

PROGRAMMING AND MATHEMATICAL THINKING

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CHILDREN'S MATHEMATICAL THINKING IN PRIMARY YEARS
KEITH DEVLIN JOHN MASON KEITH J. DEVLIN JORDAN ELLENBERG MASAMI ISODA RANDALL MADDOX JONATHAN D. KATZ DIANE DRISCOLL SCHWARTZ DAVID TALL ROBERT J. STERNBERG DAVID TALL ANNIE SELDEN ALAN H. SCHOENFELD KEITH DEVLIN MASAMI ISODA BRIAN P. KATZ ROBERT J. STERNBERG FRIEDRICH WAISMANN MARILYN A. REBA JULIA ANGHILERI

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IF PEOPLE ARE ENDOWED WITH A NUMBER INSTINCT SIMILAR TO THE LANGUAGE INSTINCT AS RECENT RESEARCH SUGGESTS THEN WHY CAN'T EVERYONE DO MATH IN THE MATH GENE
MATHEMATICIAN AND POPULAR WRITER KEITH DEVLIN ATTACKS BOTH SIDES OF THIS QUESTION
DEVLIN OFFERS A BREATHTAKINGLY NEW THEORY OF LANGUAGE DEVELOPMENT THAT DESCRIBES HOW LANGUAGE EVOLVED IN TWO STAGES AND HOW ITS MAIN PURPOSE WAS NOT COMMUNICATION
DEVLIN GOES ON TO SHOW THAT THE ABILITY TO THINK MATHEMATICALLY AROSE OUT OF THE SAME SYMBOL MANIPULATING ABILITY THAT WAS SO CRUCIAL TO THE VERY FIRST EMERGENCE OF TRUE LANGUAGE
WHY THEN CAN'T WE DO MATH AS WELL AS WE SPEAK
THE ANSWER SAYS DEVLIN IS THAT WE CAN AND DO WE JUST DON'T RECOGNIZE WHEN WE'RE USING MATHEMATICAL REASONING

PREPARED FOR COURSES ECT405 ECT705 OFFERED BY THE FACULTY OF EDUCATION IN DEAKIN UNIVERSITY'S OPEN CAMPUS PROGRAM

MATHEMATICAL THINKING IS NOT THE SAME AS DOING MATH UNLESS YOU ARE A PROFESSIONAL MATHEMATICIAN FOR MOST PEOPLE DOING MATH MEANS THE APPLICATION

OF PROCEDURES AND SYMBOLIC MANIPULATIONS MATHEMATICAL THINKING IN CONTRAST IS WHAT THE NAME REFLECTS A WAY OF THINKING ABOUT THINGS IN THE WORLD THAT HUMANS HAVE DEVELOPED OVER THREE THOUSAND YEARS IT DOES NOT HAVE TO BE ABOUT MATHEMATICS AT ALL WHICH MEANS THAT MANY PEOPLE CAN BENEFIT FROM LEARNING THIS POWERFUL WAY OF THINKING NOT JUST MATHEMATICIANS AND SCIENTISTS BACK COVER

WITTY COMPELLING AND JUST PLAIN FUN TO READ EVELYN LAMB SCIENTIFIC AMERICAN THE FREAKONOMICS OF MATH A MATH WORLD SUPERSTAR UNVEILS THE HIDDEN BEAUTY AND LOGIC OF THE WORLD AND PUTS ITS POWER IN OUR HANDS THE MATH WE LEARN IN SCHOOL CAN SEEM LIKE A DULL SET OF RULES LAID DOWN BY THE ANCIENTS AND NOT TO BE QUESTIONED IN HOW NOT TO BE WRONG JORDAN ELLENBERG SHOWS US HOW TERRIBLY LIMITING THIS VIEW IS MATH ISN'T CONFINED TO ABSTRACT INCIDENTS THAT NEVER OCCUR IN REAL LIFE BUT RATHER TOUCHES EVERYTHING WE DO THE WHOLE WORLD IS SHOT THROUGH WITH IT MATH ALLOWS US TO SEE THE HIDDEN STRUCTURES UNDERNEATH THE MESSY AND CHAOTIC SURFACE OF OUR WORLD IT'S A SCIENCE OF NOT BEING WRONG HAMMERED OUT BY CENTURIES OF HARD WORK AND ARGUMENT ARMED WITH THE TOOLS OF MATHEMATICS WE CAN SEE THROUGH TO THE TRUE MEANING OF INFORMATION WE TAKE FOR GRANTED HOW EARLY SHOULD YOU GET TO THE AIRPORT WHAT DOES PUBLIC OPINION REALLY REPRESENT WHY DO TALL PARENTS HAVE SHORTER CHILDREN WHO REALLY WON FLORIDA IN 2000 AND HOW LIKELY ARE YOU REALLY TO DEVELOP CANCER HOW NOT TO BE WRONG PRESENTS THE SURPRISING REVELATIONS BEHIND ALL OF THESE QUESTIONS AND MANY MORE USING THE MATHEMATICIAN'S METHOD OF ANALYZING LIFE AND EXPOSING THE HARD WON INSIGHTS OF THE ACADEMIC COMMUNITY TO THE LAYMAN MINUS THE JARGON ELLENBERG CHASES MATHEMATICAL THREADS THROUGH A VAST RANGE OF TIME AND SPACE FROM THE EVERYDAY TO THE COSMIC ENCOUNTERING AMONG OTHER THINGS BASEBALL REAGANOMICS DARING LOTTERY SCHEMES VOLTAIRE THE REPLICABILITY CRISIS IN PSYCHOLOGY ITALIAN RENAISSANCE PAINTING ARTIFICIAL LANGUAGES THE DEVELOPMENT OF NON EUCLIDEAN GEOMETRY THE COMING OBESITY APOCALYPSE ANTONIN SCALIA'S VIEWS ON CRIME AND PUNISHMENT THE PSYCHOLOGY OF SLIME MOLDS WHAT FACEBOOK CAN AND CAN'T FIGURE OUT ABOUT YOU AND THE EXISTENCE OF GOD ELLENBERG PULLS FROM HISTORY AS WELL AS FROM THE LATEST THEORETICAL DEVELOPMENTS TO PROVIDE THOSE NOT TRAINED IN MATH WITH THE KNOWLEDGE THEY NEED MATH AS ELLENBERG SAYS IS AN ATOMIC POWERED PROSTHESIS THAT YOU ATTACH TO YOUR COMMON SENSE VASTLY MULTIPLYING ITS REACH AND STRENGTH WITH THE TOOLS OF MATHEMATICS IN HAND YOU CAN UNDERSTAND THE WORLD IN A DEEPER MORE MEANINGFUL WAY HOW NOT TO BE WRONG WILL SHOW YOU HOW

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

THE ABILITY TO CONSTRUCT PROOFS IS ONE OF THE MOST CHALLENGING ASPECTS OF THE WORLD OF MATHEMATICS IT IS ESSENTIALLY THE DEFINING MOMENT FOR THOSE TESTING THE WATERS IN A MATHEMATICAL CAREER INSTEAD OF BEING SUBMERGED TO THE POINT OF DROWNING READERS OF MATHEMATICAL THINKING AND WRITING ARE GIVEN GUIDANCE AND SUPPORT WHILE LEARNING THE LANGUAGE OF PROOF CONSTRUCTION AND CRITICAL ANALYSIS RANDALL MADDOX GUIDES THE READER WITH A WARM CONVERSATIONAL STYLE THROUGH THE TASK OF GAINING A THOROUGH UNDERSTANDING OF THE PROOF PROCESS AND ENCOURAGES INEXPERIENCED MATHEMATICIANS TO STEP UP AND LEARN HOW TO THINK LIKE A MATHEMATICIAN A STUDENT'S SKILLS IN CRITICAL ANALYSIS WILL DEVELOP AND BECOME MORE POLISHED

THAN PREVIOUSLY CONCEIVED MOST SIGNIFICANTLY DR MADDOX HAS THE UNIQUE APPROACH OF USING ANALOGY WITHIN HIS BOOK TO CLARIFY ABSTRACT IDEAS AND CLEARLY DEMONSTRATE METHODS OF MATHEMATICAL PRECISION

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

THIS BOOK IS THE FIRST MAJOR STUDY OF ADVANCED MATHEMATICAL THINKING AS PERFORMED BY MATHEMATICIANS AND TAUGHT TO STUDENTS IN SENIOR HIGH SCHOOL AND UNIVERSITY TOPICS COVERED INCLUDE THE PSYCHOLOGY OF ADVANCED MATHEMATICAL THINKING THE PROCESSES INVOLVED MATHEMATICAL CREATIVITY PROOF THE ROLE OF DEFINITIONS SYMBOLS AND REFLECTIVE ABSTRACTION IT IS HIGHLY APPROPRIATE FOR THE COLLEGE PROFESSOR IN MATHEMATICS OR THE GENERAL MATHEMATICS EDUCATOR

FIRST PUBLISHED IN 1996 ROUTLEDGE IS AN IMPRINT OF TAYLOR FRANCIS AN INFORMA COMPANY

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

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

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

A GROUNDBREAKING BOOK ABOUT MATH AND LANGUAGE FROM THE WELL KNOWN NPR COMMENTATOR KEITH DEVLIN

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

MATHEMATICS IS NOT A SPECTATOR SPORT SUCCESSFUL STUDENTS OF MATHEMATICS GRAPPLE WITH IDEAS FOR THEMSELVES DISTILLING IDEAS PRESENTS A CAREFULLY DESIGNED SEQUENCE OF EXERCISES AND THEOREM STATEMENTS THAT CHALLENGE STUDENTS TO CREATE PROOFS AND CONCEPTS AS STUDENTS MEET THESE CHALLENGES THEY DISCOVER STRATEGIES OF PROOFS AND STRATEGIES OF THINKING BEYOND MATHEMATICS IN OTHER WORDS DISTILLING IDEAS HELPS ITS USERS TO DEVELOP THE SKILLS ATTITUDES AND HABITS OF MIND OF A MATHEMATICIAN AND TO ENJOY THE PROCESS OF DISTILLING AND EXPLORING IDEAS DISTILLING IDEAS IS AN IDEAL TEXTBOOK FOR A FIRST PROOF BASED COURSE THE TEXT ENGAGES THE RANGE OF STUDENTS PREFERENCES AND AESTHETICS THROUGH A CORRESPONDING VARIETY OF INTERESTING MATHEMATICAL CONTENT FROM GRAPHS GROUPS AND EPSILON DELTA CALCULUS EACH TOPIC IS ACCESSIBLE TO USERS WITHOUT A BACKGROUND IN ABSTRACT MATHEMATICS BECAUSE THE CONCEPTS ARISE FROM ASKING QUESTIONS ABOUT EVERYDAY EXPERIENCE ALL THE COMMON PROOF STRUCTURES EMERGE AS NATURAL SOLUTIONS TO AUTHENTIC NEEDS DISTILLING IDEAS OR ANY SUBSET OF ITS CHAPTERS IS AN IDEAL RESOURCE EITHER FOR AN ORGANIZED INQUIRY BASED LEARNING COURSE OR FOR INDIVIDUAL STUDY

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A CLASSROOM TESTED ALTERNATIVE APPROACH TO TEACHING MATH FOR LIBERAL ARTS PUZZLES PARADOXES AND PROBLEM SOLVING AN INTRODUCTION TO MATHEMATICAL THINKING USES PUZZLES AND PARADOXES TO INTRODUCE BASIC PRINCIPLES OF MATHEMATICAL THOUGHT THE TEXT IS DESIGNED FOR STUDENTS IN LIBERAL ARTS MATHEMATICS COURSES DECISION MAKING SITUATIONS THAT PROGRESS FROM RECREATIONAL PROBLEMS TO IMPORTANT CONTEMPORARY APPLICATIONS

DEVELOP THE CRITICAL THINKING SKILLS OF NON SCIENCE AND NON TECHNICAL MAJORS THE LOGICAL UNDERPINNINGS OF THIS TEXTBOOK WERE DEVELOPED AND REFINED THROUGHOUT MANY YEARS OF CLASSROOM FEEDBACK AND IN RESPONSE TO COMMENTARY FROM PRESENTATIONS AT NATIONAL CONFERENCES THE TEXT S FIVE UNITS FOCUS ON GRAPHS LOGIC PROBABILITY VOTING AND CRYPTOGRAPHY THE AUTHORS ALSO COVER RELATED AREAS SUCH AS OPERATIONS RESEARCH GAME THEORY NUMBER THEORY COMBINATORICS STATISTICS AND CIRCUIT DESIGN THE TEXT USES A CORE SET OF COMMON REPRESENTATIONS STRATEGIES AND ALGORITHMS TO ANALYZE DIVERSE GAMES PUZZLES AND APPLICATIONS THIS UNIFIED TREATMENT LOGICALLY CONNECTS THE TOPICS WITH A RECURRING SET OF SOLUTION APPROACHES REQUIRING NO MATHEMATICAL PREREQUISITES THIS BOOK HELPS STUDENTS EXPLORE CREATIVE MATHEMATICAL THINKING AND ENHANCE THEIR OWN CRITICAL THINKING SKILLS STUDENTS WILL ACQUIRE QUANTITATIVE LITERACY AND APPRECIATION OF MATHEMATICS THROUGH THE TEXT S UNIFIED APPROACH AND WIDE RANGE OF INTERESTING APPLICATIONS

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

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