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[PISA for Development Assessment and Analytical Framework Reading, Mathematics and Science](#) - OECD 2018-09-25

"What is important for citizens to know and be able to do?" The OECD Programme for International Student Assessment (PISA) seeks to answer that question through the most comprehensive and rigorous international assessment of student knowledge and skills. As more countries join its ranks, PISA ...

Public Papers of the Presidents of the United States - United States.

President 2004

"Containing the public messages, speeches, and statements of the President", 1956-1992.

Study and Master Mathematical Literacy Grade 10 Learner's Book -

Busisiwe Goba 2005-01-01

Study & Master Mathematical Literacy was developed with the help of practising teachers, and covers all the requirements of the National Curriculum Statement for Mathematical Literacy. Learner's Book: module openers, which clearly explain the outcomes key skills boxes, detailing the skills necessary to perform certain mathematical functions language skills activities, to assist in mastering the language of Mathematical Literacy assessment activities module reviews, which provide extra practice projects, which deal with issues related to the real world, and move

learners beyond the confines of the classroom Teacher's Guide: an overview of the RNCS an introduction to outcomes-based education a detailed look at the Learning Outcomes and Assessment Standards for Mathematical Literacy, and how much time to allocate to each during the year information on managing assessment solutions to all the activities/exercises in the Learner's Book photocopiable assessment X-kit FET Grade 12 MATHEMATICAL LITERACY - Derek Swart 2009

Twenty-Twenty Hindsight - Mosiuoa Sekese 2013-05-16

Twenty-twenty hindsight means perfect understanding of events only after they have happened. In his book, Mosiuoa Sekese looks back on his life in the old and new South Africa and gives his own perceptive interpretation of the past events. Sekese suffered discrimination and prejudice under the old apartheid government as well as the new, democratic regime. His story is highly personal, but provides the reader with unique insights into the social and educational challenges that South Africa continues to grapple with. I had a quick read and I find the content heartbreaking but fascinating. Especially as a white South African you are drawing me into a world that I always knew existed, but which few people have the guts and conviction to paint into words. Louise Heystek-Emerton: CEO Wordwise/Khuluma Awethu

X-kit Fet G10 Business Studies -

Mathematical Literacy, Grade 10 - Karen Morrison 2012-02-23
Study & Master Mathematical Literacy Grade 10 has been especially developed by an experienced author team according to the Curriculum and Assessment Policy Statement (CAPS). This new and easy-to-use course helps learners to master essential content and skills in Mathematical Literacy. The Teacher's File includes: * a weekly teaching schedule, divided into the four terms to guide the teacher on what to teach * extra project templates for teachers to choose from * solutions to all the activities in the Learner's Book.

Plastic - Susan Freinkel 2011-04-18

"This eloquent, elegant book thoughtfully plumbs the . . . consequences of our dependence on plastics" (The Boston Globe, A Best Nonfiction Book of 2011). From pacemakers to disposable bags, plastic built the modern world. But a century into our love affair, we're starting to realize it's not such a healthy relationship. As journalist Susan Freinkel points out in this eye-opening book, we're at a crisis point. Plastics draw on dwindling fossil fuels, leach harmful chemicals, litter landscapes, and destroy marine life. We're drowning in the stuff, and we need to start making some hard choices. Freinkel tells her story through eight familiar plastic objects: a comb, a chair, a Frisbee, an IV bag, a disposable lighter, a grocery bag, a soda bottle, and a credit card. With a blend of lively anecdotes and analysis, she sifts through scientific studies and economic data, reporting from China and across the United States to assess the real impact of plastic on our lives. Her conclusion is severe, but not without hope. Plastic points the way toward a new creative partnership with the material we love, hate, and can't seem to live without. "When you write about something so ubiquitous as plastic, you must be prepared to write in several modes, and Freinkel rises to this task. . . . She manages to render the most dull chemical reaction into vigorous, breathless sentences." —SF Gate "Freinkel's smart, well-written analysis of this love-hate relationship is likely to make plastic lovers take pause, plastic haters reluctantly realize its value, and all of us understand the importance of individual

action, political will, and technological innovation in weaning us off our addiction to synthetics." —Publishers Weekly "A compulsively interesting story. Buy it (with cash)." —Bill McKibben, author of *The End of Nature* "What a great read—rigorous, smart, inspiring, and as seductive as plastic itself." —Karim Rashid, designer

Focus - 2003

Literacy Instruction for Adolescents - Karen D. Wood 2009-03-12

Thorough and accessible, this professional resource and text shows how the latest research in adolescent literacy can be translated into effective practice in middle and high school classrooms. Leading authorities discuss findings on the adolescent learner, addressing such essential topics as comprehension, content-area literacy, differentiated instruction, gender differences in literacy learning, and English language learners. With a focus on evidence-based methods, coverage ranges from techniques for building digital literacy and comprehension skills to strategies for flexible grouping and writing instruction. Ideal for courses in adolescent literacy, each chapter includes guiding questions, discussion questions, and classroom examples.

U.S. History - P. Scott Corbett 2017-12-19

Published by OpenStax College, U.S. History covers the breadth of the chronological history of the United States and also provides the necessary depth to ensure the course is manageable for instructors and students alike. U.S. History is designed to meet the scope and sequence requirements of most courses. The authors introduce key forces and major developments that together form the American experience, with particular attention paid to considering issues of race, class and gender. The text provides a balanced approach to U.S. history, considering the people, events and ideas that have shaped the United States from both the top down (politics, economics, diplomacy) and bottom up (eyewitness accounts, lived experience).

Team Oxford Comma - Oxford Journals 2020-12-30

This Team Oxford Comma 120 Low Vision Lined Pages - 6" x 9" - Planner, Journal, Notebook, Composition Book, Diary for Women, Men, Teens, and

Children has 120 Low Vision Lined pages that provides enough room to write down your whole life journey. A journal is a great way to cultivate a better you. This is a self exploration journal that will help you set and reach your goals, set a plan of action to achieve those goals. There are many critical metrics in becoming the best you. We all say that we'll do our best, but going through the process of writing down your goals and tracking your performance has a major impact on you actually achieving your goals. Grab a copy for yourself (and for a friend) and get started today. A great gift idea for men, girls, mom, teens, women, dad, husband, boys, wife, on Valentine's Day, Graduation, Easter, Anniversary, Father's Day, Christmas, Birthday, Mothers' Day, Thanksgiving, Halloween, or Wedding Anniversary.

PISA The PISA 2003 Assessment Framework Mathematics, Reading, Science and Problem Solving Knowledge and Skills - OECD 2004-03-02
The PISA 2003 Assessment Framework presents the conceptual underpinning of the PISA 2003 assessments. Within each assessment area, the volume defines the content that students need to acquire, the processes that need to be performed and the contexts in which knowledge and skills are applied.

Study and Master Economic and Management Sciences Grade 8 CAPS Exercise Book - Marietjie Barnard 2013-10-31

The Educational year book. [5 issues]. - 1879

Imagined Liberation - Heribert Adam 2013-12-01

ÿOn a spectrum of hostility towards irregular migrants, South Africa ranks on top, Germany in the middle and Canada at the bottom. South African xenophobic violence by impoverished slum dwellers is directed against fellow Africans. Why would a society that liberated itself in the name of human rights turn against people who escaped human rights violations or unlivable conditions at home? What happened to the expected African solidarity? Why do former victims become victimizers?ÿ Imagined Liberationÿasks what xenophobic societies can learn from other immigrant societies which avoided the backlash against multiculturalism

in Europe.

Tourism and Hospitality Studies - Irfan Yazicioglu 2020-12-16

This book discusses "tourism and hospitality" from different perspectives and disciplines. In addition, this book, considering the tourism and hotel management terminology, is expected to be a source book for the theoretical and practical scientific studies in the fields which is in close relationship such as gastronomy, recreation and marketing.

Resources in Education - 1998-05

Mother to Mother - Sindiwe Magona 2014-09-02

Sindiwe Magona's novel *Mother to Mother* explores the South African legacy of apartheid through the lens of a woman who remembers a life marked by oppression and injustice. Magona decided to write this novel when she discovered that Fulbright Scholar Amy Biehl, who had been killed while working to organize the nation's first ever democratic elections in 1993, died just a few yards away from her own permanent residence in Guguletu, Capetown. She then learned that one of the boys held responsible for the killing was in fact her neighbor's son. Magona began to imagine how easily it might have been her own son caught up in the wave of violence that day. The book is based on this real-life incident, and takes the form of an epistle to Amy Biehl's mother. The murderer's mother, Mandisi, writes about her life, the life of her child, and the colonized society that not only allowed, but perpetuated violence against women and impoverished black South Africans under the reign of apartheid. The result is not an apology for the murder, but a beautifully written exploration of the society that bred such violence.

X-kit FET Grade 10 Mathematical Literacy - 2006

PASS Mathematical Literacy Grade 12 CAPS - Cornelia G. Turner 2014-06-26

Seven Skills of Media Literacy - W. James Potter 2019-08-12

In *Seven Skills of Media Literacy*, best-selling author and renowned scholar W. James Potter provides readers with the practical guidance they

need to make substantial improvements on seven major skills required to increase their media literacy. For each of these seven skills, Potter provides easy-to-follow algorithms and heuristics that structure the process of using the skill. Chapters also offer many exercises to help readers practice using these algorithms and heuristics while avoiding traps in thinking. The book is organized to guide readers progressively through the sequence of media literacy skills, starting with the most fundamental and building to the more complex skills. This book is a must read for those people serious about becoming more strategic in using the media to satisfy their own needs for information and entertainment and thereby avoid being exploited by media messages. INSTRUCTORS: Bundle Seven Skills of Media Literacy with Potter's core text, Media Literacy, Ninth Edition, for only \$5 more! Bundle ISBN: 978-1-5443-9525-8
Taxonomy of Educational Objectives - 1984

X-kit Fet G10 Mathematics -

Teacher's Skills Tests For Dummies - Colin Beveridge 2014-06-03
If you're preparing for the newly revised Numeracy and Literacy Skills Tests, Teacher's Skills Tests For Dummies is your one-stop for both exams, providing you with subject-matter review, revision and practice tests you need to tackle the tests with confidence and succeed. Written by expert authors in Maths, English, and Education (with the credentials to prove it), Teacher's Skills Tests For Dummies provides you with: - A review of the key maths and English concepts you need to know to do well - Full length practice tests and tons of additional practice questions - Online accessible audio tests for spelling and mental arithmetic — to better prepare you for the actual test - Tips and tricks (along with mistakes to avoid) to become a better test taker With this book — and a bit of work on your part — you'll be positioned to pass your skills tests and gain that coveted place on a teacher-training course.
Study and Master Mathematical Literacy Grade 12 CAPS Learner's Book - Karen Morrison 2014-05-01

X-kit Fet G10 English Home Language - Gosher, S 2009

Accounting Questions & Answers - Speedy Publishing 2014-08-13
An accounting study guide with questions, and answers is a helpful tool for anyone that is taking an an accounting class. An accounting course book covers topics extensively. With the study guide the person can take the quizzes, and check their answers. The study guide shows which answer is correct. Some study guide books will explain why the other answers is close, but not correct. Once the person takes the quiz on a specific topic. They will find out where their weakness is, and what areas they have to study. The book will help them prepare for class exams, and any professional exams they may take.

The Reference Catalogue of Current Literature - 1913

Research for Educational Change - Jill Adler 2016-06-17
Research for Educational Change presents ways in which educational research can fulfil its commitments to educational practice. Focussing its discussion within the context of mathematics education, it argues that while research-generated insights can have beneficial effects on learning and teaching, the question of how these effects are to be generated and sustained is far from evident. The question of how to turn research into educational improvement is discussed here in the context of learning and teaching hindered by poverty and social injustice. In the first part of the book, four teams of researchers use different methodologies while analysing the same corpus of data, collected in a South African mathematics classroom. In the second part, each of these teams makes a specific proposal about what can be done and how so that its research-generated insights have a tangible, beneficial impact on what is happening in mathematical classrooms. Combining two discourses – that of researchers speaking to one another, and that of researchers communicating their insights to those responsible for educational practice – the book deals with the perennial question of communication between those who study educational processes and those who are directly responsible for teacher education, educational research and classroom

practices. This book will be key reading for postgraduates, researchers and academics in education and particularly in the areas of mathematics education, education research, teacher education and classroom practice. It will also appeal to teacher educators, practitioners and undergraduate students interested in educational research.

Maths Made Easy - Kevin Smith 2011

Which One Doesn't Belong? - Christopher Danielson 2019-02-12

Talking math with your child is simple and even entertaining with this better approach to shapes! Written by a celebrated math educator, this innovative inquiry encourages critical thinking and sparks memorable mathematical conversations. Children and their parents answer the same question about each set of four shapes: "Which one doesn't belong?" There's no one right answer--the important thing is to have a reason why. Kids might describe the shapes as squished, smooshed, dented, or even goofy. But when they justify their thinking, they're talking math! Winner of the Mathical Book Prize for books that inspire children to see math all around them. "This is one shape book that will both challenge readers' thinking and encourage them to think outside the box."--Kirkus Reviews, STARRED review

Concepts of Biology - Samantha Fowler 2018-01-07

Concepts of Biology is designed for the single-semester introduction to biology course for non-science majors, which for many students is their only college-level science course. As such, this course represents an important opportunity for students to develop the necessary knowledge, tools, and skills to make informed decisions as they continue with their lives. Rather than being mired down with facts and vocabulary, the typical non-science major student needs information presented in a way that is easy to read and understand. Even more importantly, the content should be meaningful. Students do much better when they understand why biology is relevant to their everyday lives. For these reasons, Concepts of Biology is grounded on an evolutionary basis and includes exciting features that highlight careers in the biological sciences and everyday applications of the concepts at hand. We also strive to show the

interconnectedness of topics within this extremely broad discipline. In order to meet the needs of today's instructors and students, we maintain the overall organization and coverage found in most syllabi for this course. A strength of Concepts of Biology is that instructors can customize the book, adapting it to the approach that works best in their classroom. Concepts of Biology also includes an innovative art program that incorporates critical thinking and clicker questions to help students understand--and apply--key concepts.

X-kit FET Grade 11 Mathematical Literacy - Derek Swart 2006

Mathematical Literacy, Grade 11 - Karen Morrison 2012-09-10

Study & Master Mathematical Literacy Grade 11 has been especially developed by an experienced author team according to the Curriculum and Assessment Policy Statement (CAPS). This new and easy-to-use course helps learners to master essential content and skills in Mathematical Literacy. The comprehensive Learner's Book includes: * thorough coverage of the basic skills topics to lay a sound foundation for the development of knowledge, skills and concepts in Mathematical Literacy * margin notes to assist learners with new concepts - especially Link boxes, that refer learners to the basic skills topics covered in Term 1, Unit 1-16 * ample examples with a strong visual input to connect Mathematical Literacy to everyday life.

Knowing What Students Know - National Research Council 2001-10-27

Education is a hot topic. From the stage of presidential debates to tonight's dinner table, it is an issue that most Americans are deeply concerned about. While there are many strategies for improving the educational process, we need a way to find out what works and what doesn't work as well. Educational assessment seeks to determine just how well students are learning and is an integral part of our quest for improved education. The nation is pinning greater expectations on educational assessment than ever before. We look to these assessment tools when documenting whether students and institutions are truly meeting education goals. But we must stop and ask a crucial question: What kind of assessment is most effective? At a time when traditional

testing is subject to increasing criticism, research suggests that new, exciting approaches to assessment may be on the horizon. Advances in the sciences of how people learn and how to measure such learning offer the hope of developing new kinds of assessments—assessments that help students succeed in school by making as clear as possible the nature of their accomplishments and the progress of their learning. *Knowing What Students Know* essentially explains how expanding knowledge in the scientific fields of human learning and educational measurement can form the foundations of an improved approach to assessment. These advances suggest ways that the targets of assessment—what students know and how well they know it—as well as the methods used to make inferences about student learning can be made more valid and instructionally useful. Principles for designing and using these new kinds of assessments are presented, and examples are used to illustrate the principles. Implications for policy, practice, and research are also explored. With the promise of a productive research-based approach to assessment of student learning, *Knowing What Students Know* will be important to education administrators, assessment designers, teachers and teacher educators, and education advocates.

Reference Catalogue of Current Literature - 1902

The World Book Encyclopedia - 2002

An encyclopedia designed especially to meet the needs of elementary, junior high, and senior high school students.

Learning and Doing Policy Analysis in Education: Examining Diverse Approaches to Increasing Educational Access - Maria Teresa Tatto 2012-09-17

This book originated in a policy analysis class at Michigan State University taught during 2010. Using Professor Tatto's unique approach to teaching policy analysis, the professor and students agreed to construct a class that represented a reflective and grounded experience in the policy analysis of a current and relevant issue with global ramifications; we began exploring policies that were developed at the global level and that were implemented locally. We investigated the surge of globally

developed standards and regulations in an effort to improve education. Our goal was to learn cross-nationally about policies that seek to reform curriculum and instruction under efficiency and global competitiveness arguments, such as Education for All (EFA) and its USA cousin No Child Left Behind (NCLB). We knew our work would be bounded by the time available in a one-semester class, and by resource constraints. We did exploratory inquiry supported by literature reviews, reports on rigorous research studies, and in one case an exploratory case study. The policies we chose to explore, such as EFA and NCLB, offered us the opportunity to examine current reform tendencies that are intended to provide access to quality education for all children, the preparation of teachers to support diverse populations, the organization of schools to accommodate these children in response to vague policy mandates, and power issues affecting the different constituencies and stakeholders. The effects of these and other policies were difficult to track because research is scant and decisions are frequently made based on ideology or political persuasion. Our purpose was to explore the critical issues that originated such policies, and to search for documented evidence regarding policy implementation and effectiveness. We investigated the factors that seemed to interfere with successful implementation, from conceptual, theoretical, and methodological perspectives. In this class we learned that there are not ready-set frameworks for policy analysis, but rather that these have to be constructed according to the issues that emerge as policies are conceptualized and implemented to fit local contexts and needs. The book pays particular attention to the contexts of policy, including the evolving conceptualization of global and local systems of governance, knowledge regimes, and policy spaces. The book is designed for faculty and doctoral students in education who are interested in understanding diverse frameworks for policy analysis, and for those in the general public who are interested in the policies we analyze here.

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

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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===== Celisa Counterman M.A.T.H. = Making Algebraic Thinking Holistic
<https://doi.org/10.37626/GA9783959872188.0.023> 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 self-rating 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 problem-based 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/GA9783959872188.0.032> First page: 175 Last page: 180 Abstract The present work describes an educational

experience, being implemented since 2015, based on the Rondine Method application in mathematics teaching. This experience has involved 135 students from State Schools throughout Italy. The general method was developed by an Italian research team aiming at resolving conflicts in situations of contrast. The goal of the work is highlighting how the care of relationships may be a means for overcoming difficulties in mathematics. Below we describe activities referring to the general principles of active education and of socio-constructivism, which are oriented to train students both in learning by action and participation, and in bringing their own contribution to the whole class work.

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 ===== Courtney Fox Integrating Mathematics and Science: A Plan for a High School Integrated Pre-Calculus and Physics Course
<https://doi.org/10.37626/GA9783959872188.0.033> First page: 181 Last page: 185 Abstract This paper explores the integration of mathematics and science as a means to improve learning for high school students. Scholars have acknowledged the benefits of integration for over 50 years, but in the United States we have failed in large measure to adopt an integrative curriculum. This work provides a corrective to this problem by creating a practical curriculum for an integrated Pre-Calculus and Physics course with suggestions for implementation in any school.

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 ===== Kathy R. Fox Building an Understanding of Family Literacy: Changing Perspectives Regarding Authentic Learning 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 Last page: 236 Abstract Tools for easily creating infographics are
widely available, both online and through statistics, mathematics, and
other programs. Determining the appropriate graphs to produce for
different kinds of data is an important skill for students at all levels to
learn, as is determining the best graph for a specific audience. With the
increased availability of data comes the increased expectation that
researchers in all disciplines can effectively communicate their findings to
a wide range of audiences. Experts in graphical design have defined
aspects of "graphical excellence," but the effectiveness of graphically
portrayed information depends a great deal on the needs and abilities of
the intended audience. To create effective graphs, students not only need
to be familiar with tools for creating graphs, they also need to be familiar
with the communication, cognitive, and aesthetic principles associated
with infographic design.

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===== Andrew Izsák Foregrounding Multiplicative Structure in
Essential Calculus Topics

<https://doi.org/10.37626/GA9783959872188.0.043> First page: 237 Last
page: 242 Abstract Approaches to calculus have emphasized limits,
derivatives, and integrals, among other topics. Yet, across different
approaches, the subject continues to pose significant challenges. The
present study reports a new approach to calculus that takes multiplicative
structure as an equally essential topic that is often overlooked or taken
for granted. In an experimental course, 18 college students learned to
reason about multiplication understood as coordinated measurement with
two different units and proportional relationships 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 thought-provoking. This workshop includes many such problems with various real-world and contrived contexts. Participants will work in groups to find the solutions as well as identify similarities and contrasts among the problems. We will explore whether there are related mathematical concepts (e.g., algebra, discrete mathematics, geometry) or mathematical processes (reasoning, connecting, communicating, representing, problem-solving, selecting tools and strategies). Many of these problems are taken from resources published broadly for students from ages 11-19+. We will compare our findings and experiences with those of school students and discuss use of technology in both face-to-face and online settings: from the past to the future! Keywords: problem-solving, reasoning, communication, collaboration, algebra, representations, Chalk Talk, Thinker-Doer problems

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 ===== Gibbs Y. Kanyongo, Nandini Bhowmick & Erika Williams
 Structural Equation Modeling: Focus on Confirmatory Factor Analysis
 https://doi.org/10.37626/GA9783959872188.0.046 First page: 254 Last page: 255 Abstract This workshop will expose participants to the statistical technique of Structural Equation Modeling (SEM), with a focus on confirmatory factor analysis (CFA), using the statistical software AMOS. Structural equation modeling is a multivariate statistical analysis technique that is used to analyze structural relationships. Confirmatory Factor Analysis examines whether collected data fit a hypothesized model of what the data are meant to measure. It is the measurement part of SEM, which shows relationships between latent variables and the 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/GA9783959872188.0.050> 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/GA9783959872188.0.051> 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/GA9783959872188.0.052> 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/GA9783959872188.0.054> 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.

===== Sigal Levy & Yelena Stukalin Introducing Main
Statistical Concepts to Non-statisticians
<https://doi.org/10.37626/GA9783959872188.0.055> 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

===== 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.

===== 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.

===== 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 to self-efficacy, and interest to self-efficacy, were stronger among the male than the female students. Overall, the findings confirm that TSR have an important influence on Chinese students' mathematics academic motivation and achievement and that gender differences affect the patterns of these relationships. Possible explanations for the results and practical implications are discussed. Key words: teacherstudent relationship, interest, self-efficacy, mathematics achievement, crossgender comparison.

===== Cheryl Ann Lubinski & Allison Kroesch Developing, Not Teaching, Problem-Solving Strategies
<https://doi.org/10.37626/GA9783959872188.0.059> First page: 322 Last page: 324 Abstract Many teachers use explicit instruction to teach students how to solve a problem and then have their students practice a specific strategy. Research indicates this type of teaching does not necessarily improve problem solving skills. Students need to solve problems using their intuitive strategies which might include pictures and concrete materials. For a specific problem, we will share the strategies used by students in the United States, 17-year-old brothers and their family in Poland, and teachers of students ages 5-17 in Zimbabwe. Findings indicate that most people do not choose a picture strategy but a trial-and-error strategy using symbols. Most are unsuccessful at solving the problem. We will share teaching strategies that encourage developing, not teaching, problem-solving strategies.

===== Jürgen Maaß Professional Mathematical Modelling: What we can Learn about Teaching Real World 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/>)
===== 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

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 developed negative attitudes to the change. This paper examines recent students' opinions: in particular, the opinions of mathematics undergraduates who had experienced the transition and who took a Mathematics Education module at one Irish university in 2019-20. They studied old and new curriculum documents and examination papers, and watched videos of reform-type lessons; their reflective comments were posted to a discussion board. Thematic analysis of posts from the 18 (out of 25) students who gave permission for use of their work in research indicates that, by then, these students supported many

aspects of the reformed curriculum.

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 ===== Nick Vincent Otuma Mismatch between Spoken Language and Visual Representation of Mathematical Concepts
<https://doi.org/10.37626/GA9783959872188.0.073> First page: 384 Last page: 388 Abstract This paper examines secondary students' mismatch in meaning between spoken language and visual representation of mathematical concept of a rightangled triangle. Forty-eight students, age 16-17years participated in the case study. Students were asked to select plane figures that matched the descriptions given on each questionnaire item. In group interview, participants were asked to give properties of selected plane figures and draw a diagram representing the same plane figures. The results of this research suggested that many students had similar imperfect conception of a right-angled triangle. Keywords: Mathematical language, conceptual understanding.

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 ===== Jenny Pange & Alina Degteva Project-based Learning in Statistics
<https://doi.org/10.37626/GA9783959872188.0.074> First page: 389 Last page: 394 Abstract Online teaching process is triggered by the Covid-19, and project-based learning (PBL) goes through a new stage of development as it includes ICT tools and up-to-date teaching methods. We applied this approach in an online undergraduate course in statistics. This paper describes the process and evaluates the outcome of PBL in teaching statistics course to a group of undergraduate students at the University of Ioannina, Greece. Students had to attend the class and react to practical exercises according to the demands of the PBL. They were asked to use questionnaires and go through interviews to evaluate the teacher-to-student, student-to-student, and student-to-content interactions in PBL method. Data obtained from online questionnaire and were analysed. The results implied high level of interactions during PBL in statistics. Key words: project-based learning, statistics, ICT tools, interaction

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 ===== Andrea Peter-Koop School-Readiness in Mathematics:

Development of a Screening Test for Children Starting School
<https://doi.org/10.37626/GA9783959872188.0.075> First page: 395 Last page: 400 Abstract The study reported in this paper involved the development of a screening test to be applied by teachers with the whole class at school entry. The goal of this screening instrument is the identification of children who are at risk with respect to their school mathematics learning and therefore need immediate support and intervention. The paper reports the results of a study with 1757 children from 97 Grade 1 classes in 39 primary schools in Germany that have 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 instructional shifts around the adaptive reasoning categories of flexibility, understanding, and deliberate practice, as related to multilingual learners. We conclude with implications for both research and practice related to secondary mathematics specialists, multilingual mathematics instruction, and studio day professional learning.

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===== Keith Robins Applying Mathematical Thinking Principles to Real Life Situations to Create an Objective Thinking Strategy
<https://doi.org/10.37626/GA9783959872188.0.081> First page: 429 Last page: 433 Abstract Teaching set thinking can make a great difference in teaching and learning mathematics as it demonstrates its relevance to real life. The following examples include how socialising is a mathematical process and how one can create a mathematical model for any experience or system rather than creating perceptions.

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===== Christine Robinson & Karen Singer-Freeman Digital

Enhancements for Common, Online Mathematics Courses

<https://doi.org/10.37626/GA9783959872188.0.082> First page: 434 Last page: 438 Abstract The University of North Carolina System Office (UNC System) established the Digital Enhancement Project to rapidly develop high-quality, online course materials to support faculty and student success in online courses. Content was created for Calculus I, a course that is critical to student progress, is in high demand, and has large enrollments. To evaluate the usefulness and impact of the materials, project evaluators developed assessment instruments that included a survey for students enrolled in 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 π (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 things 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/GA9783959872188.0.089> 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 (\heartsuit) 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/GA9783959872188.0.090> 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/GA9783959872188.0.091> 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 $1.27201965\dots$] 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-world applications.

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===== Janet (Hagemeyer) Tassell, Jessica Hussung, Kylie Bray, Darby Tassell & Haley (Clayton) Carbone Elementary Pre-Service Teachers' Beliefs about Mathematics Fluency: Transforming Through Readings & Discussions <https://doi.org/10.37626/GA9783959872188.0.100> First page: 531 Last page: 536 Abstract Teacher candidates continue to enter Elementary Math Methods with the belief that mathematics fluency is synonymous to speed and rote memorization -assessed best by timed tests. In the Elementary Math Methods 2018-2021 school years, fall and spring semesters, qualitative data were gathered from pre-service elementary mathematics teachers' pre/post-assessments of reading mathematics fluency journal articles, viewing video samples, and participating in full-class discussions. The pre- to post-assessment themes show that reading research articles may be a possible intervention to add to their clinical

school observations in the K-6 setting.

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===== Eleni Tsami, Dimitra Kouloumpou & Andreas Rokopanos The Gender Gap in Statistics Courses: A Contemporary View on a Statistics Department <https://doi.org/10.37626/GA9783959872188.0.101> First page: 537 Last page: 541 Abstract Gender equality remains a strategic objective of the EU educational system. The present paper provides a contemporary view of the gender balance in the Department of Statistics and Insurance Science at the University of Piraeus. Our results indicate that a gender gap is prevalent in this specific department, although this gap is only marginal in terms of the 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.

===== 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.

===== 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. Unfortunately, learning mathematics is difficult after graduating from school. It is clear that lifelong learning has now become an important learning venue for all. I decided to call this school education "In School", and to be released from the school system and call learning "Out School". I will describe the richness of the future of "Out School", which is a place for learning in the future. Out School is an important mathematical education that is an

extension of In School. Key words: In School, Out School, Creativity, Mathematical Learning
===== Laura Watkins, Patrick Kimani, April Ström, Bismark Akoto, Dexter Lim Representational Competence with Linear Functions: A Glimpse into the Community College Algebra Classroom
<https://doi.org/10.37626/GA9783959872188.0.105> First page: 560 Last page: 565 Abstract Teaching and learning strategies that encourage students to develop the ability to use mathematical representations in meaningful ways are powerful tools for building algebraic understandings of mathematics and solving problems (American Mathematical Association of Two-Year Colleges [AMATYC], 2018). The study of functions in algebra courses taught at community colleges in the United States provides students the opportunity and space to make connections between important characteristics of various families of functions. Using examples of teaching and learning linear functions from intermediate and college algebra courses in community colleges, we explore the ways instructors and students use a variety of representations (visual, symbolic, numeric, contextual, verbal, and/or physical) in teaching and learning linear functions, while connecting between and within these representations.

===== Ian Willson Formative Assessment Activities for Introductory Calculus
<https://doi.org/10.37626/GA9783959872188.0.106> First page: 566 Last page: 568 Abstract A hands-on workshop in which participants engage as beginning learners in an extensive range of stand-alone tasks, and in which some of the tenets and guiding principles of formative assessment are used to highlight what many consider to be the best kind of teaching practice—and that which is critically important if we are to improve the quality of instruction for all. The idea is that clear articulation of just what is meant by formative assessment is provided in the actual context of ready-to-use classroom tasks.

===== Kay A. Wohlhuter & Mary B. Swarouth Number Talks: Working to Deepen and Grow Number Sense Knowledge

<https://doi.org/10.37626/GA9783959872188.0.107> First page: 569 Last page: 573 Abstract Deep, flexible number understandings are foundational for mathematics learning. This workshop is based on two mathematics teacher educators' journey to better understand how to facilitate future teachers' development and use of number sense. Engaging preservice teachers in Number Talks enabled the educators to identify and to examine the strategies preservice teachers used during number talks while also providing a context for improving and expanding their own professional knowledge about number sense. Participant engagement includes experiencing Number Talks, examining preservice teachers' work samples, and responding to the educators' observations about 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.