



it's about identifying  
relationships and  
reasoning about them

Explained

# Mathematical Thinking

Five Big Ideas in Teaching for Mastery



# Mathematical Thinking And Learning

**Douglas H. Clements, Julie Sarama**



## **Mathematical Thinking And Learning:**

*Mathematical Thinking and Learning* Na'ilah Suad Nasir, Na'ilah Suad Nasir, Paul Cobb, 2002 The articles developed for this special issue of Mathematical Thinking and Learning grew out of a series of two meetings held at Vanderbilt University in November 1999 and Northwestern University in September 2000 As a group the six articles in this special issue have the potential to help us reframe issues of equity in mathematics education and to enrich understandings of the process by which diverse learners experience mathematics education Some of these articles are theoretical in orientation and offer insights to how the sociocultural approach to equity in math education might be developed Other papers rely on close analyses of mathematical learning in and out of the classroom to understand the construction of equity at the micro level of social interactions In sum the articles that make up this special issue take the social and cultural worlds in which mathematics is learned to be central to the understandings of the dynamics of equity The editors hope that the understandings of equity diversity and mathematical learning continue to evolve and that this special issue will serve to spark thought controversy debate and further research on this critically important topic

**Mathematical Thinking and Problem Solving** Alan H. Schoenfeld, Alan H. Sloane, 2016-05-06 In the early 1980s there was virtually no serious communication among the various groups that contribute to mathematics education mathematicians mathematics educators classroom teachers and cognitive scientists Members of these groups came from different traditions had different perspectives and rarely gathered in the same place to discuss issues of common interest Part of the problem was that there was no common ground for the discussions given the disparate traditions and perspectives As one way of addressing this problem the Sloan Foundation funded two conferences in the mid 1980s bringing together members of the different communities in a ground clearing effort designed to establish a base for communication In those conferences interdisciplinary teams reviewed major topic areas and put together distillations of what was known about them A more recent conference upon which this volume is based offered a forum in which various people involved in education reform would present their work and members of the broad communities gathered would comment on it The focus was primarily on college mathematics informed by developments in K 12 mathematics The main issues of the conference were mathematical thinking and problem solving

Models and Modeling Perspectives Richard A. Lesh, 2014-07-16 This special issue of Mathematical Thinking and Learning describes models and modeling perspectives toward mathematics problem solving learning and teaching The concern is not only the mature forms of models and modeling in communities of scientists and mathematicians but also the need to initiate students in these forms of thought The contributions of this issue suggest a variety of ways that students children through adults can be introduced to highly productive forms of modeling practices Collectively they illustrate how modeling activities often lead to remarkable mathematical achievements by students formerly judged to be too young or too lacking in ability for such sophisticated and powerful forms of mathematical thinking The papers also illustrate how modeling activities often create productive

interdisciplinary niches for mathematical thinking learning and problem solving that involve simulations of similar situations that occur when mathematics is useful beyond school

**Advanced Mathematical Thinking** Annie Selden, John Selden, 2013-10-15 This is Volume 7 Issue 1 2005 a Special Issue of Mathematical Thinking and Learning which looks at Advanced Mathematical Thinking Opening with a brief history of attempts to characterize advanced mathematical thinking beginning with the deliberations of the Advanced Mathematical Thinking Working Group of the International Group for the Psychology of Mathematics Education The articles follow the recurring themes a the distinction between identifying kinds of thinking that might be regarded as advanced at any grade level and taking as advanced any thinking about mathematical topics considered advanced b the utility of characterizing such thinking for integrating the entire curriculum c general tests or criteria for identifying advanced mathematical thinking and d an emphasis on advancing mathematical practices

*Diversity, Equity, and Mathematical Learning* Nailah Suad Nasir, Paul Cobb, 2002-09-12 The articles developed for this special issue of Mathematical Thinking and Learning grew out of a series of two meetings held at Vanderbilt University in November 1999 and Northwestern University in September 2000 As a group the six articles in this special issue have the potential to help us reframe issues of equity in mathematics education and to enrich understandings of the process by which diverse learners experience mathematics education Some of these articles are theoretical in orientation and offer insights to how the sociocultural approach to equity in math education might be developed Other papers rely on close analyses of mathematical learning in and out of the classroom to understand the construction of equity at the micro level of social interactions In sum the articles that make up this special issue take the social and cultural worlds in which mathematics is learned to be central to the understandings of the dynamics of equity The editors hope that the understandings of equity diversity and mathematical learning continue to evolve and that this special issue will serve to spark thought controversy debate and further research on this critically important topic

Hypothetical Learning Trajectories Douglas H.

Clements, Julie Sarama, 2012-12-06 The purpose of this special issue is to present several research perspectives on learning trajectories with the intention of encouraging the broader community to reflect on better define adopt adapt or challenge the concept The issue begins by briefly introducing learning trajectories The remaining articles provide elaboration examples and discussion of the construct They purposefully are intended to be illustrative exploratory and provocative with regard to learning trajectories construct they are not a set of verification studies

**Understanding Emotions in Mathematical Thinking and Learning** Ulises Xolocotzin, 2017-05-12 Emotions play a critical role in mathematical cognition and learning Understanding Emotions in Mathematical Thinking and Learning offers a multidisciplinary approach to the role of emotions in numerical cognition mathematics education learning sciences and affective sciences It addresses ways in which emotions relate to cognitive processes involved in learning and doing mathematics including processing of numerical and physical magnitudes e g time and space performance in arithmetic and algebra problem solving and reasoning attitudes learning

technologies and mathematics achievement Additionally it covers social and affective issues such as identity and attitudes toward mathematics Covers methodologies in studying emotion in mathematical knowledge Reflects the diverse and innovative nature of the methodological approaches and theoretical frameworks proposed by current investigations of emotions and mathematical cognition Includes perspectives from cognitive experimental psychology neuroscience and from sociocultural semiotic and discursive approaches Explores the role of anxiety in mathematical learning Synthesizes unifies the work of multiple sub disciplines in one place      *Learning and Teaching Early Math* Douglas H. Clements, Julie Sarama, 2014-05-23 In this important book for pre and in service teachers early math experts Douglas Clements and Julie Sarama show how learning trajectories help diagnose a child s level of mathematical understanding and provide guidance for teaching By focusing on the inherent delight and curiosity behind young children s mathematical reasoning learning trajectories ultimately make teaching more joyous They help teachers understand the varying levels of knowledge exhibited by individual students which in turn allows them to better meet the learning needs of all children Using straightforward no nonsense language this book summarizes the current research about how children learn mathematics and how to build on what children already know to realize more effective teaching This second edition of *Learning and Teaching Early Math* remains the definitive research based resource to help teachers understand the learning trajectories of early mathematics and become quintessential professionals Updates to the new edition include Explicit connections between Learning Trajectories and the new Common Core State Standards New coverage of patterns and patterning Incorporation of hundreds of recent research studies      *Mathematical Learning and Understanding in Education* Kristie Newton, Sarah Sword, 2018-05-16 Mathematics holds an essential ubiquitous presence in the education sector as do ongoing explorations of its effective teaching and learning Written by leading experts on mathematics and mathematics education this book situates issues of student thinking and learning about mathematics within the broader context of educational psychology research and theory and brings them to a wider audience With chapters on knowing and understanding mathematics mathematical habits early mathematical thinking and learning mathematics this concise volume is designed for any educational psychology mathematics education or general education course that includes student learning in the curriculum It will be indispensable for student researchers and both pre and in service teachers alike      *The Nature of Mathematical Thinking* Robert J. Sternberg, Talia Ben-Zeev, 1996 First Published in 1996 Routledge is an imprint of Taylor Francis an informa company

**Early Childhood Mathematics Education Research** Julie Sarama, Douglas H. Clements, 2009-04-01 This important new book synthesizes relevant research on the learning of mathematics from birth into the primary grades from the full range of these complementary perspectives At the core of early math experts Julie Sarama and Douglas Clements s theoretical and empirical frameworks are learning trajectories detailed descriptions of children s thinking as they learn to achieve specific goals in a mathematical domain alongside a related set of instructional tasks designed to engender those

mental processes and move children through a developmental progression of levels of thinking Rooted in basic issues of thinking learning and teaching this groundbreaking body of research illuminates foundational topics on the learning of mathematics with practical and theoretical implications for all ages Those implications are especially important in addressing equity concerns as understanding the level of thinking of the class and the individuals within it is key in serving the needs of all children

**Developing Mathematical Thinking** Jonathan D. Katz,2014-07-07 In this country we have done a poor job of helping students come to see the wonder beauty and power of mathematics Standards can be brought into the picture but unless we think about what it means to truly engage students in mathematics we will continue to be unsuccessful The goal of this book is to begin to change the way students experience mathematics in the middle and high school classrooms In this book you will find a theoretical basis for this approach to teaching mathematics multiple guides and questions for teachers to think about in relation to their everyday teaching and over 30 examples of problems lessons tasks and projects that been used effectively with urban students

**Whole Class Mathematics Discussions** Teruni Lamberg,2012-05-03 This is the eBook of the printed book and may not include any media website access codes or print supplements that may come packaged with the bound book NCTM standards and the Common Core standards emphasize communication as an integral part of how students should learn mathematics This book provides a comprehensive approach to facilitating whole class math discussions and addresses how to set up a classroom cultivate classroom routines plan for instruction facilitate discussions and assess for future improvement Reflective questions throughout the book enable teachers to develop professionally and support formal workshop or book study experiences The accompanying PDToolkit website offers video clips from five real classrooms which illustrate whole class math discussions in action teacher and student interviews and chapter PPTs for professional development sessions

**Children's Mathematical Thinking in Primary Years** Julia Anghileri,2005-05-01 This popular Continuum series intended chiefly for teachers and trainee teachers places strong emphasis on practice but at the same time incorporates the latest research in the field The book demonstrates a strong belief in the ability of children to learn and in the ability of teachers to increase children s learning potential The series authors are distinguished practitioners in their fields who write with authority but without jargon With the increasingly popular constructivist framework for learning teachers are coming to recognize the limitations of taught procedures and to find ways to encourage children to generate their own knowledge and understanding in mathematics The challenge for teachers is to promote an environment that encourages mathematical thinking in which pupils of all abilities are able to achieve their full potential This text brings together experiences of teachers and researchers who examine the ways children work mathematically in order to provide an enhanced learning environment within the classroom It also addresses key issues in current maths teaching

**Teaching and Learning Proof Across the Grades** Despina A. Stylianou,Maria L. Blanton,Eric J. Knuth,2010-09-23 A Co Publication of Routledge for the National Council of Teachers of Mathematics NCTM In recent years there has been increased interest in

the nature and role of proof in mathematics education with many mathematics educators advocating that proof should be a central part of the mathematics education of students at all grade levels This important new collection provides that much needed forum for mathematics educators to articulate a connected K 16 story of proof Such a story includes understanding how the forms of proof including the nature of argumentation and justification as well as what counts as proof evolve chronologically and cognitively and how curricula and instruction can support the development of students understanding of proof Collectively these essays inform educators and researchers at different grade levels about the teaching and learning of proof at each level and thus help advance the design of further empirical and theoretical work in this area By building and extending on existing research and by allowing a variety of voices from the field to be heard Teaching and Learning Proof Across the Grades not only highlights the main ideas that have recently emerged on proof research but also defines an agenda for future study

**Teaching Mathematical Thinking** Marian Small, 2017 This new resource by math education expert Marian Small helps schools and districts to refine their teaching of standards based mathematical practices Small devotes a chapter to each of the eight standards of practice and includes a discussion of what each standard looks like in grades K 2 3 5 and 6 8 Specific attention is given to helping students make sense of problems and persevere in solving them Standard 1 and to encouraging students to create viable mathematical arguments and to effectively and respectfully critique the reasoning of others Standard 3 The author also discusses how to formatively assess student performance for each practice standard To provide additional support to U S teachers in their instructional planning this resource includes attention to the Canadian math processes of visualization and mental math and estimation Whether you are a new teacher or a seasoned educator this book will enrich your abilities to develop your students mathematical thinking From the Foreword by Linda Dacey professor emerita Mathematics Lesley University One of the best ways to prepare students for their futures is to teach mathematical thinking Marian Small shows us the way with powerful tasks probing questions and incredible student work samples This is the book I have been looking for and is definitely a must have for every teacher Ruth Harbin Miles Mary Baldwin University

*Mathematical Thinking* Masami Isoda, Shigeo Katagiri, 2012 Developing mathematical thinking is one of major aims of mathematics education In mathematics education research there are a number of researches which describe what it is and how we can observe in experimental research However teachers have difficulties developing it in the classrooms This book is the result of lesson studies over the past 50 years It describes three perspectives of mathematical thinking Mathematical Attitude Minds set Mathematical Methods in General and Mathematical Ideas with Content and explains how to develop them in the classroom with illuminating examples

**Forms of Mathematical Knowledge** Dina Tirosh, 2013-03-14 What mathematics is entailed in knowing to act in a moment Is tacit rhetorical knowledge significant in mathematics education What is the role of intuitive models in understanding learning and teaching mathematics Are there differences between elementary and advanced mathematical thinking Why can't students prove What are the characteristics

of teachers ways of knowing This book focuses on various types of knowledge that are significant for learning and teaching mathematics The first part defines discusses and contrasts psychological philosophical and didactical issues related to various types of knowledge involved in the learning of mathematics The second part describes ideas about forms of mathematical knowledge that are important for teachers to know and ways of implementing such ideas in preservice and in service education The chapters provide a wide overview of current thinking about mathematics learning and teaching which is of interest for researchers in mathematics education and mathematics educators Topics covered include the role of intuition in mathematics learning and teaching the growth from elementary to advanced mathematical thinking the significance of genres and rhetoric for the learning of mathematics and the characterization of teachers ways of knowing

**Learning Over Time** Alan P. Maloney, Jere Confrey, Kenny H. Nguyen, 2014-06-01 The driving forces behind mathematics learning trajectories is the need to understand how children actually learn and make sense of mathematics how they progress from prior knowledge through intermediate understandings to the mathematics target understandings and how to use these insights to improve instruction and student learning In this book readers will come to understand what learning trajectories are the research and methodology that are necessary for developing them and gain insight into potential applications of learning trajectories A synthesis and research outcome in their own right learning trajectories provide detailed description of instructionally grounded development of mathematical concepts and reasoning from the perspective of student learning and overall building on decades of accumulated experience in mathematics education research However their greater importance may lie in their potential as frameworks that contribute an unprecedented coherence across classroom instruction professional development standards and assessment by focusing squarely on conceptual understanding and reasoning instead of assessment driven procedural knowledge This potential was sufficiently compelling as an organizing framework to have been cited as a basis for the Common Core mathematics standards the new mathematics learning expectations that are now consistent across most of the United States Among the conference attendees were the writers of the Common Core State Standards for Mathematics at the beginning of the Standards drafting process This book is an outgrowth of a conference on learning trajectories hosted in 2009 at North Carolina State University which examined research on learning trajectories An overarching message of the chapters in this volume is that learning trajectories by focusing on how children s mathematical reasoning develops are coming into their own as a rigorous underpinning for both instruction and accountability Some of the learning scientists featured in this volume have played major roles learning trajectories evolution from small scale day to day conjectures by individual teachers to systematic research endeavors that teachers and scientists alike can use to interpret standards plan instruction and formatively assess student work The work in this volume will be of interest to mathematics educators teachers and professional development specialists **How Humans Learn to Think Mathematically** David Tall, 2013-09-02 How Humans Learn to Think Mathematically describes



the development of mathematical thinking from the young child to the sophisticated adult Professor David Tall reveals the reasons why mathematical concepts that make sense in one context may become problematic in another For example a child's experience of whole number arithmetic successively affects subsequent understanding of fractions negative numbers algebra and the introduction of definitions and proof Tall's explanations for these developments are accessible to a general audience while encouraging specialists to relate their areas of expertise to the full range of mathematical thinking The book offers a comprehensive framework for understanding mathematical growth from practical beginnings through theoretical developments to the continuing evolution of mathematical thinking at the highest level

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