computer Science Teacher Association (CSTA) standards to guide game development. The team decomposed the standards into essential knowledge, skills, and abilities. In this study, we describe how we used a cognitive walkthrough with a middle school student to

investigate: (a) the ways in which the game supports student learning (b) the barriers to learning, and (c) the necessary changes to facilitate learning.

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===== Ariana-Stanca Vacaretu  
GROWE in Math

<https://doi.org/10.37626/GA9783959872188.0.103> First page: 548

Last page: 553 Abstract Getting Readers on the Wavelength of Emotions (GROWE) is an Erasmus+ project initiated with the aim to develop all (including math) teachers' competences to address students' literacy and emotional learning needs. The GROWE classroom approach includes meaningful reading and writing learning activities and develops mastery of such strategies using diverse authentic texts (i.e. not `clean` textbook texts), while learning the discipline. Simultaneously, the students enhance their social-emotional skills by learning to

recognise and manage their emotions, establish positive relationships, and make responsible decisions. This paper presents my experience in implementing the GROWE approach in my maths lessons with high-school students: the authentic texts I used and related tasks, and some implementation results.

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===== Shin Watanabe & Takako Aoki In School and Out School

<https://doi.org/10.37626/GA9783959872188.0.104> First page: 554

Last page: 559 Abstract Currently, learning in developed countries is centred on school education. It is not only Japanese teachers who regret that few students enjoy learning mathematics under the current school system. And in the age of 100 years of life, everyone should continue to study academics even after graduating from school.





number sense language (decomposition of numbers, fluency and flexibility with numbers, and mathematical properties).

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===== Ryan G. Zonnefeld & Valorie L. Zonnefeld Rural STEM Teachers: An Oasis in the Desert

<https://doi.org/10.37626/GA9783959872188.0.108> First page: 574

Last page: 579 Abstract Teacher preparation programs for STEM education should prepare teachers for all settings, including rural schools. Students across

geographic locales show equal interest in STEM fields, but rural students often lack access to highly qualified STEM teachers. UNESCO (2014) notes that the

disparity in education between rural and urban schools is a concern of many countries. In the United States, the National Center for Educational Statistics confirms that twenty percent of

students are educated in rural schools and the STEM teachers in these schools are often the only STEM expert. These teachers become backbone teachers that set the foundation and direction of STEM education in the entire school. This paper reviews the landscape of STEM education in rural schools, explores strategies for ensuring high-quality STEM education in rural schools, and outlines early successes of a university teacher preparation program in meeting these needs.

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===== Valorie L. Zonnefeld Pedagogies that Foster a Growth Mindset Towards Mathematics

<https://doi.org/10.37626/GA9783959872188.0.109> First page: 580

Last page: 584 Abstract Research demonstrates that a student's mindset plays an important role in achievement and that mindsets are domain specific.

Carol Dweck claimed that mathematics needs a mindset

makeover and has shown that teachers can foster a growth mindset through their pedagogical choices. This paper shares how one university trains preservice teachers in mathematics pedagogies that are key to fostering a growth mindset. These practices include educating students on brain function, equitable access, metacognition strategies, feedback practices, the importance of productive struggle, and learning from mistakes.

Eureka Math Grade 1 Study Guide - Great Minds 2015-09-18  
Eureka Math is a comprehensive, content-rich PreK–12 curriculum that follows the focus and coherence of the Common Core State Standards in Mathematics (CCSSM) and carefully sequences the mathematical progressions into expertly crafted instructional modules. The companion Study Guides to Eureka Math gather

the key components of the curriculum for each grade into a single location, unpacking the standards in detail so that both users and non-users of Eureka Math can benefit equally from the content presented. Each of the Eureka Math Curriculum Study Guides includes narratives that provide educators with an overview of what students should be learning throughout the year, information on alignment to the instructional shifts and the standards, design of curricular components, approaches to differentiated instruction, and descriptions of mathematical models. The Study Guides can serve as either a self-study professional development resource or as the basis for a deep group study of the standards for a particular grade. For teachers who are new to the classroom or the standards, the Study Guides introduce them not only to Eureka Math but also to the content of the grade level in a

way they will find manageable and useful. Teachers familiar with the Eureka Math curriculum will also find this resource valuable as it allows for a meaningful study of the grade level content in a way that highlights the coherence between modules and topics. The Study Guides allow teachers to obtain a firm grasp on what it is that students should master during the year. The Eureka Math Curriculum Study Guide, Grade 1 provides an overview of all of the Grade 1 modules, including Sums and Differences to 10; Introduction to Place Value Through Addition and Subtraction Within 20; Ordering and Comparing Length Measurements as Numbers; Place Value, Comparison, Addition and Subtraction to 40; Identifying, Composing, and Partitioning Shapes; and Place Value, Comparison, Addition and Subtraction to 100.

*Guide to Math Materials* - Phyllis

J. Perry 1997

Do the new math standards have you scrambling? Have you been searching for pattern blocks, multilink cubes, prisms, tangrams, or puzzles to use in your next lesson? Do you want to know where to find the best calculators, math books, games, reproducibles, toys, or other math materials? You'll find math resources quickly and easily with Perry's new guide! Organized by such topics as problem solving, estimation, number sense and numeration, and geometry and spatial relationships, this book shows you where to find the manipulatives and materials you need to support the new NCTM standards. Each product is briefly described along with its classroom applications. Materials of exceptional quality and value are indicated. Even the addresses of publishers and suppliers are given. If you're looking for ways to make the implementation of the standards easier, you'll want



this book. It's a great resource and a real time-saver!

**The Official ACT Prep Guide 2021-2022, (Book + 6 Practice Tests + Bonus Online Content) -**  
ACT 2021-04-20

THE OFFICIAL ACT® PREP GUIDE 2021-2022 The comprehensive guide to the 2021-2022 ACT® test, with 6 genuine, full-length practice tests in print and online. This 2021-2022 guide includes six actual ACT® tests – all of which contain the optional writing test – that you can use to practice at your own pace. To help you review test subjects and improve your understanding, this guide provides clear explanations for every answer. You'll also get practical tips for boosting your score on the English, math, reading, and science tests, as well as the optional writing test. Additionally, you can access the six tests online through the access code provided in the guide. The code also provides access to 400

online flashcards to help you prepare for all sections in the ACT® examination. The test's creators filled this guide with expert advice on how to both mentally and physically prepare for the exam. It will also help you: Review the entire ACT® test content so you'll know what to expect on test day Understand the procedures you'll follow when you're taking the ACT® Prepare for the types of questions you can expect to find on the test Adopt test-taking strategies that are right for you The Official ACT® Prep Guide 2021-2022 is the best resource to prepare you for test day. By using this guide you can feel comfortable that you're prepared to do your best! [ALEKS Math Full Study Guide -](#)  
Reza Nazari 2021-05-29  
Preparing for your ALEKS Math test? Looking for the best prep book to help you ace the ALEKS Math test? ALEKS Math Full Study Guide, which reflects the 2023 test guidelines, contains

extensive exercises, math problems, sample ALEKS math questions, and practice tests to help you hone your math skills, overcome your exam anxiety, boost your confidence, and do your best to succeed on the ALEKS Math test. This book reviews a handful of ALEKS Math topics and concepts such as: Fractions, Mixed numbers, Integers, Percent, Equations, Polynomials, Exponents, Radicals, and more. All topics are simply and concisely explained, allowing you to develop your mathematics skills. Two realistic ALEKS Math practice tests that reflect the format and question types on the ALEKS will help you check your exam-readiness and identify where you need more practice. ALEKS Math Full Study Guide contains many exciting and unique features to help you prepare for your ALEKS Math

test, including: ✓ Content 100% aligned with the 2023 ALEKS test ✓ Complete coverage of all ALEKS Math concepts which you will be tested ✓ A beginner-friendly guide for all ALEKS Math topics ✓ Abundant Math skills building exercises to help you approach unfamiliar question types ✓ 2 full-length ALEKS Math practice tests featuring new questions, with decisive answers. ✓ And much more ... With ALEKS Math Full Study Guide, you can focus on rapidly improving your ALEKS Math test scores. It doesn't matter if you don't have a tutor, as this comprehensive ALEKS Math study guide was designed for self-study in mind. However, this book can also be used with a tutor or for classroom usage. Ideal for self-study and classroom usage!

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