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**Introduction to Probability** Apr 30 2021 This text is designed for an introductory probability course at the university level for sophomores, juniors, and seniors in mathematics, physical and social sciences, engineering, and computer science. It presents a thorough treatment of ideas and techniques necessary for a firm understanding of the subject.

**Mathematics for the IB Diploma: Applications and interpretation HL** Jan 28 2021 Enable students to construct mathematical models by exploring challenging problems and the use of technology. - Engage and excite students with examples and photos of maths in the real world, plus inquisitive starter activities to encourage their problem-solving skills. - Build mathematical thinking with our 'Toolkit' and mathematical exploration chapter, along with our new toolkit feature of questions, investigations and activities. - Develop understanding with key concepts and applications integrated throughout, along with TOK links for every topic. - Prepare your students for assessment with worked examples, extended essay support and colour-coded questions to highlight the level of difficulty and the different types of questions. - Check understanding with review exercise at the end of the textbook. Follows the new 2019 IB Guide for Mathematics: applications and interpretation Higher Level Available in the series Mathematics for the IB Diploma: Analysis and approaches SL Student Book ISBN: 9781510462359 Student eTextbook ISBN: 9781510461895 Whiteboard eTextbook ISBN: 9781510461901 Mathematics for the IB Diploma: Analysis and approaches HL Student Book ISBN: 9781510462366 Student eTextbook ISBN: 9781510461857 Whiteboard eTextbook ISBN: 9781510461864 SL & HL Teaching & Learning Resources ISBN: 9781510461918 Mathematics for the IB Diploma: Applications and interpretation SL Student Book ISBN: 9781510462380 Student eTextbook ISBN: 9781510461994 Whiteboard eTextbook ISBN: 9781510462007 Mathematics for the IB Diploma: Applications and interpretation HL Student Book ISBN: 9781510462373 Student eTextbook ISBN: 9781510461956 Whiteboard eTextbook ISBN: 9781510461963 SL and HL Teaching & Learning Resources ISBN: 9781510462014 Dynamic learning packages (include Teaching & Learning resources and Whiteboard eTextbooks) Analysis & approaches SL & HL ISBN: 9781510461925 Applications and interpretation SL and HL ISBN: 9781510462021 Analysis & approaches SL & HL and Applications and interpretation SL and HL ISBN: 9781510468474

**Global Perspectives and Practices for Reform-Based Mathematics Teaching** Jan 20 2023 Reform-based mathematics has become a popular topic in the education field as this teaching emphasizes classroom discourse and instructional goals related to student engagement and an understanding of mathematical reasoning, concepts, and procedures using instructional practices that build on students' informal knowledge of mathematics. It also connects mathematics with other disciplines and the real world and provides opportunities for students to contribute and invent their own methods during problem-solving. Further study on the best practices, benefits, and challenges of implementing this teaching into education is required. Global Perspectives and Practices for Reform-Based Mathematics Teaching explores international perspectives on diverse reform-based practices in teaching and learning mathematics, describes challenges and issues for teachers and teacher educators, promotes reflection and academic discussion at various levels and in various educational systems, and raises questions for the field of mathematics education. Covering a range of topics such as teacher preparation programs and integrated learning spaces, this reference work is ideal for academicians, practitioners, researchers, instructors, educators, and students.

**Control and Optimization with PDE Constraints** Apr 18 2020 Many mathematical models of physical, biological and social systems involve partial differential equations (PDEs). The desire to understand and influence these systems naturally leads to considering problems of control and optimization. This book presents important topics in the areas of control of PDEs and of PDE-constrained optimization, covering the full spectrum from analysis to numerical realization and applications. Leading scientists address current topics such as non-smooth optimization, Hamilton–Jacobi–Bellmann equations, issues in optimization and control of stochastic partial differential equations, reduced-order models and domain decomposition, discretization error estimates for optimal control problems, and control of quantum-dynamical systems. These contributions originate from the “International Workshop on Control and Optimization of PDEs” in Mariatrust in October 2011. This book is an excellent resource for students and researchers in control or optimization of differential equations. Readers interested in theory or in numerical algorithms will find this book equally useful.

**Mathematics HL and SL with HL Options** Jul 26 2023 This comprehensive and concise text is ideal for use with the International Baccalaureate Mathematics HL & SL courses in a clear and easy to use format. The author has developed this text after many years of teaching and examining IB Mathematics. This 2006-13 Edition of Mathematics HL & SL has been written specifically for the International Baccalaureate Syllabuses for students taking exams until November 2013. Students taking exams in May 2014 or later should buy the 2012-19 Edition instead of this one. The HL Options of Statistics and Probability, Set, Relations and Groups, and Series and Differential Equations are included. In each chapter the information relative to the topic is discussed and several examples providing various approaches to the solutions are given. The exercises provided with each section have been carefully graded from the relatively easy to the more difficult. Answers to all odd-numbered questions and some even-numbered ones are provided. The required outcomes are featured at the end of each chapter.

**Theory and Practice: An Interface or A Great Divide? The Mathematics Education for the Future Project – Proceedings of the 15th International Conference** Jun 13 2022 This volume contains the papers presented at the International Conference on Theory and Practice: An Interface or A Great Divide? and held from August 4-9, 2019 at Maynooth University, Kildare, Ireland. The Conference was organized by The Mathematics Education for the Future Project – an international educational project founded in 1986 and dedicated to innovation in mathematics, statistics, science and computer education world-wide. Ouder, Fouze Abu; Amit, Miriam: Incorporating Ethnomathematical Research in Classroom Practice – The Case of Geometrical Shapes in Bedouin Traditional Embroidery. pp 1 – 4 Ethnomathematics asserts that in addition to the formal mathematics taught in schools, there are other forms of mathematics, which have been taught in different societies and cultures around the world. Research and educational experience has shown that combining ethnomathematics with the formal mathematics curriculum in the classroom can improve students' academic achievement, since it strengthens their self-image and reinforces their motivation for studying mathematics. We adopted this approach with Bedouin students who are defined as 'underachievers' in national mathematics tests. In this paper, we offer an ethnomathematical analysis of Bedouin embroidery samples taken from traditional dresses made by Bedouin women. We then describe how ethnomathematical elements were incorporated in the teaching of mathematics for Bedouin students, and how doing so contributed to their learning. <https://doi.org/10.37626/GA9783959871129.0.01> Adams, Nadine; Hayes, Clinton: Providing

Synchronous Mathematics Instruction to Distance Students- Workshop. pp 5 – 8 In theory technology breaks down boundaries and allows us to more easily connect to our students. But in practice despite all of the technology available mathematics instruction is still best given in a “talk and chalk” format. The use of instructional videos, where the student is able to watch handwritten instruction, has become standard. These are great in that they provide asynchronous instruction and allow the student to learn at a time that suits them. What these videos lack is the interactive component that makes face-to-face teaching preferable. To overcome this online lectures are conducted using a combination of Zoom, PDF Annotator and a Tablet PC. Students are provided with an experience much closer to that of face-to-face. <https://doi.org/10.37626/GA9783959871129.0.02> Adenegan, Kehinde Emmanuel: Managing Pupils with Dysgraphia in Early Child Numeracy. pp 9 – 13 Dysgraphia is a specific learning difficulty which is a brain-based disorder that impacts on writing skills whereby affected individuals have difficulty with forming letters, writing figures, spacing words and even organizing text into complete sentences. Early child numeracy is a competence built in the young child at an early childhood stage in the mathematical skills needed to cope with everyday life and an understanding of information presented mathematically. To this end, this paper presents dysgraphia, its symptoms in pupils, offers measures on how to manage dysgraphia pupils by teachers and parents and highlights strong recommendations to assist such pupils in performing and competing favourably in Mathematics and other subjects with other pupils in the classroom. Keywords: Dysgraphia, Early Child Numeracy (ECN), Mathematics, Pupils, Numerophobia. <https://doi.org/10.37626/GA9783959871129.0.03> Anhalt, Cynthia O.; Cortez, Ricardo: Mathematical Modeling Thinking: Laying the Foundation for Mathematical Modeling Competency. pp 14 – 19 Mathematical modeling competency requires frequent practice and sufficient time to derive experience solving open-ended contextual problems. Specific ways of thinking necessary in modeling are identified by contrasting Pólya’s general problem-solving framework, which may be familiar worldwide. These ways of thinking are developed through mathematical activities that promote dispositions for eventual success in modeling. We posit that mathematical modeling thinking (MMT) is necessary for building modeling competency. This paper describes MMT and illustrates how it can be developed through a well-known problem of universal human cultural greeting exchange. While connecting to world cultures, we examine ways to promote MMT practices such as making useful simplifications, looking for patterns, utilizing multiple representations, mathematizing the situation, and reflecting on the solution. We conclude with practical ways to effect MMT as the foundation for developing mathematical modeling competency. <https://doi.org/10.37626/GA9783959871129.0.04> Ashleigh, Glenda Jean: Individual Differences in Cognition and Affect in Multiplicative Knowledge in Basic Mathematics Problems. pp 20 – 25 This paper discusses the roles that individual differences in cognitive and affective variables play in the formation of increasingly complex multiplicative knowledge structures in basic mathematics problems. The effectiveness of learner strategies and teaching strategies to optimise the development of authentic multiplicative knowledge will vary according to these individual differences. <https://doi.org/10.37626/GA9783959871129.0.05> Banach, Katarzyna: Ok Notebook as an Untypical Form of Student’s Notebook – Own Experience. pp 26 – 28 In recent years, the methods of work at the Polish school have been evaluated. From the Prussian school model, we are slowly moving to the model of a modern school meeting contemporary challenges. At the present time, much attention is devoted to the search for new working methods and teaching tools. We draw on the experience of other countries. We test our own solutions. This paper deals with the use of formative assessment in association with the untypical formula of a student’s notebook. <https://doi.org/10.37626/GA9783959871129.0.06> Bateiha, Summer; Mir, Sadia: Engaging with Mathematics through Three Types of Storytelling. pp 29 – 33 Throughout history, storytelling has been used as a way to appeal to people’s imagination and emotions. When stories are told in the mathematics classroom, the subject comes to life. Students begin to understand the purpose of learning the content, and mathematics becomes something greater than a plethora of irrelevant facts and formulas that are meant to be memorized, applied, and repeated. This workshop focuses on the use of storytelling as a way to engage students in a nontraditional and pertinent form of learning mathematics. In this session, participants will listen to stories used with predominantly Arab students in an American university in Qatar and partake in doing mathematical tasks related to the stories presented. Although the stories in this workshop were applied in an Arab context, the ideas can be edited for use in any cultural context. <https://doi.org/10.37626/GA9783959871129.0.07> Bedwell, Mike: Freedom of Speech. pp 34 – 35 This paper rues the fact that submissions to some academic journals are treated increasingly badly by the publishers, with little succour offered by the editor. The writer gives an example where changes in terminology, spelling and punctuation were introduced after the paper had been accepted by the peer appraisers. This paper also argues for rigid ruling on the graphical presentation of quantitative data, such as the dimensionless labelling of the axes in Cartesian graphs, and the default rule for ordering the nominal variables on a bar-chart. <https://doi.org/10.37626/GA9783959871129.0.08> Bentley, Brianna: College Students’ Views of Fraction Arithmetic. pp 36 – 41 College students view mathematics, specifically fraction arithmetic, as a series of tricks that can lead them to the correct answer. This view of mathematics is a direct reflection of their lack of conceptual understanding of fraction arithmetic and their reliance on procedural understanding. College students have an imprecise remembrance of fraction arithmetic and instead rely on tricks they vaguely remember and cannot explain. This reliance on procedural processes that they do not fully understand causes them to make mistakes in their arithmetic. If we do not require students to think critically about the mathematical processes they are completing when first taught a subject and require this critical thought as students progress through mathematics courses, mathematics loses meaning and our students will not have the ability to think critically or conceptually about mathematics. <https://doi.org/10.37626/GA9783959871129.0.09> Betts, Paul; et al: Foundational Experiences as a Design Principle for Mathematics Curriculum for Children. pp 42 – 47 Students must make sense of the mathematics they are learning, if they are to understand it. When students are encountering a mathematics topic primarily through that topic’s mathematical forms—its symbols, terminology, definitions, operations, and algorithms—the richness, potency, and completeness of their understanding will depend on their prior, pre-formal experiences with that topic. Foundational experiences activities enable students to construct images, patterns, and ideas—in a word, memories—that will enable them to see the sensibility of the topic’s mathematical forms when they learn them. We invite participants to explore some examples of instructional activities designed to provide foundational experiences for multiplication. What are the qualities that we should invest in foundational experience activities? How can such activities be positioned within curriculum design, with the goal of increasing the quality of students’ understandings of mathematics topics, in pursuit of success for all participants in school math? <https://doi.org/10.37626/GA9783959871129.0.10> Billings, Esther; Kasmer, Lisa: Learning via Teaching: Examples of Mediated Field Experiences in Early Coursework of Pre-Service Teachers. pp 48 – 53 Twenty years ago, Ball and Cohen (1999) described a vision for practicebased professional education in which teachers’ learning is situated within practice. We have purposefully designed practice-based educational experiences early in teacher preparation coursework around McDonald et al.’s (2013) learning cycle to include mediated field experiences. Such experiences are structured to explicitly connect coursework and fieldwork and are organized around core practices; preservice teachers (PSTs) deepen their learning of mathematics and ways to teach mathematics by doing the work of teachers within authentic K-12 classroom settings. In this paper we describe examples of mediated field experiences structured on McDonald et al.’s (2013) learning cycle that occur early in PSTs’ coursework, prior to student teaching. <https://doi.org/10.37626/GA9783959871129.0.11> Brahier, Daniel J.: Research into Practice: 29 Years of Classroom Teaching. pp 54 – 59 The preparation and professional development of mathematics teachers requires instructors who are not only proficient in their content and pedagogy but can bring successful teaching experiences to the classroom. In this paper, the author shares his experience of 29 years of simultaneously teaching in a K-12 secondary school, while also serving as a university professor who teaches mathematics methods courses. Examples of classroom experiences that enhanced university methods courses are described, as are some of the benefits of teaching in both settings to connect research and practice in mathematics teaching. <https://doi.org/10.37626/GA9783959871129.0.12> Browning, Sandra: Elementary Preservice Teachers and Questioning Strategies in Mathematics. pp 60 – 65 Research has demonstrated an interest in the relationship between teachers’ questioning strategies and children’s ability to reason and learn (Baroody & Ginsburg, 1990; Buschman, 2001; Fennema, Franke, Carpenter & Carey, 1993). Helping preservice teachers develop effective questioning strategies is an important component of a teacher education program. This session describes an exploration designed to determine if EC-6 preservice teachers can (a) recognize effective questioning strategies when observing inservice teachers and (b) use Hess’s Cognitive Rigor Matrix to analyze the level and effectiveness of their own questioning strategies during field experiences. <https://doi.org/10.37626/GA9783959871129.0.13> Burrill, Gail: Statistical Literacy and Quantitative Reasoning. pp 66 – 71 Given a world awash with data, students of today will be consumers of statistical information whatever their future. What can we do to make them critical consumers as articulated by researchers such as Gal and Steen and as suggested in the National Council of Teachers of Mathematics Catalyzing Change, able to process information, ask the right questions and make informed decisions? This paper explores what it means to be statistically literate able to reason with quantitative information in today’s world and why it is important from both a personal and professional perspective. Examples from several fields illustrate features of essential core concepts that should be components of the curriculum for all students if we are to have statistically literate citizens capable of thinking and reasoning in quantitative situations. The discussion will also address some of the challenges we face in making this recommendation a reality. <https://doi.org/10.37626/GA9783959871129.0.14> Cametti, Cristina; et al: Advantages, Challenges and Opportunities in Teaching Statistics in Doctoral Training to a Heterogeneous Group: the

Case of FLAMES Summer School. pp 72 – 77 FLAMES is an inter-university doctoral training network in which all Flemish universities of Belgium collaborate. It aims to support young researchers, in need of methodological and statistical insights and skills, by offering them high quality training at basic, intermediate and advanced levels. One of our most successful activities is a yearly two-week summer school which features a range of modules on research design, statistical methodology and data analysis. Each module connects theory with hands-on exercises, focusing on various disciplines and using different software packages. In this paper, we discuss the FLAMES approach in teaching statistics to a heterogeneous group of young researchers from various disciplines with a different background in statistics and methodology. FLAMES' 'measuring is knowing' principle is used to evaluate the content, applicability and educational aspects of the current modules and to receive suggestions for future topics. <https://doi.org/10.37626/GA9783959871129.0.15> Castro Miguez, Luis Alexander; et al: Diagrammatic Reasoning from Reflections on Peircean Semiotics. pp 78 – 83 The document illustrates some elements of reflection on Peirce's semiotics focused on reasoning through diagrams. The solution of a Euclidean geometry problem is taken as a reference in which mathematical diagrams are recognized as epistemological tools in the learning and teaching of geometry. This is how an interpreter, who systematically observes and experiments with a geometric diagram, generates different interpretants by means of abductive, inductive and deductive reasoning. <https://doi.org/10.37626/GA9783959871129.0.16> Chapman, Olive; Babb, Paulino Preciado: Prospective Secondary Mathematics Teachers' Development of Knowledge of Modelling for Teaching. pp 84 – 89 Given the growing attention on modelling in school mathematics curriculum, prospective teachers are likely to need special help to develop a rich sense of mathematical modelling [MM] and effective classroom practices to support students' development of MM competencies. This paper is based on a study involving the use of inquiry-based activities to engage prospective secondary mathematics teachers [PTs] in developing such knowledge of MM for teaching. Participants were students in a mathematics education course. Data sources included course work and field notes. We report findings related to the inquiry-based activities and the learning they afforded in the participants' understanding of specific components of problem-solving [PS] and MM knowledge for teaching and the relationship between them. <https://doi.org/10.37626/GA9783959871129.0.17> Chin, Kin Eng; Jiew, Fui Fong: Misconceptions or Preconceptions in Making Sense of Decimals. pp 90 – 95 This paper aims to explore the root causes of students' misconceptions in decimals. A set of decimal tasks and follow-up interviews were used to gather the relevant data. Eight Year Six primary school students participated in this study on a voluntary basis. In this paper, data collected from two students were reported because they showed qualitatively distinct responses and could cover the spectrum of responses of this group of participants. Findings revealed that students' misconceptions maybe regarded as preconceptions that were developed from work experiences in other contexts such as integers. This shows that the learning experiences from other contexts may impede future learning of students in new contexts. <https://doi.org/10.37626/GA9783959871129.0.18> Civil, Marta; Hunter, Roberta: Supporting Mathematics Teachers to Build Deep Understandings of the Home Contexts of their Students. pp 96 – 99 Teachers face many challenges in meeting the cultural diversity they encounter in current mathematics classrooms. To avoid marginalisation of specific groups of students we advocate for a strength-based approach in which teachers are supported to build deep understandings of the lived home context of their students. We discuss findings from our research projects with immigrant students (Pʻsifika) in New Zealand and with Mexican American students in the United States. While our contexts are quite different, our approaches have much in common, in particular through their focus on teachers learning from and about their students' communities to then build on this learning in their mathematics teaching. Bridging theory and practice, we share specific strategies that we have used to support teachers as learners of their students' home contexts (e.g., home visits; parents' classroom visits; school meetings led by parents). <https://doi.org/10.37626/GA9783959871129.0.19> Clemmer, Katharine; et al: Collaborative Solution Discovery: A Problem Solving Process. pp 100 – 103 Loyola Marymount University (LMU) has developed a new approach to problem solving, Collaborative Solution Discovery (CSD), to help practitioners in a school system leverage their individual passions in a way that grows students' positive math identity through mathematical thinking, problem solving, and self-regulation. By focusing on how students and teachers interact with each other in real-time in an ideal classroom, practitioners take ownership of a process to guide their students in growing their positive math identity and thus taking ownership of their own math learning. Practitioners measure progress along the way through metrics that are created, defined, used, and continually refined by themselves to attain their ideal math learning environment. The entire CSD process results in a system that owns its improvement efforts—improvement efforts that are flexible, adaptable, and sustainable. <https://doi.org/10.37626/GA9783959871129.0.20> Coggins, Porter; et al: The Mathematical Culture of Ojibwe Students – An Ethnographic Study. pp 104 – 109 Human beings have an innate capacity to communicate, count, detect patterns, locate, and create. With these capacities we invent, design, play, and explain. Regardless of academic background, we also have the innate capacity to use mathematics in meaningful ways. However, in spite of this innate capacity, there is a large disconnect between innate function and success in academic mathematics. Our research is based on interviews of 14 Ojibwe-identifying tribal college students. The instrument was constructed based on Bishop's (1988) set of six universals or activities people have always done. We present the development of the instrument, interview process, and initial findings. Findings include common ethnomathematical threads found among the interviewed students. Our goal is to use this research to improve our preK-12 professional education teacher program and positively impact Ojibwe student learning. <https://doi.org/10.37626/GA9783959871129.0.21> Collins, Ken: Using CAS to Improve Student Understanding of Calculus Concepts. pp 110 – 114 This session will explore two areas of application of CAS: one focusing on how teachers can improve student learning using CAS, the other focusing on how students can use CAS directly to help them improve their understanding of calculus concepts. We will illustrate the first area by sharing some examples of calculus teaching lessons that use CAS to help students understand or apply a particular concept. We will illustrate the second area by sharing some examples of student explorations that utilize CAS. These allow students to explore some relationships and applications we use in calculus that would be difficult to do otherwise. For example, the Mean Value Theorem (MVT) is one of the most important theorems in calculus. Many first year calculus students have difficulties really understanding or applying the MVT. Using CAS, a student can explore how to apply the MVT to a differentiable function and develop a better understanding of the MVT and its graphical interpretation. This session will focus on first year calculus topics. <https://doi.org/10.37626/GA9783959871129.0.22> Curry, Marjorie: Culturally Responsive Math. pp 115 – 117 Using the Ready for Rigor framework, Zaretta Hammond's book *Culturally Responsive Teaching and the Brain: Promoting Authentic Engagement and Rigor Among Culturally and Linguistically Diverse Students* gives educators a neuroscience-based approach to closing the achievement gap. The Ready for Rigor framework consists of four strands: awareness, learning partnerships, information processing, and community building. Acknowledging that all four strands are paramount to culturally responsive teaching but restricting focus to information processing, this session will give participants examples of and strategies for making their mathematics lessons more culturally responsive. More specifically, participants will learn to game-ify it, story-ify it, and make it social. <https://doi.org/10.37626/GA9783959871129.0.23> Czarnocha, Bronislaw: Constructivist Teaching Experiment: Constructivist Research and Constructivist Teaching. pp 118 – 123 The aim of the discussion is twofold: first, we formulate and present examples of the creative bisociativity inherent in teaching-research TR/NYCity model (Section 1). Second, we bring the creative model of teaching-research as the precise solution to the difficulties experienced by Common Curriculum Standards in Mathematics (CCSM). Section 2 analyzes the reason for extraordinary difficulties in successful introduction of the curriculum into practice, which manifest themselves among others, by the necessity of scripted lessons telling teachers exactly what to do in all different moments of the lesson time. The root reason for the contemporary difficulties is the absence of teachers involvement in the design process It is in contradiction with the irreducible presence of teaching within the central constructivist instrument of research- constructivist teaching experiment of Cobb and Steffe (1983). <https://doi.org/10.37626/GA9783959871129.0.24> Das, Mili: Curriculum for Mathematics Education – An Approach to Discuss Relation Between Theory and Practice. pp 124 – 129 A new curriculum has been introduced in Teachers' Training course as the course is shifted from one year to two-year course in West Bengal, a state of India. In this curriculum in each course-paper theory and practicum are given equal importance so is in mathematics education also. In this new approach most of the educational experiences in mathematics education, gathered by the trainees are set and organized by combining theory and practicum. So, instead of only theory in this paper relationship is discussed on intertwined function of theory and practicum with practice. <https://doi.org/10.37626/GA9783959871129.0.25> De Lange, Jan: Curious Minds: Serious Play. pp 130 – 135 We describe the background, theory, implementation and results so far of the Curious Minds Project, carried out by seven Dutch and Belgian Universities. The present article focuses on the Utrecht University's involvement and results. Issues addressed are: hypothesis, role of manipulatives (toys), designing student activities from pre-primary to primary, creativity and curiosity, the role of adults and the challenges for professional development. Keywords: Early Childhood, Curiosity, Scientific Reasoning, Practice. <https://doi.org/10.37626/GA9783959871129.0.26> Demirbec, Maifer Remzie: Puerto Rico Gas Prices Fall – „The Math of Cheap Oil“. pp 136 – 138 This project is an application of “Rate of change” and “Equation of the line” in business and finance field, as part of College Algebra and Trigonometry syllabus. The goal of this project is to develop students' skills to understand and interpret graphs, tables, Math concepts as absolute value and percent change by showing them how Math is connected with real life issues. Also, is to engage students with the topic and through that how to use their Math knowledge of reading tables, complete tables, calculate the absolute and percent change,

construct and interpret graphs. <https://doi.org/10.37626/GA9783959871129.0.27> Dick, Thomas P.; Pilgrim, Mary E.: Learning (and Learning Teaching) by Doing Problems. pp 139 – 144 Active learning is often a challenge to find in mathematics classrooms at the post-secondary level. Still, teachers are expected to be experts in student-centered approaches despite not having experiences with such approaches as students. The aim of this workshop is to introduce participants to a totally problem-based instructional experience, with the opportunity to actively engage in mathematics as students. During the workshop, participants will engage in discourse and reflection – reflection on both mathematics as well as the impact such a problem-based instructional experience could have on their practice. <https://doi.org/10.37626/GA9783959871129.0.28> Dorrington, Pam: Family Maths: Experiential Learning. pp 145 – 149 The international Family Maths programme adopts an inquiry teaching and learning approach and it encourages learners, often from diverse backgrounds, to participate fully in the learning process. The programme also aims to develop the vocabulary necessary for meaningful communication in mathematics, develop problem solving skills and increase confidence and enjoyment of mathematics. The programme has proven to be a powerful catalyst in this regard and holds important lessons for both curriculum development and developing positive attitudes towards mathematics teaching and learning. This experiential learning, interactive work-session focuses on primary school mathematics curricula (for pupils approximately 9 – 13 years of age) and aims at giving participating conference delegates an opportunity to engage with and experience some of the hands-on problem solving activities used in the Family Maths programme. Discussion will be encouraged around the relevance of these activities for the teaching and learning of mathematics. Our conference organisers encourage presenters to consider the relationship between research and classroom teaching, and how, and if, these relate to each other in practice. Can the Family Maths philosophy and practice be a catalyst in narrowing the divide between the theory and practice of effective mathematics teaching and learning? <https://doi.org/10.37626/GA9783959871129.0.29> Ferrarello, Daniela; et al: Serious Games in Teaching/Learning Mathematics: the Experience of FunGo. pp 150 – 155 In this paper we present a general overview of serious games and their educational potential. We focus in particular on serious games for the teaching/learning of mathematics, highlighting how the method of horizontal teaching is effective in enabling students to achieve the learning objectives set by the teacher. FunGo, a serious game designed by the authors (researchers in mathematics education) in synergy with a group of graphic designers and computer scientists, is part of this line of ideas. We will show how FunGo has a multiple usability: it has, in fact, a double didactic use and has been used in public events of dissemination of mathematics, reporting in both cases positive results. <https://doi.org/10.37626/GA9783959871129.0.30> Fine, Benjamin; et al: The Impact of Mathematics and Mathematicians. pp 156 – 160 The 1600's ushered in our modern world, but not in the way most people learn in school. There was a revolution; started by Kepler, continued by Galileo, Descartes and Fermat and culminating in Newton and Leibniz. This revolution allowed for the development of modern mathematics which in turn led to modern science and engineering to advance. Hence, the technological revolution occurred which has shaped our present-day existence much more than anything else. In this article we examine these developments during the amazing seventeenth century. We keep an eye on the fact that for whatever reason human beings for the most part seem not to do hard engineering until the hard science is developed and not to do the hard science until the correct mathematics has been discovered. <https://doi.org/10.37626/GA9783959871129.0.31> Fox, Courtney: Clean Water for Women and Children. pp 161 – 163 This workshop gives participants an outline of a full unit in Trigonometry that covers right triangle trigonometry, the law of sines, and the law of cosines. Attendees will participate in abbreviated student tasks. In the unit students are introduced to the world water crisis and how it affects women and children the most and why this is. Using their knowledge of trigonometry and the Desmos (or other graphing) calculator to “solve” a water crisis in a town and bring clean sanitation to a remote island. This unit helps students develop critical thinking and problem-solving skills, numerical literacy, and global awareness. Students make connections to the “real world” using mathematics and become world citizens. <https://doi.org/10.37626/GA9783959871129.0.32> Galluzzo, Ben; Kavanagh, Katie: Getting Started Getting Students Modeling: Designing and Facilitating Open-ended Math Modeling Experiences. pp 164 – 167 “Modeling” is a term that has several meanings in general, but particularly in mathematics. Here math modeling 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 using a formula that arises from an application (for example, distance equals rate times time) and the actual creation of a mathematical relationship itself that can be useful in an applied setting. In this two part workshop, we demonstrate how to develop authentic math modeling challenge problems that are accessible and relevant to students. In the second part of the workshop we talk about how to facilitate math modeling so that students have an opportunity to be creative and innovative in their modeling process while having ownership over their solution. <https://doi.org/10.37626/GA9783959871129.0.33> Gazit, Avikam: Mathe Teachers' Attitudes toward Integrating Humor in Math Lessons. pp 168 – 172 The purpose of this study was to examine the attitudes mathematics teachers toward integrating humor in math lessons. Mathematics and humor are not seen as consistent with each other. Mathematics is seen as a subject is difficult to understand and its subject matter is isolated without any humanistic elements. Integrating humor in math lessons may create a pleasant atmosphere and reduce math anxiety. Humor can increase motivation as well as promoting creative thinking. A sample of 25 math teachers, most of them from elementary schools, answered a questionnaire. An important conclusion to be drawn from the findings is the positive attitudes of the teachers regarding the integration of humor in math lessons. It recommended strengthen math teacher to integrate humor in their lessons. <https://doi.org/10.37626/GA9783959871129.0.34> Gill, Eoin: Maths Week Ireland: Promoting a Positive Attitude to Mathematics in Ireland. pp 173 – 176 Maths Week Ireland is an annual festival established in 2006 by people in the STEM community as an all-island event including the Republic of Ireland and Northern Ireland. Particular effort is made to highlight maths for life, for careers and as part of our culture. While the core principle is “Maths for All” the main engagement is with schools. In 2018 teachers reported 354,000 primary and second level pupils participating through in-school activities, online activities and events at partner centres. Maths Week creates an opportunity to disseminate new ideas in maths education. It also creates a space whereby teachers can try out new ideas and invent and create new activities with their pupils. This paper describes the organisation and activities of Maths Week and discusses the impact of the initiative with particular reference to evaluation with teachers. <https://doi.org/10.37626/GA9783959871129.0.35> Goodell, Joanne E.: Learning to Teach Mathematics Through Project-Based Instruction. pp 177 – 182 Project-based instruction (PBI) is gaining prominence in the USA as an instructional innovation that promotes deep and connected understanding in mathematics. In this paper, I describe a program developed at the University of Texas at Austin known as UTeach that is being replicated in 45 universities across the USA. Concepts of inquiry teaching, problem-based and project-based instruction are developed across the program. In this paper I argue that the structure, timing and location of student teaching impacts whether or not pre-service teachers are able to implement PBI during student teaching, which in turn impacts satisfaction with the student teaching experience and ultimately the intention to enter and continue in the teaching profession. <https://doi.org/10.37626/GA9783959871129.0.36> Gordon, John; et al: A Problem-Solving Approach to the Introduction to Ordinary Differential Equations for Undergraduate Students at an American Two-year College. pp 183 – 188 Undergraduate students in STEM (Science, Technology, Engineering, and Mathematics) at City University of New York (CUNY)-Queensborough Community College (QCC) working toward a baccalaureate degree at one of CUNY's senior colleges are required to take an introductory course in ordinary differential equations (ODE). Faculty in the Mathematics Department at QCC are experimenting with a problem-solving approach to this course in which students engage in learning course material through the development of mathematical models of real-world problems. The results seem promising and we outline them in this paper. Key-Words: First-order, linear system, integrating factor, homogeneous equation, research-based. <https://doi.org/10.37626/GA9783959871129.0.37> Grzegorzczuk, Ivona: Magic Tricks and Activities Supporting Abstract Thinking in Mathematics. pp 189 – 192 This workshop will involve you in mathematics based magic tricks activities promoting pattern recognition and algebraic modeling in various contexts. The interactive, hands-on activities are designed for introductory algebra courses, but they can be modified to generate more complexity and advanced mathematical thinking. <https://doi.org/10.37626/GA9783959871129.0.38> Gurevich, Irina: Do Future Mathematics Teachers Need the Course „Integration of Digital Technologies in Teaching Mathematics“, and if so, what exactly can it help them with? pp 193 – 198 In the current research we analysed our teaching experience in the course “Integration of digital technologies in teaching mathematics”. The students were mathematics student teachers. The main goal of the course was to demonstrate the potential of digital technologies in teaching mathematics and to provide the students with basic skills in the intellectual use of these technologies. During the course the students, after getting acquainted with various mathematical software packages, build and present their own teaching units. We were interested to analyse the students' attitudes towards the course. A multiple-choice questioner was formulated, and the collected data were analysed. We observed that most of the students found the course being helpful for their future teaching. The obtained results indicated that the described course provided them a didactic model to emulate. <https://doi.org/10.37626/GA9783959871129.0.39> Hansen, Heidi B.; Magiera, Marta T.: Working Together: A Cross-cultural Study Addressing Mathematics Anxiety in K-8 Pre-service Teachers. pp 199 – 204 This study will present data from research on K-8 pre-service teachers' math anxiety across three universities: one public, one private and one non-U.S. The article discusses background rationale, literature, tools used and results of this study. The results of the study indicated that similar math anxiety levels exist in students in all three types of academic institutions. The paper also incorporates discussion of the importance of including the topic in pre-service teacher training, and

possible interventions for alleviating math anxiety. <https://doi.org/10.37626/GA9783959871129.0.40> Hansen-Smith, Bradford: Why the Circle cannot be Squared. pp 205 – 210 Squaring the circle using compass and straight edge in such a way that both have the same area is not possible. The question is, why not? Math logic assumes there must be an area equal to both. Presumably there is a need to make these very different 2-D shapes equal, possibly to find a geometric proof to an inverse mathematical concept about differences. To “square the circle” gives preference to the square, four straight lines and four 90° angles, over a single line of the circle without angles. Maybe the emphasis more correctly is about the relationship of difference. Logically the truncation process suggests the circle is origin to the square, meaning there can be no polygon equal to the circle. Folding the circle gives a unique perspective about the relationship of circle to square, revealing 90° to be an angle of change, of directional movement between two points before any construction of a fixed angle or measuring of lines and areas.

<https://doi.org/10.37626/GA9783959871129.0.41> Herrelko, Janet M.: Change the Paradigm of Solitary Lesson Planning to Collaborative Planning that Unites Research and Practice. pp 211 – 216 Teachers are planning mathematics lessons using a basic protocol created in the 17th century. The results of the Programme for International Student Assessment provide evidence that this is not a successful approach to teaching students mathematical concepts today.

Research in cognitive sciences has established how people attend to, sort, and store new content. Educational research provides case studies of successful pedagogical methods that help students learn. It is time for mathematics educators to unite these resources to create integrated lessons that focus on problem solving with experiential learning. This is a proposal to have teachers integrate educational and cognitive research creating lessons that improve access and equity to help students learn mathematics. <https://doi.org/10.37626/GA9783959871129.0.42>

Horwitz, Kenneth: Utilizing Analytics to show Representations used in Comparing and Ordering Unit Fractions. pp 217 – 222 Video Analytics bring together the world of educational research and classroom teaching with technology and the internet. Through use of more than 4500 hours of video data, an open source analytic creation tool, this study creates a video analytic that supports a research paper. In addition to supporting research, analytics can be a reflective tool for teachers, as well as support professional development as all levels. This report illustrates the video analytic, Using Meredith’s models to reason about comparing and ordering unit fractions, (Horwitz, 2015, available at <http://dx.doi.org/doi:10.7282/T33J3FQG>), as well as the methods used in the creation of the analytic used to support research in student use of representations to make sense of fractions. <https://doi.org/10.37626/GA9783959871129.0.43>

Huang, Hsin-Mei E.; et al: Investigating Junior High School Students’ Length Estimation Ability and Strategies. pp 223 – 228 This study investigated junior high school students’ length estimation ability with respect to everyday objects with lengths between 1 millimetre and 1 meter. Students’ strategies used for estimating the length of the longer side of a basketball court in school were analysed. A total of 240 Grade 7-9 students from cities in northern Taiwan completed a paper-and-pencil test assessing length estimation abilities. Results showed a significant gender effect on length estimation, but neither effects of grade level nor any interaction between grade level and gender on length estimation. About 40% of the students used effective strategies for estimating length measures, including visualizing, utilizing body parts, applying previous experiences, using a mental ruler, and making use of objects nearby. Still, about 60% of the students used ineffective strategies such as guessing. Implications for research and education practices are discussed. <https://doi.org/10.37626/GA9783959871129.0.44>

Humarán Martínez, Yuitza T.: Using Manipulatives to Develop the Understanding of the Concept of the Fraction of Preservice Elementary Teachers: The Meaning of Measure. pp 229 – 234 Manipulatives are a tool when that well-implemented can contribute to the development of mathematical concepts and processes, and is a popular strategy in elementary school. However, educators usually don’t use this technique efficiently for several reasons. For example, they had never used manipulatives before starting to work at school. In this quasi-experimental research, the understanding of preservice elementary school teachers of the concept of the fraction, specifically, the meaning of measure, was studied. Statistically significant evidence was gathered to conclude that the understanding of the meaning of measure improves after the implementation of the lesson with tangible manipulatives. <https://doi.org/10.37626/GA9783959871129.0.45>

Hydorn, Debra L.: Tools for Modern Mathematics: A Course to Introduce Experimental Mathematics. pp 235 – 239 The accessibility of computational methods and resources has made it easier to include undergraduates in mathematical research projects. However, based on the traditional form of mathematics education, many students aren’t confident in developing their own research questions or conjectures. Originally created to introduce students to programming tools (R, Mathematica and MATLAB), this course has evolved into an introduction to experimental mathematics. Students first learn the fundamentals of programming along with algorithmic structures and methods of simulation. Then, following the approach used by the Summer Undergraduate Research Institute in Experimental Mathematics at Michigan State University, students participate in (1) an experimental phase, where they use algorithms and simulations to produce output, (2) a conjecture phase, where they review their output to identify potential relationships and patterns, and (3) a 2nd experimental phase where additional output is produce to determine if any of their conjectures are still viable. The focus of the course is on developing students’ ability to pose research questions and their ability to use computational tools to address those questions. <https://doi.org/10.37626/GA9783959871129.0.46>

Iji, Clement O.; Andortan, Joseph A.: Brandishing Ethno-Mathematics Approach as an Interface for Improving Upper Basic Education (UBE) Students’ Interest and Achievement in Number and Numeration. pp 240 – 244 The study considered how ethno-Mathematics approach could be brandished to serve as an interface to improving UBE students’ interest and achievement in number and numeration (NN). The study was carried out in Obudu, a rural community in Cross River State of Nigeria. It adopted a quasi-experimental of pre-test post-test control groups design with intact classes used. Population of study comprised all the 6,226 upper basic education students from the 23 government controlled basic education schools in the study area. Two instruments were used for data collection. The study found among other things that when ethnomathematics was properly brandished, the UBE students improved in their interest and achievement in the NN concepts taught during the period of this study. It was also found that the initial noted gap between the male and female UBE students’ interest and achievement in NN was drastically reduced. Key words: Brandishing, Ethnomathematics, Interface, Number and Numeration, Upper Basic Education, Interest and Achievement <https://doi.org/10.37626/GA9783959871129.0.47>

Innabi, Hanan; et al: Patterns of Variation in the Work of „Mathematics in the City Project“: A Suggested Research Question. pp 245 – 250 The framework of this paper is based on the variation theory (VT), which explains the necessary conditions for learning. According to this theory, students have to experience patterns of variation for learning to take place. This paper highlights the patterns of variation that can be found in the work of the “Mathematics in the City” (MitC) project. Some examples are presented, and a research question is proposed related to using VT as a tool to analyze students’ learning in the MitC classrooms. <https://doi.org/10.37626/GA9783959871129.0.48>

Jackson, Colin: Going Against the Grain: Critical Thinking in and Beyond Mathematics. pp 251 – 256 In the UK, it is almost universal that secondary mathematics is taught in classes organised on the basis of differential ‘ability’: all-attainment teaching is rare. This paper is based on data collected from in-depth interviews with a small number of teachers whose beliefs and practices defy this norm. A number of themes emerged in their teaching, but in this paper I explore, very briefly, how the teachers enacted their belief in the importance of developing their students’ critical thinking skills as well as their mathematics. <https://doi.org/10.37626/GA9783959871129.0.49>

Jiew, Fui Fong; Chin, Kin Eng: The Embodiment of Mathematical Meanings with Special Reference to Multiplication: Issues and Challenges. pp 257 – 262 This paper aims to illustrate how two primary school teachers (Doreen and Edwin – pseudonyms) make sense of mathematics in particular the multiplication of fractions and decimals. The meaning of a particular mathematical expression and symbol could be conveyed through language however a mathematical procedure that is performed for a purpose may be difficult to make sense sometimes. Data were collected through semistructured interviews. Findings revealed that Doreen recognised the meaning of multiplication as the notion “of” in the contexts of fractions. Both of them rote learned the mathematical procedures in the multiplication of fractions and decimals and they could not make sense of them. One of the main reasons for this was because they were not aware of the changes of mathematical meanings across different contexts. <https://doi.org/10.37626/GA9783959871129.0.50>

Johnston, Peter; et al: Supporting Transition for Mathematics and Science Students under an Assumed Knowledge Approach. pp 263 – 268 In Australia there is concern over the poor mathematical skills of students entering University STEM degrees (King & Cattlin, 2015). Challenged by the introduction of an assumed knowledge approach for mathematics dependent university degrees, we noted diagnostic testing approaches (Ní Fhloinn et al., 2014) and sought to adapt the successful GetSet2 quiz that previously had been applied only to pre-requisite mathematics university entry (Burton et al., 2013). We introduced the on-line self-assessment Get Ready Maths/Science quizzes for commencing science and mathematics students. This allowed students to receive timely personalised feedback on their level of knowledge and skills compared with the expected assumed/pre-requisite knowledge for university entry. This paper reviews the design, development and initial implementation of transition quizzes under the challenges of an assumed knowledge framework, instead of a pre-requisite framework. <https://doi.org/10.37626/GA9783959871129.0.51>

Johnston-Wilder, Sue; Lee, Clare: How can we Address Mathematics Anxiety more Efficiently as a Community? pp 269 – 274 Mathematics anxiety has been discussed for over 60 years. The majority of those suffering belong to an identifiable subgroup, often identified as ‘female’, or learners with a ‘feeling’ rather than a ‘thinking’ preference, or empathisers. These learners prefer to understand the value, meaning, purpose and narrative of the mathematical tools they are required to learn. Ten years ago, we planted a seed for a change in practices that engender anxiety to those that build a positive stance. This seed has grown into a group of teacher and research practitioners working to overcome mathematics

anxiety and build mathematical resilience. The paper discusses what is known, by these researchers and teachers, and how to develop innovative communication in order to work internationally toward elimination of the acquired, disabling condition of mathematics anxiety. <https://doi.org/10.37626/GA9783959871129.0.52> Kaino, Luckson Muganyizi: Enhancing Mathematical Modeling Activities in Classroom Instruction. pp 275 – 280 The ability of students in mathematical modeling was enhanced through activities that involved systems of linear equations with two variables. Students involved were in form four, at the final year of the ordinary secondary school level where they were expected to have mastered the knowledge on systems of linear equations with two variables. Students' knowledge on ill-conditioned linear systems was explored as well as their knowledge on practical problems in linear equations. Then after, mathematics subject teachers guided students to identify practical problems in linear equations of two variables. Students were put into groups to think of problems in real life and come up with solutions. The solutions were related to the real situations in the environment and each group had to make a presentation in the class. Problems in transportation, manufacturing, production and diet were identified by students and the results presented for discussion. It came out clearly that students acquired knowledge on solving real life problems at the end of the activities. Before these activities, students had theoretical knowledge on solving problems with two unknowns without relating these to real life problems. While knowledge on independent and inconsistent systems was known to students, enthusiasm was noted among students at the end of the activities when they got involved in real aspects of solutions obtained. It was concluded that with more time availed in the school curricula, students can acquire useful knowledge on mathematical modeling to achieve problem-thinking skills that involve real life situations. <https://doi.org/10.37626/GA9783959871129.0.53> Kania, Sylwia: Solving Mathematical Problems in the Context of Some Obstacles between Teachers and Students. pp 281 – 286 Great mathematical discoveries are mostly based on huge knowledge of their explorers and long, solid work leading slowly to the finding. There are also well known cases of the “accidental” discoveries that happened quickly, intense and their founders did not even realize the range of the discovery, because they were working on something else at the time. Nevertheless, each finding requires energy, devotion and concentration of its discoverer. Solving mathematical problems demands quite the same things, thus teachers may find some opportunities to create curious, open-minded young discoverers. It is not an easy job to do though, because there is a great risk of killing pupils' enthusiasm by teacher's skepticism, there is a large chance to nip pupils' energy in the bud by routine operations and there is a huge possibility to discourage pupils' endeavors by giving them wrong-chosen problems to solve. <https://doi.org/10.37626/GA9783959871129.0.54> Kennedy, Tierney: Exploring the Nature of Teacher Questioning with Challenging Tasks for Inducing Conceptual Change. pp 287 – 292 Recent research has considered how to support teachers using challenging tasks in mathematics with students who struggle. Teacher questioning in response to correct or incorrect answers has been identified as an important element for maintaining the cognitive load. This paper examines the nature of teacher questioning within challenging tasks in which struggling students were noted to change their own conceptions and proposes a minor change to include a questioning phase within the Launch-Explore-Summarise structure by Lappan et al. (2006). It presents evidence from a two-year study in which the combination of conceptual change questioning with challenging tasks led to substantial gains for low-performing students across six primary schools on standardised tests compared with Education Department expectations ( $d = 0.7$ ). <https://doi.org/10.37626/GA9783959871129.0.55> Klymchuk, Sergiy; Wilson, David: Integrating Pen-enabled Tablet PCs in Teaching Engineering Mathematics. pp 293 – 298 The paper analyses the attitudes and experiences of two university lecturers involved in integrating pen-enabled Tablet PCs (penTPCs) in teaching engineering mathematics. The first lecturer has an engineering background and teaches an advanced engineering mathematics course (year four). The second lecturer has a mathematics background and teaches a second year engineering mathematics course. Two rounds of interviews with the lecturers on using penTPCs were conducted in 2015 and 2019. Analysis of these interviews suggests that, for the lecturer in mathematical disciplines, a key factor in their initial adoption of penTPC technology may be their perception of the usefulness of the technology in enhancing delivery within the context of existing pedagogical approaches in a classroom/lecture setting. <https://doi.org/10.37626/GA9783959871129.0.56> Krevisky, Steve: Using Sports Data in Statistics and Math Classes: An Overview and Update. pp 299 – 300 Sports data can be a very good way to motivate students, in both statistics and math classes. Background to this usage will be discussed, along with some new ideas on how to employ this in the classroom. <https://doi.org/10.37626/GA9783959871129.0.57> Kusaka, Satoshi: Analysis of the Characteristics of Mozambican Primary Mathematics Textbooks compared with Japanese Textbooks focusing on Tasks and Problems related to the Real World. pp 301 – 305 This study aims to clarify the pertinent characteristics of Mozambican primary mathematics textbooks from a sociocultural perspective (in comparison to Japanese ones) by focusing on how they treat ‘real-world’ mathematics. The following four perspectives are discussed: (1) Proportion of the tasks related to the real world via the introduction of new learning content (2) Proportion of problem solving exercises related to the real world (3) Categorization of the situation of the tasks and problems related to the real world (4) Appearance of socially open-ended problems and their content. As a result, we found that there are few problems which are related directly to the real world in the Mozambican primary mathematics textbooks. The content of the problems related to the real world are about the tax system and salaries, which means students are given opportunities to view and think mathematically about their social system right from the primary school age. <https://doi.org/10.37626/GA9783959871129.0.58> Laskasky, Katie; et al: Innovative Problem Solving: What happens when Math Education, Business, and Engineering Perspectives Interact. pp 306 – 311 For years, practitioners and researchers have attempted to solve the same math education problem. Though the approach varies, they use outdated processes and see few results. Thus, there is an overall need to use new strategies. This paper explores how one K-12 school district uses an innovative, collaborative, problem solving process to understand its math learning problem. Stakeholders engage diverse viewpoints, use research based recommendations to define success in how students learn mathematics, develop context-sensitive solution options, and evaluate those options' adaptability. This innovative problem solving process' foundation emerges from research and best practice recommendations found at the intersection of multiple disciplines: math education, business, systems engineering, and implementation science. The current observation and interview data indicate that stakeholders feel a sense of ownership, embrace variability in problem solving, and understand how to collect data about students' math learning. <https://doi.org/10.37626/GA9783959871129.0.59> Lemieux, Collette; Roettger, Eric: Students' Reasoning During a Calculus Two-Stage Exam. pp 312 – 317 For a two-stage exam, students first write their exam individually and then repeat it in a small group. This study analyzed the discussions that students had during the group stage of a two-stage exam in a first-year calculus course in order to investigate students' reasoning and how they arrived at their answers. Data, consisting of 14 transcripts of audio-recordings of the students' discussions, were analyzed qualitatively, guided by Lithner's (2007) conceptual framework on mathematical reasoning. The results suggest that, though students primarily used imitative reasoning or rote learning to answer many questions, they also demonstrated creative reasoning by using a novel & plausible approach and grounding their reasoning in mathematics. Further, though the imitative reasoning relied primarily on remembering a theorem or term in calculus, creative reasoning was demonstrated in multiple ways. <https://doi.org/10.37626/GA9783959871129.0.60> Corredor, Olga León; et al: Integrating Technology and Didactic Resources for Enhancing Learning Processes. An Exploratory Study. pp 318 – 323 Some limitations that affect the learning of mathematics are related to two dysfunctional issues: lack of acknowledgment of students' differences in the didactic designs and of the students' awareness about their learning skills. Accessible and affective didactic designs aim to overcome such dysfunctional issues. In this direction, the document presents three contributions: first, the exploration of technological relationships that foster cognitive convergence between the student and tools; second, a revision of hypotheses that give support to accessible and affective didactic designs; and third, the documentation of the learning trajectories that some diverse Colombian populations made while they were playing the game called The Jumper. The methodologies used in the research were Design Science Research and Teaching Experiments. <https://doi.org/10.37626/GA9783959871129.0.61> Liang, Su: Enquiry-Based Learning in College Mathematics Education: Theory and Practice. pp 324 – 329 The practice of Inquiry-Based Learning (IBL) has a very long history. In the western world, the ancient Greek philosopher, Socrates (469 – 399 B.C.) had utilized IBL to engage his interlocutors in dialogue for discovering basic truth and principles. In the Eastern world, the ancient Chinese philosopher and educator Confucius (551 -479 B.C.) had also raised the idea of IBL approach for teaching and learning. Confucius had said: “I hear, I forget; I see, I remember; I do, I understand”. Active learning is the essence of IBL way of teaching. The IBL discussed in the paper is guided IBL. In the research literature, many research showed evidence that guided IBL produced better learning outcomes comparing to pure lecture approach. In recent years, promoting IBL in the field of education becomes a trend, because researchers believe that the features of IBL can fulfill the 21st century education through cultivating students' critical and creative thinking, nurturing inquiry mind of problem-solving, and preparing life-long learners, for our society. However, in reality, the traditional way of teaching – lecture is still dominated at school teaching. Why has IBL been promoted in the educational research but most teachers still never employ it in their teaching practice yet? In this paper, I will discuss the challenging we are facing and propose some ideas for IBL implementation. <https://doi.org/10.37626/GA9783959871129.0.62> Lipovec, Alenka; Ferme, Jasmina: Some Factors Influencing Effectiveness of Mathematics Homework. pp 330 – 335 Empirical research, which examines the relationship between mathematical achievement of elementary school students and mathematics homework assignments, gives inconsistent results. We present the results of the crosscultural study (N = 1061) with 12-15 years old students from Slovenia, Croatia and Slovakia. The results show that homework frequency, teacher

responses, and the support of parents are not related to students' mathematics achievements; but parental control and the time spent doing homework are negatively related to those achievements.

<https://doi.org/10.37626/GA9783959871129.0.63> Lousis, Michael: Recommendations for Instructional Designers and Textbook Writers Concerning the Correction of Significant and Persistent Errors in Arithmetic and Algebra. pp 336 – 342 An error analysis of the 200 English and 150 Greek learners' tests in arithmetic and algebra was accomplished. Those tests stemmed from the Kassel Project. Following this error analysis, specific recommendations are presented in each domain of arithmetic and algebra that should be taken into account by instructional designers and textbook writers. These recommendations were founded on terms of psychology and cognitive science as applied to information-processing. The study has shown the educational media (textbooks etc.), as being responsible for the emergence and persistence of these errors in the learners' minds too, since instruction is mostly based on the use of those media. Key words: error analysis, Kassel Project, textbooks, educational media, recommendations. <https://doi.org/10.37626/GA9783959871129.0.64> Marchand, Patricia: Interface between Theoretical Guidelines and Classroom Practices to Create Activities that Enhance the Development of Spatial Reasoning in Elementary School. pp 343 – 346 The spatial reasoning has been identified by many researchers as being linked to positive mathematical performance and, therefore, is a determining factor in mathematics and scientific success at elementary, secondary and upper levels (Davis & The spatial reasoning study group, 2015). Also, spatial reasoning has been proven to be a type of reasoning that is malleable and can be develop, implying that teachers are empowered in this development (Moss, Bruce, Caswell, Flynn & Hawes, 2016; Wai, Lubinski & Benbow, 2009; Marchand, 2009a; Berthelot & Salin, 1992). The goal of this workshop is to expose theoretical guidelines to analyse and to create classroom activities focusing on developing spatial reasoning in elementary school. The interface between these theoretical guidelines and classrooms activities allows us to unfold new ideas to deal with spatial reasoning at the elementary level. <https://doi.org/10.37626/GA9783959871129.0.65> Markun, Urska; Kos, Jasna: Research Work in a Secondary School Classroom: How Well are Teachers Equipped for it? pp 347 – 352 A university degree is not enough in itself to equip a mathematics teacher for successful secondary school-teaching in the longer term. Without continuous training and career-long learning, a teacher will not be able to provide adequate support for students in activities such as extended essays or explorations, both of which are compulsory components of the IB programme. In this paper, we present some examples of such work by IB students at our school. In addition, some Slovenian secondary school students regularly participate in a national research competition for which they must submit project-based work in various fields. The present article describes how university departments co-operated with our secondary school in the course of such research. Examples of research carried out by a number of 16-year-old students at our school are also presented here. <https://doi.org/10.37626/GA9783959871129.0.66> Mart, Malgorzata: The Impact of Teacher Self-Efficacy on the Level of Implementation of Graphing Technology in Teaching Factoring Quadratic Functions in Introductory Algebra. pp 353 – 357 The purpose of the study was to determine whether there is a relationship between self-efficacy of global and local algebra teachers and their level of incorporating technology in teaching factoring quadratic functions to introductory algebra students. The participants (54 mathematics educators from 15 countries and five continents) replied to the UVGIA survey instrument. Quantitative analysis of data brought the conclusion that there is a strong positive relationship between the level of self-efficacy of teachers and their level of implementations of technology regardless of country of origin. <https://doi.org/10.37626/GA9783959871129.0.67> Mason, Ralph; et al: Foundational Experiences as a Curriculum Design Principle for Secondary Mathematics. pp 358 – 363 Students must make sense of the mathematics they are learning, if they are to understand it. When students are encountering a mathematics topic primarily through that topic's mathematical forms—its symbols, terminology, definitions, operations, and algorithms—the richness, potency, and completeness of their understanding will depend on their prior, pre-formal experiences with that topic. Foundational experiences activities enable students to construct images, patterns, and ideas—in a word, memories—that will enable them to see the sensibility of the topic's mathematical forms when they learn them. We invite participants to explore some examples of instructional activities designed to provide foundational experiences for the mathematics of powers, from power laws through geometric sequences to exponential functions. With these examples, participants will consider these questions: How can foundational experiences contribute to students' understandings of the math behind the topic's formal content? What are the qualities that we should invest when designing foundational experience activities? <https://doi.org/10.37626/GA9783959871129.0.68> May, Bernie (Dov): Engage Students More Hopscotch Mathe has Students Jumping for Joy. pp 364 – 367 The goal was to create a system to teach children deep thinking skills, as well as problem solving skills which they could later use in tomorrow's innovation economy. The by-product is they learn the Times Table. We cover more in less time...under 5 hours, we go up to  $20 \times 20$ , and introduce the children to complex algebraic equations, too. Guess what? They love it – and ask for more! The times table represents the problem to be solved. Each intersection represents a smaller aspect of the problem. They learn various techniques. No dumb sing-song melodies. They build on what they know. We do not go linearly through the table. We jump around...and cover whatever we can. When we are through I show them that if they only knew  $7 \times 4 = 28$ , they have the problem solving skills where they can solve the whole table. The idea behind Kinesthetic Math is to get into their world, and reach them at their level. Children like to run, jump, colour and move around – so do we. We use our fingers, our knuckles, and our legs to learn the Times Table. This paper covers a small section of the program, Magic Squares and Hopscotch Math, as an introduction to a different kind of thinking and how innovative thinking can be applied to teaching. I introduce the program with a  $10 \times 10$  grid representing the times table. Every time we solve one of the blocks on the table, they get to color the block however they want. <https://doi.org/10.37626/GA9783959871129.0.69> Menz, Petra; Mulberry, Nicola: Open Source Differential and Integral Calculus Material Development to Support Student Accessibility and Learning. pp 368 – 373 Educational resources in mathematics are an important aspect of the teaching and learning landscape. Moreover, resources have come a long way from the spoken word with such inventions as paper and the computer to the point where there is now an infrastructure around open educational resources (OER) that has matured into viable alternatives to traditional resources. The newfound prevalence of these materials provides opportunities to customize OER to the specific needs of students and institutions. We designed open source material for the social science strand of differential and integral calculus by adopting an open source textbook and adapting it for our needs. Along with the course notes, we developed lecture notes, student notes based on the Cornell note-taking system, and assignments with solutions. Students are appreciative of free material, but moreover, the cohesiveness and interconnectivity among the various course materials provides for a smoother learning journey through our courses. This paper presents our philosophy, an overview of our open source material, and the operation of both courses. <https://doi.org/10.37626/GA9783959871129.0.70> Michelsen, Claus: The MACAS Symposiums 2005 – 2019. Mathematics Education in an Interdisciplinary Context. pp 374 – 379 The symposium series Mathematics and its Connections to the Arts and Sciences (MACAS) has been held since 2005. The vision which the MACAS initiative is based upon is to develop a humanistic approach to education that combines various disciplines in a single curriculum. According to this vision the aim is to educate students by enabling them to pursue diverse fields of research, while at the same time exploring the aesthetic and scientific connections between the arts and science. In view of the challenges of the 21st century, a modern approach to education with a focus on multi- and interdisciplinarity is more important than ever. Five MACAS symposiums have been held since 2005, and the proceedings of the symposiums provide an insight into ideas, experiences, conceptual frameworks, and theories to connect mathematics education to the arts and sciences. Based on the symposiums proceedings we provide an overview of five main themes addressed at the MACAS symposiums (i) mathematics and science (ii) mathematics and art (iii) mathematics and technology, (iv) mathematics and literature, and (v) educational perspectives on interdisciplinarity. The overview highlights the need for joint empirical investigations that operationalize, model and study the rich ideas presented in at the symposiums. <https://doi.org/10.37626/GA9783959871129.0.71> Miheso-O'Connor, Marguerite K.: Teaching Mathematics through Historic Environment. A Time-Travel Grounded Pedagogy. pp 380 – 385 Mathematics has been used by generations to make important decisions for a long period of time. History is littered with problem solving events which are results of mathematization of tasks based on available tools in any given generation. While History of mathematics focuses on what each culture contributed to present day conventional mathematics as taught in schools as a subject, Mathematics in a Historic environment focuses on identifying mathematical thinking that exists in all historical events. Historical events when enacted through the Time Travel approach learners get the opportunity to relive past events in the present context. Teaching mathematics in historic environment uses the time travel events that are practised by bridging ages international, to provide a reflective meaningful conceptualization of mathematics is a living subject. The strategy illuminates the centrality of mathematical thinking in all historical events. This paper shares findings from a study carried out on the effectiveness of this approach for teaching mathematics and provides an opportunity to discuss the approach as a viable pedagogic strategy that can be replicated across the curriculum <https://doi.org/10.37626/GA9783959871129.0.72> Missen, Jenny: Researching and Implementing in the Mathematics Classroom Australian Curriculum General Capabilities. pp 386 – 391 The Australian Curriculum (AC) provides teachers with a great amount of detail in each curriculum area. In addition to teaching these curricula, the AC requires incorporation of Cross-Curriculum Priorities and General Capabilities. This paper documents the work done on an action research project considering ways in which the General Capabilities (GCs) of the Australian Curriculum could be incorporated into teaching Mathematics and the difficulties I faced as a teacher researching during the teaching term. <https://doi.org/10.37626/GA9783959871129.0.73> Morge, Shelby: Addressing

Teachers' Culturally Responsive Teaching Beliefs through Course Activities. pp 392 – 397 Making data-based decisions about course content is a difficult process for teacher educators. This difficulty is amplified when considering complex issues focused on diversity. In order to understand and address pre- and in-service teachers' culturally responsive teaching beliefs, the Culturally Responsive Teaching Outcome Expectancy Scale (Siwatu, 2007) was administered during graduate and undergraduate courses in mathematics education at two southeastern US universities. From the survey results instructors identified items with high and low means (on a 100 point scale). The lowest items provided a basis for constructing future course activities. In this paper we share the expectancy scale results and course activities that were implemented. We also discuss opportunities for improving the culturally relevant practices and activities in our courses in order to ensure the transfer to classroom practice. <https://doi.org/10.37626/GA9783959871129.0.74>

Morska, Janina: From the Purpose of the Lesson to Success. pp 398 – 400 This paper deals with efficiency in teaching. The purpose of the lesson and the criterion of success are complex elements in the didactic process. Between these elements are theory and practice, various forms of work, feedback and student self – evaluation. I would like to share my professional experience as an apprenticeship teacher, as well as a deputy head teacher (vice-director) observing the work of other teachers in formative assessment. <https://doi.org/10.37626/GA9783959871129.0.75>

Moscardini, Lio; et al: Collaborating Across the Pond: Cognitively Guided Instruction Project. pp 401 – 405 This paper describes a primary-school (ages 5-11) project implemented in Scotland, based on the United States research from Cognitively Guided Instruction (CGI), and as envisioned by Dr. Lio Moscardini. Three schools, two public and one private, participated in this two-year long initial study that focused on helping teachers to understand the developmental stages pupils naturally progress through in order to understand the mathematics for their class level as defined by the Scottish government. This project provides evidence that a rise in attainment can occur by focusing on teachers' knowledge, pedagogy, and pedagogical content knowledge in relation to mathematics rather than by focusing on attainment itself. Additionally, this project addresses the teaching and learning of a diverse group of students, i.e. inclusion, low socio-economics. <https://doi.org/10.37626/GA9783959871129.0.76>

Movshovitz-Hadar, Nitsa; et al: Bridging between School Mathematics and Contemporary Mathematics: Turning a Dream into Reality. pp 406 – 411 In many countries, school mathematics curriculum does not go beyond the 18th century mathematics. Any solution for bridging this gap must consider students' limited background, as well as teachers' time constraints. Our 'bridge' consists of periodically interweaving Mathematics-News Snapshots (MNSs), i.e., short descriptive presentations of recent mathematical results, throughout the teaching of the ordinary math curriculum during the three years of senior high school. More than 20 MNSs are already available (see <https://MNS.co.il>). Our two-part workshop is aimed at sharing our solution. This will include a discussion of its underlying principles, a reverse engineering analysis of sample MNSs vis-à-vis the MNS authoring guidelines, an overview of three teacher preparation models, and results of our implementation follow-up studies. Finally, in the spirit of the conference, we'll invite attendees to adopt our solution, and possibly also to participate in developing more MNSs, thus turning our dream of bridging the gap into reality. <https://doi.org/10.37626/GA9783959871129.0.77>

Narayanan, Ajayagosh: Peer Tutoring: Developing and Sustaining Effective Teaching Practices with Mathematics Teachers in Lesotho. pp 412 – 417 This paper shows how a group of educators initiated in-service workshops for primary and secondary mathematics teachers since 2012 in collaboration with the Ministry of Education and Training (MoET) in Lesotho. The prime focus of these workshops was to develop teachers' capacity building in mathematics through peer-support. The paper also narrates how a chain of these workshops evolved to a capacity building program with innovative approaches in classrooms. These workshops explored ideas on numbers, shapes (through the use of origami) and problem solving for effective teaching/learning of mathematics. The concept of peer tutoring/learning had emerged from these workshops as an idea that suits Lesotho education system. A capacity building program was thus recommended for the sustainability of these activities. <https://doi.org/10.37626/GA9783959871129.0.78>

Navarro Robles, María Estela: Variation Theory used to make a Personalized Diagnostic in the Level of Knowledge of Fundamental Concepts about Rational Numbers and their Operations in Undergraduate Students. pp 418 – 421 This lecture explains how through Marton Variation Theory was designed and evaluated a test about rational numbers to identify for each student the specific knowledge and skills about the theme to solve problems and to make operations and thus which concepts they need to learn or what skills they need to develop. The variation theory was used in the sense of one problem, multiple changes. The test was answered by 115 students of 7 groups of a private university, who are enrolled in a leveling course. From the answers of the students it was characterized the lived object of learning and this was the start point to classify the conceptual or operational needs of each student. With the detailed results it was possible to design a personalized route of learning. Key words: Rational numbers, variation theory, undergraduate student, personalized course <https://doi.org/10.37626/GA9783959871129.0.79>

Niess, Margaret L.: Online Strategies Enhancing Mathematics Teacher Knowledge for the Digital Age: Discourse and Critical Reflection. pp 422 – 427 This study designed online graduate courses to enrich inservice mathematics teachers' Technological Pedagogical Content Knowledge (TPACK). The effort identified key experiences to engage teachers in discourse and critical reflections for relearning, rethinking, and redefining teaching and learning as they know and learned it, transforming their TPACK with respect to teaching with digital technologies. The experiences modeled inquiry tasks merging content, technology and pedagogy as described in TPACK, connecting teachers with experiences as students learning about and with technologies. Critical reflections on the experiences as learners and as teachers combined with the online community of learners' discourse, transforming their teacher knowledge. The collection of strategies involving discourse and critical reflection did enhance the participants' TPACK, providing recommendations for designing online inservice teacher education courses. <https://doi.org/10.37626/GA9783959871129.0.80>

O'Dell, Jenna R.; Frauenholtz, Todd R.: An Unsolved Graph Theory Problem: Comparing Solutions of Grades 4, 6, & 8. pp 428 – 433 This study investigated how students in Grades 4, 6, and 8 reasoned through a non-routine, unsolved problem. The study took place at a K-8 school in the Midwestern United States. Each grade participated in two or three task-based sessions lasting between 45 and 60 minutes with the researchers. During the sessions, students engaged in the Graceful Tree Conjecture where they examined graceful labelling for Star, Path, and Caterpillar Graphs. We examined differences in students' generalized solutions across the grades and how they were able to provide justifications and state generalizations of a graceful labelling for the graphs in the Path Class. Descriptions of students' generalized solutions are included for each grade level. <https://doi.org/10.37626/GA9783959871129.0.81>

O'Meara, Niamh; Faulkner, Fiona: Professional Development for Out-of-field Post-primary Teachers of Mathematics: A pre and post Analysis of the Impact of Mathematics Specific Pedagogical Training. pp 434 – 439 The Professional Diploma in Mathematics for Teaching is a 2-year part-time programme dedicated to out of field teachers of mathematics in second level education in Ireland. The programme was introduced in Ireland after a report highlighted that 48% of second level teachers of mathematics in Ireland were not qualified to teach mathematics (Ní Ríordáin & Hannigan 2011). The programme has been running since 2012 and is currently upskilling its 6th cohort of out-of-field teachers. As part of the programme, teachers are required to undertake mathematics content modules as well as mathematics specific pedagogy modules. One such mathematics specific pedagogy module requires students to undertake five 3-hour workshops which examine mathematics content contained on the second level curriculum and offers suggestions on how to teach it for conceptual understanding. Teachers in Cohort 5 of the programme completed a questionnaire prior to completing the 5 workshops to outline how confident they felt teaching particular aspects of the second level mathematics curriculum. They were also asked to best describe the teaching approaches that they favoured at that point in time. Upon completion of the 5 workshops, this same cohort of teachers completed a similar questionnaire investigating their level of confidence in teaching the curriculum and any changes in their teaching practices that occurred as a result of participation in this module. <https://doi.org/10.37626/GA9783959871129.0.82>

Page, Jenny: Effective Use of ICT and Storytelling to Teach Statistics in the Preschool Classroom. pp 440 – 444 New school curricula and modern teachers are trying to get the child engaged and interested in statistics through accessibility and enjoyment. This has been backed up by much research into the correlation of a child's engagement and their academic achievement (Gunuc, & Kuzu, 2014). Using storytelling as a teaching method, teachers can provide a meaningful context for statistics which can change this prejudice from a young age (Casey et al., 2004, Walters et al 2018) and is shown to have many educational benefits for children (Sherwood, 2018). In the last years ICT tools, games and storytelling have been used to achieve this engagement (Lekka et al, 2017, Walters 2018). ICT provides children with the opportunity to enhance their communication skills, creativity, high-order thinking and practical technological skills which are needed in a modern society (Corel, 2019). This paper includes a brief overview of research that looks at the use of ICT applications, and use of storytelling to teach descriptive statistics in the preschool classroom. <https://doi.org/10.37626/GA9783959871129.0.83>

Paolucci, Catherine: Supporting Pre-service Mathematics Teacher Development through Transformative Community Engagement. pp 445 – 449 Opportunities for field-based transformative learning are a critical part of mathematics teacher education, yet several factors limit the extent to which teacher preparation programs can offer them. This paper discusses the value of transformative learning for pre-service mathematics teachers and presents an example of an international community engagement program that was specifically designed to support transformative learning for pre-service teachers in both the United States and South Africa. It highlights evidence of key aspects of transformative learning in the reflections of both the pre-service teachers and the students in the program and discusses the implications of this for future research and program development. <https://doi.org/10.37626/GA9783959871129.0.84>

Pearn, Catherine; et al: Developing and Assessing Algebraic Reasoning in the Middle



Years. pp 450 – 455 New school curricula and modern teachers are trying to get the child engaged and interested in statistics through accessibility and enjoyment. This has been backed up by much research into the correlation of a child's engagement and their academic achievement (Gunuc, & Kuzu, 2014). Using storytelling as a teaching method, teachers can provide a meaningful context for statistics which can change this prejudice from a young age (Casey et al., 2004, Walters et al 2018) and is shown to have many educational benefits for children (Sherwood, 2018). In the last years ICT tools, games and storytelling have been used to achieve this engagement (Lekka et al, 2017, Walters 2018). ICT provides children with the opportunity to enhance their communication skills, creativity, high-order thinking and practical technological skills which are needed in a modern society (Corel, 2019). This paper includes a brief overview of research that looks at the use of ICT applications, and use of storytelling to teach descriptive statistics in the preschool classroom. <https://doi.org/10.37626/GA9783959871129.0.85> Pearson, Esther: „STEPS“ to a Brighter Future. pp 456 – 461 The „Science, Technology, Engineering, Precollege Studies“ (STEPS) program was developed in 1988 by Dr. Esther Pearson. The STEPS program has served thousands of youth over the past two decades to provide academic support and mentoring to minorities and women students. The STEPS program focuses on demonstrating a connected learning approach to STEM academics. Students participate in mentoring through the STEM pipeline of course choices, extra-curricular activities, and exposure to STEM practitioners. Students learn to overcome the challenges that prevent successful matriculation into STEM fields. Minority and women students in elementary through college in the Boston and greater Boston areas learn how to navigate from a desire for a STEM career to achieving one. <https://doi.org/10.37626/GA9783959871129.0.86> Pilgrim, Mary E.; Dick, Thomas P.: Actively Engaging in Calculus to Support all Students. pp 462 – 466 Research findings support the use of active engagement in the mathematics classroom. Active learning not only has the potential to positively impact student learning, it also helps to address equity issues in the mathematics classroom. However, with limited experiences in student-centered instruction and little to no pedagogical training, mathematics faculty are often underprepared to meet the needs to today's STEM majors. In addition, content-specific professional development is typically not readily available to faculty on their campuses. With a focus on calculus, this workshop aims to fill this professional development gap by providing participants with the opportunity to engage in student-centered activities as well as reflect and discuss the implications for their own mathematics classrooms. <https://doi.org/10.37626/GA9783959871129.0.87> Pomuczne Nagy, Ildikó-Anna: How and wherer can a Mathematics Teacher Utilize his 33 Years of Teaching Experience? A Math Teacher about Teaching Mathematics-Excerpt from 33 Years of Teaching Experience. pp 467 – 472 This paper shows how a mathematics teacher can utilize his teaching experience. I have been working as a mathematics and physics teacher in Hungary for 33 years. I have taught at various levels of the education system: at elementary school, high school, teacher training college, and in teacher training too, but at most time of my job I taught at high school. I am currently working on the series of a new mathematics textbook for 10 to 14-year-old students. It is based on the traditions of the Hungarian mathematics education, but using the opportunities offered by the 21st century, it also includes modern sample tasks that fit into the curriculum, for example Geogebra files, written by me. I would like to share how I use my teaching experience in textbook writing and how I focus primarily on the didactic aspects of teaching mathematics. I pursue my PhD research in the topic of problem-solving thinking, so I study the mathematical thinking of my students studying in different school types. In my lecture, I analyse different tasks by focusing on mathematical methodological aspects. For example I will tell that I believe it is advantageous to introduce mathematical definitions with examples which are astonishing for students in order to draw attention to maths as much as possible. I will give examples of how I build my experience into the textbook in order to make the system of mathematical concepts optimal for pupils. I would like it if give you an insight into a segment the current Hungarian mathematics education, the current teaching of problem-solving thinking and the different ways of students' thinking. <https://doi.org/10.37626/GA9783959871129.0.88> Povey, Hilary: Moral and Political Dilemmas in Working with the Concept of Citizenship within Mathematics Teaching in Schools: a Personal Perspective. pp 473 – 478 This paper springs out of my engagement with a curriculum development project framed in response to a European Union call for action on global citizenship. But citizenship is a complex and elusive concept – slippery, dangerous and contested. Inevitably, tensions arise as we seek to find a way of acting in the world and trying to find, however limited and partial, an answer to the question: „what is to be done?“. In this paper, I identify and offer a personal response to some of moral and political dilemmas we have identified during the design and implementation of the project. <https://doi.org/10.37626/GA9783959871129.0.89> Prendergast, Mark; et al: Incentivising the Study of Higher Level Mathematics. pp 479 – 484 In Ireland, mathematics has been assigned a special status within the postprimary school curriculum with the introduction of a Bonus Points initiative (BPI) in 2012. Students are now awarded an extra 25 points in their upper post-primary school state examination results if they achieve a passing grade at Higher Level (HL) mathematics. The culmination of points that student achieve in six different subjects acts as a gatekeeper to tertiary level education. Mathematics is the only subject in which there are extra points awarded. The initiative was introduced to encourage more students to study the subject at an advanced level. Anecdotally there have been many mixed reviews about the success of the BPI. While the numbers taking HL mathematics have steadily increased, there have been concerns expressed that many students who are not mathematically capable of performing up to the standard required are now opting for the HL paper and that the difficulty of this examination and the marking schemes have been adjusted accordingly. This paper investigates the advantages and disadvantages associated with the BPI from the perspective of mathematics teachers (n=266). <https://doi.org/10.37626/GA9783959871129.0.90> Raja, Shagufta; et al: Using GIS to Develop Spatial Reasoning and Analysis of Data. pp 485 – 490 The Geographic Information System (GIS) is a spatial analysis tool that allows users to capture, store, analyze, and visualize data related to real-world problems. GIS is used daily in multiple STEM fields to solve complex problems. Educators find GIS useful for students to be able to interpret data in a spatial context. Students develop quantitative and spatial analysis reasoning using GIS to understand and develop solutions for many current scientific concerns. This paper presents two cases highlighting middle grade students' use of GIS. The cases illustrate how GIS promotes students' development of spatial reasoning as they think about patterns and relationships made evident through data visualization. The cases demonstrate how students engage in finding relative and absolute mapped features, geographic patterns, and changes over time as they make decisions using geographic inquiry, spatial thinking and problem solving. <https://doi.org/10.37626/GA9783959871129.0.91> Ramsay, John R.: Mentored Teams of Undergraduates in Real World Consulting. pp 491 – 496 One of the difficulties in mathematics education is providing a good answer to the “What can I do with mathematics?” question. Applied examples and projects within existing mathematics courses can help answer this but often aren't close enough to real world applications and they can consume considerable course time. We have addressed this difficulty with a summer program that employs students to solve actual applied problems. The College of Wooster Applied Methods & Research Experience is a summer program that puts teams of students to work as consultants in the local community. Student teams are usually composed of three students with a mathematics or computer science faculty member acting as mentor. Clients of the program come from business, industry, government agencies, and service organizations. The program also includes a significant professional development component in order to increase the educational benefit to the participants. <https://doi.org/10.37626/GA9783959871129.0.92> Rugelj, Marina: Counting with 10 Fingers as a Man, with 8 fingers as a Hen or with 2 Switches as a Computer. pp 497 – 502 In the high school curriculum of mathematics in Slovenia one of the goals is “Students can convert from decimal to binary number”. In most high schools, an algorithm for conversion is presented, which the students learn by heart like a cooking recipe, without proper understanding. A different method will be presented, where pupils play, explore and find certain conclusions on their own. This helps students to understand and learn the new concept much more efficiently, comparing to when they only listen to the instruction. Hence, the knowledge gained this way is hopefully more solid and lasting. <https://doi.org/10.37626/GA9783959871129.0.93> Sack, Jacqueline; Quander, Judith: Secondary Math Teacher Candidates' Perspectives on a Co-Taught Blended Content & Methods Geometry Course. pp 503 – 508 Two faculty, from the mathematics and education departments in an urban university, co-teach a blended methods and content geometry course for preservice secondary teachers who are also math majors. The course is entirely inquiry-based, a departure from traditional instructor-centered maths courses, and utilizes design-based trajectories developed by one of the authors over 12 years. We conducted two individual clinical interviews and one focus-group interview with 6 volunteer students, to ascertain their perspectives on how they best learn mathematics; to gauge how they perceived the inquiry-based experiences from this course; and, their reflections on inquiry-based instruction in mathematics as they move forward in their goals to become teachers. We used narrative inquiry as a research method to study the experiences of these students individually and collectively. <https://doi.org/10.37626/GA9783959871129.0.94> Sáenz-Ludlow, Adalira; Jiménez, Alexandra Jiménez: Linkages between a Teacher's Preparation and the Potential for Students' Learning. pp 509 – 514 From the Peircean perspective of diagrammatic reasoning, the paper presents a teacher's analysis of a task with a square array of dots. She conceptualizes different partitions of the array and transforms it into different tasks of sequences of squares to facilitate her inductive thinking and the emergence of different generalizations pertaining square numbers. <https://doi.org/10.37626/GA9783959871129.0.95> Santhanam, S. R.: Welcome 2019 – A Workshop on Framing Non-Routine Problems in Mathematics for all Levels. pp 515 – 516 The main aspect of mathematics is problem solving. A non-routine problem is any complex problem that requires some degree of creativity to solve. There are no standardised methods to solve a non-routine problem, if there is one then it becomes a routine problem. What about framing a non-routine problem? It is all the more difficult. In this

workshop the author attempts to make the audience to understand non-routine problems and their solutions and further to frame problems of this nature. <https://doi.org/10.37626/GA9783959871129.0.96> Shamash, Josephine: From Equations to Structures: Linking Abstract Algebra and High-School Algebra for Secondary School Teachers. pp 517 – 522 The high-school curriculum in algebra deals mainly with the solution of different types of equations. Modern algebra has a completely different viewpoint and is concerned with algebraic structures and operations. The course Algebra: From Equations to Structures is part of an M.Sc. programme for Israeli secondary school mathematics teachers. It provides an introduction to algebraic structures and modern abstract algebra, and links abstract algebra to the high-school curriculum in algebra. It follows the historical attempts of mathematicians to solve polynomial equations of higher degrees, attempts which resulted in the development of group theory and field theory by Galois and Abel. This approach leads naturally to examining topics and fundamental theorems in both group theory and field theory. Along the historical “journey”, many other major results in algebra in the past 150 years are introduced, and current research in algebra is highlighted. We examine the relevance of the course to the teachers’ work. <https://doi.org/10.37626/GA9783959871129.0.97> Showers, Dennis: Real-world Maths: Preparing Teachers to use Real-life Contexts for Teaching Maths. pp 523 – 525 Common Core Mathematics in the US promotes eight Standards for Mathematical Practice to guide instructional reform. Standard 2 includes the practice of “decontextualizing” or abstracting a given situation and representing it symbolically to solve real-world problems. Preparing teachers to employ this practice in classrooms requires knowledge and skill to apply technology to bring the real world into the classroom and the ability to discuss personal experiences in a mathematical way. Professional development with New York teacher candidates and in-service teachers in Nicaragua, China, and the US indicates the need for further dissemination with a research program to evaluate its efficacy. <https://doi.org/10.37626/GA9783959871129.0.98> Shriki, Atara; Lavy, Ilana: Shedding New Light on Common Algorithms: What can we Learn from Vedic Mathematics? pp 526 – 528 In Sanskrit, the ancient Hinduism language, ‘Vedas’ means ‘knowledge’. The Vedas are a corpus of more than 1,000,000 ancient philosophical writings divided into Sutras, some of which deal with mathematics. These mathematics Sutras, termed ‘Vedic Mathematics’, concern various fields of mathematics. The Vedic methods are coherent, logical and simple, and students enjoy practicing them. Besides ‘spicing up’ the regular mathematics lessons by integrating some of the Vedic algorithms, engaging students in proving them supports the development of their insights regarding the rationale underlying the formal rules and algorithms included in the curriculum. In this workshop, we present some of the basic Vedic arithmetic and algebraic algorithms, involve the participants in proving them and discuss the advantages and disadvantages of integrating Vedic mathematics into classes at different age groups and study levels. <https://doi.org/10.37626/GA9783959871129.0.99> Sibbald, Timothy: The Confluence of Numeracy with Interdisciplinary Mathematics. pp 529 – 534 Interdisciplinary mathematics, such as STEM, but not limited to it, has received considerable attention in recent years. Its role in mathematics is the provision of practical circumstances that support learning mathematical concepts. The validation of concepts through the adoption to interdisciplinary purposes has a broad base of examples. Furthermore, among the concepts bridging mathematics and another discipline is a group of concepts that transcend a variety of other disciplines and, within that scope, numeracy emerges. Since this is not a traditional definition of numeracy it is reconciled with other definitions of numeracy and the implications of that reconciliation with interdisciplinary instructional approaches is examined. <https://doi.org/10.37626/GA9783959871129.0.100> Siemon, Dianne: Connecting Research and Practice – The Case of Multiplicative Thinking. pp 535 – 540 There is very little of any substance that can be achieved in school mathematics, and beyond without the capacity to recognise, represent and reason about relationships between quantities, that is, to think multiplicatively. However, research has consistently found that while most students in the middle years of schooling (i.e., Years 5 to 9) are able to solve simple multiplication and division problems involving small whole numbers, they rely on additive strategies to solve more complex problems involving larger numbers, fractions, decimals, and/or proportion. This paper describes how this situation can be addressed through the use of evidence-based formative assessment tools and teaching advice specifically designed to support the development of multiplicative thinking. <https://doi.org/10.37626/GA9783959871129.0.101> Smith, Raymond; et al: Insights Gained from Implementing Teaching Toolkits: A Case of Activating Prior Knowledge. pp 541 – 546 In designing teaching toolkits for teachers the effectiveness of such a resource depends on mutual enactment and engagement by the designer, the teacher and the learners. It is a recursive process and illuminates the tensions between the intended outcomes envisaged by the designer and the realised outcomes in the classroom. In the qualitative research tradition, the exploratory investigation captured in this paper employed a descriptive phenomenological approach. With this orientation, and along the theoretical trajectory led by Todres (2005:107), this study sought to collect detailed descriptive accounts of personal experience. Data were gathered by collecting samples of learners’ work, teacher interviews and classroom observations. This paper draws attention to the practical disjuncture between assessing and activating prior knowledge. Insights acquired may contribute both to the design approach and to teaching practice. <https://doi.org/10.37626/GA9783959871129.0.102> Spooner, Kerri: Authentic Mathematical Modelling Behaviours for Secondary School Students. pp 547 – 551 Mathematical modelling is part of many curricula around the world. Some of these curriculum statements are vague and general. There is a need for statements to be more specific with supporting examples for implementation of curriculums. There is also a need for further development of activities focused on authentic mathematical modelling behaviour. To address this problem, an ethnographic study in New Zealand was carried out to identify the behaviours of a real world mathematical modelling team. These behaviours were then explored to determine what they could look like for a sixteen-year-old student. This paper will present the modelling behaviours of the real world modelling team and the potential authentic mathematical modelling behaviours of a secondary school student. <https://doi.org/10.37626/GA9783959871129.0.103> Stephens, Max: Developing Algorithmic Thinking in Mathematics in the Primary and Junior Secondary Years. pp 552 – 557 The fourth industrial revolution is already changing what we mean by mathematical reasoning in its different forms, such as algebraic, spatial and geometric, and statistical. Algorithmic thinking is one particular form of mathematical reasoning, emphasizing decomposition (breaking a complex problem down into component sub-problems and sub-tasks), pattern recognition, generalization and abstraction. With a growing global emphasis on using algorithmic thinking in coding and computing programs in schools, it is necessary to examine how algorithmic thinking should be included more explicitly in the teaching and learning of mathematics. <https://doi.org/10.37626/GA9783959871129.0.104> Takahashi, Tadashi: Proving in Mathematics Education – On the Proof using ATP. pp 558 – 563 The aim of the mathematics education is the acquisition of “knowledge/skill of the mathematics” and “the mathematical thinking”. Proving is a chain of the logic in mathematics and is “mathematical thinking” itself. So, proving is the domain that is important from a point of view that can evaluate the acquisition of enough “mathematical thinking”. There is a variety of sense of values in the present situation of the proof using the ATP (Automated theorem proving). We should establish a clear vision as mathematics education in this situation. That is, in mathematics education, we should build sense of values for proof using the ATP newly. To that end, we fix contents of the mathematics, and it is necessary to prove them by using ATP. We would like to assume the aim the theorems of Euclid’s Elements. Because the contents are the basics of the mathematical thinking. The proving is an important aim in the mathematics education, it is necessary to clarify new value by using the ATP as mathematics education. <https://doi.org/10.37626/GA9783959871129.0.105> Tannor, David: Effective Mathematics Instruction: Two-Year College Mathematics Instructors’ Knowledge and Self-Efficacy. pp 564 – 569 In this article are findings from a 2017 mixed methods study on two-year college mathematics instructors’ knowledge and self-efficacy on effective pedagogy. <https://doi.org/10.37626/GA9783959871129.0.106> Temple, Barbara Ann; et al: Designing a Transdisciplinary Approach to Elementary Math Literacy Learning through Science & the Arts. pp 570 – 574 Engaging with subject matter in isolation stymies creativity, promotes rote learning, and limits development of divergent thinking skills. Conversely, a transdisciplinary approach to math develops critical and creative thinking skills, strengthens problem solving capacity, and promotes metacognition. In this pilot study, the design-based research process began with sharing initial intervention ideas for elementary Math lessons with participants at an international elementary Math conference. Utilizing participant feedback as part of the iterative process, three specific interventions for second-grade Math concepts were designed with intentional infusion of Science and the Arts. The ultimate goal for this research is the design of an effective elementary Math curriculum offering authentic, real-world learning through a transdisciplinary approach. <https://doi.org/10.37626/GA9783959871129.0.107> Thomas, Jeffrey: Learning through Self-Assessment towards Understanding the New B.Ed. Curriculum in South Africa: Experiences from the new B.Ed. Programme at Sol Plaatje University. pp 575 – 580 The mismatch between instruction and learning could pose a serious barrier to effective teaching and learning. Effective teaching should be a dynamic alignment and realignment of teaching and learning styles to optimise achievement. When teaching and learning styles do not complement each other students may become anxious, frustrated and disengaged which may have negative effects on their performance. The focus of the study is to gather evidence on how students perceive their own learning in order to adapt the teaching approach which will accommodate the students’ preferred way of learning. The main findings in this study showed that students prefer to work independently and that elements of metacognition are present during their efforts to learn. This study therefore suggests that self-assessment activities should become an integral part of the teaching and learning process. Thus, students are afforded the opportunity to advance personal learning through the development of metacognition as self-monitoring and corrective actions. Key words: Self-assessment, metacognition, self-regulated learning <https://doi.org/10.37626/GA9783959871129.0.108> Toro-Clarke, José A.: A Participative and Individualized Laboratory: A Strategy for Increasing Student Success in College-Level

Mathe Courses. pp 581 – 586 This research was carried out within a qualitative research paradigm. The objective was to observe, analyze and enrich pedagogical practice through the use of pedagogical learning strategies. The learning strategy was a participative and individualized laboratory carried out during a research project in a non-Traditional Laboratory (LnT, abbreviated in Spanish form). The primary aim of this research was to observe if the LnT assists the students and in this way maximizes success and knowledge in the Introductory Math course (MATE3001) on the University of Puerto Rico campus. The LnT contributed to: (1) students improved their study habits; (2) the students had greater participation in the solution of math problems, their practice and discussion; (3) they accepted that the research professor supervise their work as it was carried out and understood that the presence was for their benefit. <https://doi.org/10.37626/GA9783959871129.0.109> Vacaretu, Ariana-Stanca: Developing High-School Students' Competences through Math Research Workshops – the M&L Project. pp 587 – 592 Mathematics is or it should be about problem solving and math thinking. However, what mathematics students learn in schools is more about procedures for solving different types of math exercises and problems. In many cases, students learn by heart algorithms and words (math concepts) and use them for solving different math tasks. School math is very far from what mathematicians do and, in many cases, doesn't motivate students for learning math. This paper presents the way we organized the assessment of the students' skills developed through math research workshops and some of the assessment results. Even though we didn't assess all the competences the students develop through the math research workshop, the findings show that the students certainly develop their problem-solving skills. <https://doi.org/10.37626/GA9783959871129.0.110> Walsh Jr., Thomas: Exploring Computer Science with MicroworldsEX to Learn Geometry and Logo Programming Code. pp 593 – 598 Future employment of computer-programming jobs will be best for applicants with experience in different languages and coding tools (Bureau of Labor Statistics, 2018). Empirical and meta-analysis research studies support of teaching Logo programming in developing student cognitive problem-solving skills has been documented. Using guided instruction with teacher-mediated scaffolding Exploring Computer Science with MicroworldsEX (Walsh, 2013-2017) has been found as an effective method in preparing students using the Logo code programming language to create geometric graphic, animation, and gaming projects. More research is needed to study teacher scaffolding and mediation skills to support learning Logo coding and transfer to other domains including other programming environments. <https://doi.org/10.37626/GA9783959871129.0.111> Walsh Jr., Thomas: The Survey Toolkit Curriculum Methodology for Researching Information, Survey Questioning, and Analyzing Data with TinkerPlots. pp 599 – 604 In an era where social media traffics fake news websites that publishes misinformation it is imperative to provide students' experiences in The Survey Toolkit and TinkerPlots curriculum teaching sound research principles and information gathering techniques. The field-tested program was found effective in guiding students choosing research questions, writing a research report using a paragraph cluster information strategy, developing unbiased survey questions using reliable sampling, analyzing survey data with TinkerPlots, and sharing results. The paper will present support for teaching the curriculum, development based on research direction, implementation considerations, and use of the curriculum with elementary to middle school students. <https://doi.org/10.37626/GA9783959871129.0.112> Warren, Lynae; Wohlhuter, Kay: Merging Theory and Practice in Statistics in Communities of Mathematical Inquiry. pp 605 – 606 This workshop will engage participants in statistical problem solving with real-life data, using technology. Participants will work in a Community of Inquiry, (CoI, Garrison, 2016) with other participants to formulate questions that will be answered in their community. The participants will engage in problem solving using 2018 data about world populations, to determine how best to answer their questions and how their answers may become part of a larger exploration. The facilitators will share examples from their work with developmental mathematics students and mathematics teacher candidates regarding how they use the CoI model to merge theory and practice in the areas of: teaching & learning, educational technology, curriculum development, teachers' preparation and development, and issues of equity. Participants will need access to a computer or tablet with web access and spreadsheet software. <https://doi.org/10.37626/GA9783959871129.0.113> Watson, Steven: Bridging Theory and Practice: a Posthuman Perspective on Mathematics Teacher Education. pp 607 – 612 This paper considers posthumanism in the context of mathematics teacher professional learning. Posthumanism presents a challenge to Enlightenment rationality and the privileged position and potential capability of the human mind. Posthuman perspectives present knowledge and knowing as an embodied and experiential process. Learning, then, is not simply about the acquisition of knowledge and skills, it is an embodied experience in which the learner acts within an environment and comes to make sense of this experience through a reflective process. As well as presenting a theoretical account of mathematics professional learning and the implications of the posthuman to this field, I illustrate this with my own research in mathematics teachers' preservice education and the professional development of practising teachers. <https://doi.org/10.37626/GA9783959871129.0.114> Webb, Lyn; et al: Enabling Grade 3 Teachers to Transform an Intended Curriculum into an Enacted Curriculum in Mathematics Classrooms. pp 613 – 617 The introduction of a new mathematics curriculum is usually heralded by the production of a plethora of learner workbooks and teacher aids. In South Africa this study researches the effect of curriculum change on Grade 3 mathematics teachers in an endeavour to understand what elements enable the transition from an intended curriculum to an enacted curriculum. The theoretical framing for this paper is Fullan's (2006) change theory that focuses on new materials, new practices and new beliefs. The research identifies that current South African curriculum documents and workbooks focus on mathematical content almost exclusively, and give minimal guidance concerning pedagogical content knowledge and teacher agency. A tri-level system is suggested to narrow the gap between policy and praxis. <https://doi.org/10.37626/GA9783959871129.0.115> Webb, Paul: Towards Unifying Logic for the Pedagogy of Mathematics in South Africa. pp 618 – 622 South Africa's performance in mathematics at school level is not impressive, even when measured against countries with fewer resources. As a country, it is one of the lowest performers in the world with a wide range of achievement between schools, with historically white schools achieving results much closer to the international average compared to historically-black African schools. The South African National Planning Commission has identified mathematics education as a key area of concern, particularly amongst poor children. In response, the Mapungubwe Institute for Strategic Reflection (MISTRA) initiated a research project to explore the possibility of a 'unifying pedagogy' that could help improve mathematics teaching across the range of schools in the country. This paper presents a summary of the 'cumulative resonances' of 'sagacious' members of the mathematics education community in South Africa and abroad. The data generated by these 'sagacious' sources' in academia and governmental and non-governmental organisations were analysed thematically in order to explore the possibility of framing a unifying pedagogy of mathematics for South African conditions. <https://doi.org/10.37626/GA9783959871129.0.116> Wickliff, Gregory A.; et al: Communicating Mathematics and Science: Teaching and Tutoring Writing in a Summer Program for High School Students. pp 623 – 628 Supplemental instruction and tutoring in writing, genre, and document design and illustration, can improve the quality of formal mathematics and science papers and presentations composed by rising high school junior and senior students in a four-week summer program. This paper discusses the program history and goals, its structure, the methods of instruction and tutoring, and the professional and student writing samples delivered through the University of North Carolina at Charlotte's Summer Ventures in Science and Mathematics program. The program is a no-cost, state-funded program for academically talented students who aspire to careers in science, technology, engineering, and mathematics. Participants reside on the university campus for four weeks and conduct research around topics of their own interest individually or in collaboration with like-minded peers. Participants engage in research under the supervision of university faculty. <https://doi.org/10.37626/GA9783959871129.0.117> Willson, Ian: Formative Assessment and Middle-School Classroom Tasks with the Wolfram Language. pp 629 – 630 Middle-school classroom tasks with the Wolfram Language can play a very significant role in the growth and development of mathematical competence. This can occur at the intersection of challenging Mathematical tasks, coding skills, exploration, discovery, collaboration and formative assessment. This workshop will reference all of these elements as they informed and underpinned classroom activities conducted at several different secondary schools in Melbourne Australia. <https://doi.org/10.37626/GA9783959871129.0.118> Woodcock, Stephen: Not all Equals are Equal: Decoupling Thinking Processes and Results in Mathematical Assessments. pp 631 – 636 One of the greatest challenges in mathematics education is in fostering an understanding of what mathematicians would recognise as "mathematical thought." We seek to encourage students to develop the transferable skills of abstraction, problem generalization and scalability as opposed to simply answering the specific question posed. This difference is perhaps best illustrated by the famous – but likely apocryphal – tale of Gauss's school days and his approach to summing all positive integers up to and including 100, rather than just summing each sequentially. Especially with the rise of technology-enabled marking and results-focussed tutoring services, the onus is on the educator to develop new types of question which encourage and reward the development of mathematical processes and deprioritise results alone. Some initial work in this area is presented here. <https://doi.org/10.37626/GA9783959871129.0.119> Zell, Simon: Weekly 10-minute-tasks to Promote Students Solving Equations in a Content-oriented Manner. pp 637 – 642 When solving equations in school, students often rely on routines and do not consider alternative ways of solving. Even basic equations which could be solved quite fast using common sense are regularly solved in a complicated way. To overcome this reliance on routine, a study with 17 classes of grade 10 students was carried out. Weekly 10-minute-tasks, which contained appropriate subtasks to enhance content-oriented solving, were solved by students over the course of one school year. These tasks were designed with the purpose of reducing the dominance of routines and the aim of using insight in the solving of equations. <https://doi.org/10.37626/GA9783959871129.0.120> Zollman, Alan:

Collective Participation: A Story of Business, Community, Schools, and University Partnering in STEM Education. pp 643 – 648 The quality of the public school teacher has the greatest in-school impact on nurturing cognitive abilities, developing content knowledge, and increasing motivation of students (Ferguson & Ladd 1996; Haycock 1998; Rivkin, Hanushek, & Kain 2005; Rice 2003; Sanders & Rivers, 1996; Zollman, Tahernezehadi, & Billman, 2012). We also know from educational research (Johnson & Sondergeld, 2015) that traditional professional development formats do not result in improvement of teacher practices nor substantial gain in student achievement. This paper reports on a shift in the traditional professional development project – one to enhance the quality of the public school teacher in STEM education projects through a synergy of business, community, and school districts partners with education and science university faculty. <https://doi.org/10.37626/GA9783959871129.0.121> Zonnefeld, Ryan G.; Zonnefeld, Valorie L.: Innovative Pathways in STEM Teacher Preparation: Bridging the Gap between University Expectations & Secondary School Needs. pp 649 – 651 Innovative teacher preparation programs for STEM education are essential for meeting the goal of ensuring that secondary school students receive instruction from a certified teacher. This exploratory workshop examines the role that interdisciplinary STEM and mathematics programs can have to increase the number of certified teachers prepared to teach STEM classes from an interdisciplinary approach. <https://doi.org/10.37626/GA9783959871129.0.122>

Geometry: A Comprehensive Course Sep 04 2021 Introduction to vector algebra in the plane; circles and coaxial systems; mappings of the Euclidean plane; similitudes, isometries, Moebius transformations, much more. Includes over 500 exercises.

**The Math Studies IA: Earning Full Marks on SL Math Studies Projects** Oct 05 2021 PLEASE NOTE: This book is intended for students graduating in or before November 2020. Students graduating in or after May 2021 should buy the new book, out now, which will be updated with any changes for the new syllabi for the new courses. This short step by step guide to earning full marks on the International Baccalaureate Standard Level Math Studies Projects helps students maximize their Internal Assessment marks to make it easier to earn a level 7 overall. About the Author Daniel Slosberg has been teaching SL Math Studies for the IBO since 2007, at Victoria Shanghai Academy in Hong Kong, China. It is his hope that this short book will allow students all over the globe to achieve greater success in writing their mathematical projects so that they will be under less stress when they write their external examinations. More importantly, however, he hopes that students reading this book enjoy mathematics and apply it usefully in their daily lives long after they have graduated from the diploma program.

**Mathematics - Applications and Interpretation** May 20 2020 Featuring a wealth of digital content, this concept-based Print and Enhanced Online Course Book Pack has been developed in cooperation with the IB to provide the most comprehensive support for the new DP Mathematics: applications and interpretation HL syllabus, for first teaching in September 2019.

**Exam Practice Workbook for Mathematics for the IB Diploma: Analysis and Approaches SL** Jul 02 2021 Consolidate learning and develop problem solving skills through exam practice questions; ideal for independent learning, homework or extension activities. · Strengthen skills and consolidate knowledge with a wealth of advice and questions that mirrors the syllabus line by line. · Prepare thoroughly for assessment with revision and exam tips, including a calculator skills checklist and mark scheme guidance. · Build confidence using the six mock exam papers, with accompanying mark schemes. · Ideal for independent learning, homework or extension activities, this workbook contains a wealth of exam-style practice. · Answers for the practice questions are available for free at [www.hoddereducation.com/ibextras](http://www.hoddereducation.com/ibextras)

**Oxford IB Diploma Programme: Mathematics Higher Level Course Companion** Apr 23 2023 Uniquely developed with the IB curriculum team, this online course book will ensure your students achieve their best. Blending mathematical applications with crucial practice and inquiry, it fully integrates the IB approach to learning. Full syllabus coverage - the truest match to the IB syllabus, developed with the IB to exactly match IB specifications Complete worked solutions - a full set of worked solutions included online Extensive practice - over 800 pages of practice cements comprehension Up-to-date GDC support - take the confusion out of GDC use and help students focus on the theory Definitive assessment preparation - exam-style papers and questions will build confidence The Exploration - supported by a full chapter, to guide you through this new component Real world approach - connect mathematics with human behaviour, language, morality and more About the series: The only DP resources developed directly with the IB, the Oxford IB Course Books are the most comprehensive core resources to

*IB Math SL* Feb 21 2023 The International Baccalaureate® (IB) was founded in Geneva, Switzerland in 1968 as a non-profit educational foundation that endeavored to develop inquiring, knowledgeable and caring young people who would go on to create a better and more peaceful world through intercultural understanding and respect. What began as a single program for internationally mobile students preparing for college has grown into a series of programs for students up to age 19. Barron's is pleased to offer a brand new course review and exam preparation guide for the IB Mathematics SL exam. The content of the book is based on the subject guide, published by the International Baccalaureate Organization. It covers all topics required for exams beginning in 2014 and includes: A full-length diagnostic test with markscheme and fully explained answers Study tips and exam strategies Topic review and practice for each strand of the IB Math SL curriculum, including explanations and examples as well as problem sets with fully explained solutions Two full-length practice exams with markschemes and fully explained answers This all-encompassing book can also serve as a supplement to classroom instruction throughout the two-year IB Math SL course, a resource for the Internal Assessment project, and a review resource during first year college math courses.

Data Science and Machine Learning Dec 07 2021 "This textbook is a well-rounded, rigorous, and informative work presenting the mathematics behind modern machine learning techniques. It hits all the right notes: the choice of topics is up-to-date and perfect for a course on data science for mathematics students at the advanced undergraduate or early graduate level. This book fills a sorely-needed gap in the existing literature by not sacrificing depth for breadth, presenting proofs of major theorems and subsequent derivations, as well as providing a copious amount of Python code. I only wish a book like this had been around when I first began my journey!" -Nicholas Hoell, University of Toronto "This is a well-written book that provides a deeper dive into data-scientific methods than many introductory texts. The writing is clear, and the text logically builds up regularization, classification, and decision trees. Compared to its probable competitors, it carves out a unique niche. -Adam Loy, Carleton College The purpose of Data Science and Machine Learning: Mathematical and Statistical Methods is to provide an accessible, yet comprehensive textbook intended for students interested in gaining a better understanding of the mathematics and statistics that underpin the rich variety of ideas and machine learning algorithms in data science. Key Features: Focuses on mathematical understanding. Presentation is self-contained, accessible, and comprehensive. Extensive list of exercises and worked-out examples. Many concrete algorithms with Python code. Full color throughout. Further Resources can be found on the authors website: <https://github.com/DSML-book/Lectures>

Catalog of Copyright Entries. Third Series Oct 17 2022

*Equations of Mathematical Physics* Sep 16 2022 Mathematical physics plays an important role in the study of many physical processes — hydrodynamics, elasticity, and electrodynamics, to name just a few. Because of the enormous range and variety of problems dealt with by mathematical physics, this thorough advanced undergraduate- or graduate-level text considers only those problems leading to partial differential equations. Contents: I. Classification of Partial Differential Equations II. Evaluations of the Hyperbolic Type III. Equations of the Parabolic Type IV. Equations of Elliptic Type V. Wave Propagation in Space VI. Heat Conduction in Space VII. Equations of Elliptic Type (Continuation) The authors — two well-known Russian mathematicians — have focused on typical physical processes and the principal types of equations dealing with them. Special attention is paid throughout to mathematical formulation, rigorous solutions, and physical interpretation of the results obtained. Carefully chosen problems designed to promote technical skills are contained in each chapter, along with extremely useful appendixes that supply applications of solution methods described in the main text. At the end of the book, a helpful supplement discusses special functions, including spherical and cylindrical functions.

*Lectures on Symplectic Geometry* Feb 26 2021 The goal of these notes is to provide a fast introduction to symplectic geometry for graduate students with some knowledge of differential geometry, de Rham theory and classical Lie groups. This text addresses symplectomorphisms, local forms, contact manifolds, compatible almost complex structures, Kaehler manifolds, hamiltonian mechanics, moment maps, symplectic reduction and symplectic toric manifolds. It contains guided problems, called homework, designed to complement the exposition or extend the reader's understanding. There are by now excellent references on symplectic geometry, a subset of which is in the bibliography of this book. However, the most efficient introduction to a subject is often a short elementary treatment, and these notes attempt to serve that purpose. This text provides a taste of areas of current research and will prepare the reader to explore recent papers and extensive books on symplectic geometry where the pace is much faster. For this reprint numerous corrections and clarifications have been made, and the layout has been improved.

The Mathematics Ia: Earning Full Marks on HI Or SL Mathematics Explorations: Ideal for the International Baccalaureate Diploma Feb 09 2022 PLEASE NOTE: This book is intended for students graduating in or before November

2020. Students graduating in or after May 2021 should buy the new book which will be updated with any changes for the new syllabi for the new courses. Assistant examiner Daniel Slosberg explains how to earn full marks on the International Baccalaureate Higher Level and Standard Level Mathematics Explorations in this short guide which helps students maximize their Internal Assessment marks to make it easier to earn a level 7 overall. It has been updated on July 2, 2015 to include advice for students who write computer programs as part of their Exploration. If you have already purchased the book and are using a computer program, please ask Amazon to send you the most updated version. You will know you have the most updated version because it displays "Purchase ID#20160403mia". About the Author Daniel Slosberg has been teaching HL & SL Mathematics for the IBO since 2003, first at Centennial High School in Corona, California, USA and then at Victoria Shanghai Academy in Hong Kong, China. It is his hope that this short book will allow students all over the globe to achieve greater success in writing their mathematical explorations so that they will be under less stress when they write their external examinations. More importantly, however, he hopes that students reading this book enjoy mathematics and apply it usefully in their daily lives long after they have graduated from the diploma program.

**Cumulated Index Medicus** Jun 01 2021

**Mathematics Standard Level for IB Diploma Exam Preparation Guide** Mar 10 2022 A new series of Exam Preparation guides for the IB Diploma Mathematics HL and SL and Mathematical Studies. This exam preparation guide for the IB Diploma Mathematics Standard Level course breaks the course down into chapters that summarise material and present revision questions by exam question type, so that revision can be highly focused to make best use of students' time. Students can stretch themselves to achieve their best with 'going for the top' questions for those who want to achieve the highest results. Worked solutions for all the mixed and 'going for the top' questions are included, plus exam hints throughout. Guides for Mathematics Higher Level and Mathematical Studies are also available.

**Mathematics for the IB Diploma** Oct 25 2020 Enable students to construct, communicate and justify correct mathematical arguments, with a range of activities and examples of maths in the real world. - Engage and excite students with examples and photos of maths in the real world, plus inquisitive starter activities to encourage their problem-solving skills - Build mathematical thinking with our 'Toolkit' and mathematical exploration chapter, along with our new toolkit feature of questions, investigations and activities - Develop understanding with key concepts and applications integrated throughout, along with TOK links for every topic.

*Mathematics: Analysis and Approaches HL* Nov 18 2022

**Mathematics Standard Level for the IB Diploma** Aug 27 2023 Mathematics Standard Level for the IB Diploma is a single volume that matches the Mathematics Standard Level course of the International Baccalaureate Diploma Programme, to be taught from September 2004 for first examination in 2006. The book has been adapted in consultation with seniorexaminers to ensure complete and authoritative coverage of the syllabus.

*What We Know About Mathematics Teaching and Learning* Dec 19 2022 This book supports mathematics education reform and brings the rich world of education research and practice to pre-K–12 educators. Designed for accessibility, each chapter is broken down into important questions. For each question, the authors provide background information from a research perspective, offer implications for improving classroom instruction, and list resources for further reading.

**IB Mathematics Standard Level** May 24 2023 With more practice than any other resource, unrivalled guidance straight from the IB and the most comprehensive and correct syllabus coverage, this student book will set your learners up to excel. The only resource written with the IB curriculum team, it fully captures the IB philosophy and integrates the most in-depth assessment support.

**Operads in Algebra, Topology and Physics** Aug 23 2020 Operads are mathematical devices which describe algebraic structures of many varieties and in various categories. From their beginnings in the 1960s, they have developed to encompass such areas as combinatorics, knot theory, moduli spaces, string field theory and deformation quantization.

*Further Mathematics for the IB Diploma Standard Level* Apr 11 2022 These books have been specifically written by experienced authors for the option modules in the new Higher Level IB Mathematics syllabus. Each book has been thoroughly reviewed by IB teachers and contains detailed explanations, plenty of questions, a review section and past-examination questions.

**Quantum Groups** Jun 20 2020 Here is an introduction to the theory of quantum groups with emphasis on the spectacular connections with knot theory and Drinfeld's recent fundamental contributions. It presents the quantum groups attached to SL<sub>2</sub> as well as the basic concepts of the theory of Hopf algebras. Coverage also focuses on Hopf algebras that produce solutions of the Yang-Baxter equation and provides an account of Drinfeld's elegant treatment of the monodromy of the Knizhnik-Zamolodchikov equations.

**Mathematics, the Loss of Certainty** Nov 25 2020 Most intelligent people today still believe that mathematics is a body of unshakable truths about the physical world and that mathematical reasoning is exact and infallible.

*Mathematics: The Loss of Certainty* refutes that myth.

**IB Math Studies** Jun 25 2023 The International Baccalaureate® (IB) was founded in Geneva, Switzerland in 1968 as a non-profit educational foundation that endeavored to develop inquiring, knowledgeable and caring young people who would go on to create a better and more peaceful world through intercultural understanding and respect. What began as a single program for internationally mobile students preparing for college, has grown into a series of programs for students up to age 19. Barron's is pleased to offer a brand new review guide for the IB Mathematics Studies exam. The content of the book is based on the curriculum and covers all topics required for exams beginning in 2014. It includes: An overview of the exam, including an explanation of scoring Thorough review and explanation for all curriculum subjects Extensive review and practice for each topic, including Paper 1 and Paper 2 examples Three full-length paper 1 and 2 practice exams with solutions, and comprehensive explanations Calculator instructions for the TI-84 and TI-Nspire This all-encompassing book also serves as a valuable resource during first year college math courses.

**Deep Learning** Jan 08 2022 An introduction to a broad range of topics in deep learning, covering mathematical and conceptual background, deep learning techniques used in industry, and research perspectives. "Written by three experts in the field, Deep Learning is the only comprehensive book on the subject." —Elon Musk, cochair of OpenAI; cofounder and CEO of Tesla and SpaceX Deep learning is a form of machine learning that enables computers to learn from experience and understand the world in terms of a hierarchy of concepts. Because the computer gathers knowledge from experience, there is no need for a human computer operator to formally specify all the knowledge that the computer needs. The hierarchy of concepts allows the computer to learn complicated concepts by building them out of simpler ones; a graph of these hierarchies would be many layers deep. This book introduces a broad range of topics in deep learning. The text offers mathematical and conceptual background, covering relevant concepts in linear algebra, probability theory and information theory, numerical computation, and machine learning. It describes deep learning techniques used by practitioners in industry, including deep feedforward networks, regularization, optimization algorithms, convolutional networks, sequence modeling, and practical methodology; and it surveys such applications as natural language processing, speech recognition, computer vision, online recommendation systems, bioinformatics, and videogames. Finally, the book offers research perspectives, covering such theoretical topics as linear factor models, autoencoders, representation learning, structured probabilistic models, Monte Carlo methods, the partition function, approximate inference, and deep generative models. Deep Learning can be used by undergraduate or graduate students planning careers in either industry or research, and by software engineers who want to begin using deep learning in their products or platforms. A website offers supplementary material for both readers and instructors.

**Differential Geometric Methods In Theoretical Physics - Proceedings Of The Xxi International Conference** Mar 30 2021 This book is to commemorate the 65th birthday of J J Giambiagi one of the most important Latin American physicists. Giambiagi, in collaboration with Bollini, invented the time-honoured Dimensional Regularization method in 1971. It includes contributions from many of his friends and former students, on their present fields of interest.

**Issues in Applied Mathematics: 2011 Edition** Aug 03 2021 Issues in Applied Mathematics / 2011 Edition is a ScholarlyEditions™ eBook that delivers timely, authoritative, and comprehensive information about Applied Mathematics.

The editors have built Issues in Applied Mathematics: 2011 Edition on the vast information databases of ScholarlyNews.™ You can expect the information about Applied Mathematics in this eBook to be deeper than what you can access anywhere else, as well as consistently reliable, authoritative, informed, and relevant. The content of Issues in Applied Mathematics: 2011 Edition has been produced by the world's leading scientists, engineers, analysts,

research institutions, and companies. All of the content is from peer-reviewed sources, and all of it is written, assembled, and edited by the editors at ScholarlyEditions™ and available exclusively from us. You now have a source you can cite with authority, confidence, and credibility. More information is available at <http://www.ScholarlyEditions.com/>.

**Zero Sum Game** May 12 2022 ZERO SUM GAME Best of Lists: \* Best Books of the Month at The Verge, Book Riot, Unbound Worlds, SYFY, & Kirkus \* The Mary Sue Book Club Pick \* Library Journal Best Debuts of Fall and Winter A blockbuster, near-future science fiction thriller, S.L. Huang's Zero Sum Game introduces a math-genius mercenary who finds herself being manipulated by someone possessing unimaginable power... Cas Russell is good at math. Scary good. The vector calculus blazing through her head lets her smash through armed men twice her size and dodge every bullet in a gunfight, and she'll take any job for the right price. As far as Cas knows, she's the only person around with a superpower...until she discovers someone with a power even more dangerous than her own. Someone who can reach directly into people's minds and twist their brains into Moebius strips. Someone intent on becoming the world's puppet master. Cas should run, like she usually does, but for once she's involved. There's only one problem... She doesn't know which of her thoughts are her own anymore. "Fresh and exciting... a great start to an exciting series--and an exciting career." --Boing Boing At the Publisher's request, this title is being sold without Digital Rights Management Software (DRM) applied.

**Developing Math Talent** Nov 06 2021 Build student success in math with the only comprehensive guide for developing math talent among advanced learners. The authors, nationally recognized math education experts, offer a focused look at educating gifted and talented students for success in math. More than just a guidebook for educators, this book offers a comprehensive approach to mathematics education for gifted students of elementary or middle school age. The authors provide concrete suggestions for identifying mathematically talented students, tools for instructional planning, and specific programming approaches. Developing Math Talent features topics such as strategies for identifying mathematically gifted learners, strategies for advocating for gifted children with math talent, how to design a systematic math education program for gifted students, specific curricula and materials that support success, and teaching strategies and approaches that encourage and challenge gifted learners.

**Functional Analysis, Sobolev Spaces and Partial Differential Equations** Sep 23 2020 This textbook is a completely revised, updated, and expanded English edition of the important Analyse fonctionnelle (1983). In addition, it contains a wealth of problems and exercises (with solutions) to guide the reader. Uniquely, this book presents in a coherent, concise and unified way the main results from functional analysis together with the main results from the theory of partial differential equations (PDEs). Although there are many books on functional analysis and many on PDEs, this is the first to cover both of these closely connected topics. Since the French book was first published, it has been translated into Spanish, Italian, Japanese, Korean, Romanian, Greek and Chinese. The English edition makes a welcome addition to this list.

*The English Catalogue of Books* Dec 27 2020 Vols. for 1898-1968 include a directory of publishers.

**Learning and Understanding** Mar 22 2023 This book takes a fresh look at programs for advanced studies for high school students in the United States, with a particular focus on the Advanced Placement and the International Baccalaureate programs, and asks how advanced studies can be significantly improved in general. It also examines two of the core issues surrounding these programs: they can have a profound impact on other components of the education system and participation in the programs has become key to admission at selective institutions of higher education. By looking at what could enhance the quality of high school advanced study programs as well as what precedes and comes after these programs, this report provides teachers, parents, curriculum developers, administrators, college science and mathematics faculty, and the educational research community with a detailed assessment that can be used to guide change within advanced study programs.

**Mathematics SL** Aug 15 2022 This book provides practical support and guidance to help IB Diploma Programme students prepare for their mathematics SL exams.

**Math Made Visual** Jul 22 2020 Is it possible to make mathematical drawings that help to understand mathematical ideas, proofs, and arguments? The [Author];s of this book are convinced that the answer is yes and the objective of this book is to show how some visualization techniques may be employed to produce pictures that have both mathematical and pedagogical interest. Mathematical drawings related to proofs have been produced since antiquity in China, Arabia, Greece, and India, but only in the last thirty years has there been a growing interest in so-called "proofs without words". Hundreds of these have been published in Mathematics Magazine and The College Mathematics Journal, as well as in other journals, books, and on the internet. Often a person encountering a "proof without words" may have the feeling that the pictures involved are the result of a serendipitous discovery or the consequence of an exceptional ingenuity on the part of the picture's creator. In this book, the [Author];s show that behind most of the pictures, "proving" mathematical relations are some well-understood methods. As the reader shall see, a given mathematical idea or relation may have many different images that justify it, so that depending on the teaching level or the objectives for producing the pictures, one can choose the best alternative.

*Mathematics: Applications and Interpretation SL* Jul 14 2022

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