

## ZDM Subject Classification Scheme (Subdivision of the documentation section in ZDM)

### A General

- A10 Comprehensive works on mathematics. Reference books, encyclopaedias and dictionaries  
 → textbooks see U20  
 → material for repetition see U90  
 → comprehensive works on special disciplines see each discipline
- A20 Recreational mathematics  
 → educational games see U60
- A30 Biographies. History of mathematics and of mathematics teaching  
 → innovations in education see D30
- A40 Sociological and political issues. The profession of teaching. Careers in mathematics, labour market  
 → sociological aspects of learning see C60  
 → political education in the mathematics classroom see D30
- A50 Bibliographies. Information and documentation
- A60 Proceedings. Conference reports
- A70 Theses and postdoctoral theses
- A80 Standards
- A90 Picture stories. Cartoons. Fiction. Games  
 → recreational mathematics see A20  
 → educational games see U60

### B Educational policy and educational system (Educational research, educational reforms, pilot projects, official documents, syllabuses)

- B10 Educational research and planning
- B20 General education  
 → syllabuses see B70
- B30 Vocational education  
 → syllabuses see B70
- B40 Higher education
- B50 Teacher education (Teacher pre-service and in-service education)
- B60 Out-of-school education. Adult and further education (Summer schools, working groups, student competitions. Private study)
- B70 Syllabuses, curriculum guides, official documents  
 → testing of syllabuses in pilot classes see D30

### C Psychology of mathematics education. Research in mathematics education. Social aspects

- C10 Comprehensive works and surveys
- C20 Affective aspects (Motivation, anxiety, interest, attitudes, feelings. Self concept. Attention. Affective development)
- C30 Cognitive processes. Learning, learning theories (Thought processes, information processing, concept formation, problem solving, understanding. Learning. Memory. Perception. Cognitive development)

- concept teaching see E40  
 → teaching problem solving see D50  
 → social learning see C60  
 → learning with texts see C50  
 → teaching-learning-processes see C70
- C40 Intelligence and aptitudes. Personality (Talent, intelligence, abilities and skills, creativity. Behaviour. Personality traits, personality development)  
 → learning difficulties and student errors see D70  
 → achievement control see D60  
 → special education see C90
- C50 Language and communication (Teacher/ student language styles. Language acquisition. Learning with texts. Language difficulties, multilingualism, teaching and learning mathematics in a second language. Communicative competence)  
 → mathematical language see E40  
 → readability of textbooks see U20
- C60 Sociological aspects of learning (Group dynamics. Interpersonal interaction. Social learning. Roles. Social, economic and cultural influences)  
 → teaching methods see D40  
 → mathematics and society see A40
- C70 Teaching-learning-processes. Evaluation of instruction (Relations between teaching-processes - e.g. teacher attitudes, teaching methods - and learning processes - e.g. student attitudes, achievement. Effective teaching)  
 → teacher-student interaction see also C50, C60  
 → learning see C30  
 → teaching methods see D40
- C80 Other psychological aspects (E.g.: test theory, neuropsychology, research methods in psychology)
- C90 Other educational aspects (E.g.: special education, vocational education, curriculum theory, andragogy)  
 → mathematics teaching see D  
 → educational media and media research see U10  
 → media education see U

### D Education and instruction in mathematics

- D10 Comprehensive works and surveys on mathematics instruction in general and at different school levels and types. Comparative studies on mathematics education in different countries
- D20 Philosophical and theoretical contributions to mathematical didactics. Research methods. Theory of mathematics education  
 → history see A30  
 → learning theories see C30  
 → teaching-learning research see C70
- D30 Goals of mathematics teaching. Curriculum

- development (Mathematical formation. Formation of general abilities by mathematics instruction. Minimal competencies. Objectives and content of mathematics education, also with regard to cultural demands. Impacts of new technologies on mathematics instruction. Innovations and trends. Curriculum research. Curriculum evaluation. Interaction with other subjects)  
 → syllabuses and curricula see B70  
 → history of mathematics instruction see A30  
 → socialisation in mathematics instruction see C60
- D40 Teaching methods and classroom techniques. Lesson preparation. Educational principles (E.g.: classroom conversation, classroom organization, teaching approach, ability grouping)  
 → programmed instruction see U50  
 → interactions see CS0, C60, C70  
 → evaluation of instruction see C70  
 → language in mathematics instruction see C50  
 → preparation for examinations see D60  
 → teacher resources for preparing lessons see U30  
 → interdisciplinary teaching see M10
- D50 Investigating and problem solving (E.g.: teaching problem solving and heuristic strategies, methodology of problem solving, classification of exercises, problem solving in the curriculum)  
 → psychological aspects of problem solving see C30  
 → see also test theory C80  
 → exercise problems and competition questions see U40
- D60 Student assessment (Achievement control and rating. Mathematics achievement. Assessing pupils performance. Control and measurement of knowledge, abilities and skills. Examinations, preparation for examinations)  
 → student errors see D70  
 → problem books see U40  
 → abilities as personality traits see C40
- D70 Diagnosis, analysis and remediation of learning difficulties, misconceptions and student errors  
 → special education see C90  
 → achievement control and rating see D60
- D80 Teaching units, draft lessons and master lessons
- E Foundations of mathematics**
- E10 Comprehensive works on the foundations of mathematics and their teaching. Methodology of mathematical research
- E20 Metamathematics. Philosophical and ethical aspects of mathematics. Epistemology  
 → history of mathematics see A30
- E30 Logic. Acquisition of logical verbal reasoning abilities in mathematics instruction  
 → Boolean algebra see H50
- E40 Language of mathematics. Formalization. Defining. Axiomatics and axiomatic methods. Acquisition of mathematical concepts  
 → psychological aspects of concept formation see C30  
 → verbal communication see C50
- number concept see F20  
 → mappings and functions see 120
- E50 Proof methods. Reasoning and proving in the mathematics classroom
- E60 Sets. Relations. Set theory  
 → mappings and functions see 120
- E70 Miscellaneous
- F Arithmetic. Number theory. Quantities**
- F10 Comprehensive works on arithmetic and the teaching of arithmetic
- F20 Prenumerical stage. Number concept, counting
- F30 Natural numbers and operations on natural numbers. Place value. Pencil and paper arithmetic, mental arithmetic  
 → estimates see N20  
 → representation of numbers (numerical mathematics) see N 20
- F40 Integers. Rational numbers. Arithmetic operations on integers, fractions and decimals. Extensions of number domains
- F50 Real numbers, powers and roots. Arithmetic operations on real numbers, powers and roots. Complex numbers
- F60 Number theory
- F70 Measures and units (Quantity concept, operations with specified measures and units)  
 → lengths, areas, volumes see G30
- F80 Ratio and proportion. Rule of three. Percentages and calculation of interest. Mixture problems (E.g.: proportional quantities, inversely proportional quantities)  
 → mathematics in vocational training see M20
- F90 Practical mathematics, real problem solving (E.g. real life problems)  
 → mathematical modelling and mathematical applications see M  
 → teaching problem solving see D50  
 → linguistic comprehension of word problems see C50
- G Geometry**
- G10 Comprehensive works on geometry and the teaching of geometry
- G20 Informal geometry (Spatial orientation. Basic geometrical shapes)  
 → prenumerical stage see F20
- G30 Areas and volumes (Lengths and areas, volumes and surface areas)  
 → quantities and units see also F70  
 → word problems see F90
- G40 Plane and solid geometry. Geometry in multidimensional spaces  
 → geometric transformations see G50
- G50 Transformation geometry (Isometries, similarity transformations)
- G60 Trigonometry, spherics
- G70 Analytic geometry. Vector algebra
- G80 Descriptive geometry  
 → technical drawing see M20  
 → cartography see M50

- G90 Miscellaneous (E.g.: convex sets, packings, coverings, tessellations, non-euclidean geometries, finite geometries)  
→ fractals see 190
- H Algebra**  
→ numerical methods in algebra see N30
- H10 Comprehensive works on algebra and the teaching of algebra
- H20 Elementary algebra (Variables, manipulation of expressions. Binomial theorem. Polynomials. Finite sums)  
→ theory of equations see H30
- H 30 Theory of equations and inequalities  
→ variables, terms see H20
- H 40 Operations. Groups, rings, fields  
→ computational rules see H20
- H50 Ordered algebraic structures. Lattices. Boolean algebra  
→ propositional logic see E30
- H60 Linear algebra. Multilinear algebra (Vector spaces, linear mappings, matrices, determinants, theory of equations)  
→ vector algebra see G70
- H70 Miscellaneous (E.g.: algebraic topology, algebraic geometry)
- I Analysis**  
→ numerical analysis see N40
- I10 Comprehensive works on calculus and the teaching of calculus
- I20 Mappings and functions. Elementary properties of functions. Special functions (Concept of function, representation of functions, graphs of functions. Functions of a real variable. Monotonicity, continuity, limits)  
→ sequences see 130  
→ polynomials see H20
- I30 Sequences, series, power series. Convergence, summability (infinite products, integrals)
- I40 Differential calculus (E.g.: curve sketching, extremum problems)
- I50 Integral calculus. Measure theory (Integrals of different types. E.g. applications on bodies of revolution)
- I60 Functions of several variables. Differential geometry
- I70 Functional equations (Definition of functions. Differential equations, difference equations, integral equations)  
→ Functions of a complex variable, conformal mappings  
→ complex numbers see F50
- I90 Miscellaneous (E.g.: functional analysis, settheoretical topology, catastrophe theory, non-standard analysis, fractals, chaos theory)
- K Combinatorics and graph theory. Statistics and probability**
- K10 Comprehensive works on stochastics and the teaching of stochastics
- K20 Combinatorics (Classical combinatorial theory, configurations, latin squares)  
→ tessellations and packings see G90
- K30 Graph theory  
→ discrete mathematics see N70  
→ finite geometries see G90
- K40 Descriptive statistics, statistical data handling, graphical methods of data representation, data analysis
- K50 Probability concept and probability theory
- K60 Probability distributions, stochastic processes, limit
- K70 Statistical inference (Methods, non-parametric methods, robustness, Bayesian approach, methodology and foundations)
- K80 Correlation and regression analysis. Multivariate statistics (Discrimination, cluster analysis, factor analysis)
- K90 Applied statistics (E.g.: simulation, decision theory, reliability, quality control)
- M Mathematical modelling, applications of mathematics**
- M10 Mathematization, its nature and its use in education. Interdisciplinarity. Comprehensive works on applications of mathematics  
→ probability and statistics see K  
→ numerical methods see N  
→ interactions with other subjects see D30
- M20 Mathematics in vocational training and career education  
→ see also F80, F90
- M30 Financial mathematics. Insurance mathematics
- M40 Operations research, economics  
→ mathematical programming see N60
- M50 Physics. Astronomy. Technology. Engineering. Computer science. Earth sciences
- M60 Biology. Chemistry. Medicine. Pharmacy
- M70 Behavioural sciences. Social sciences. Education
- M80 Arts. Music. Language. Architecture
- M90 Miscellaneous (E.g. sport)
- N Numerical mathematics. Discrete mathematics. Mathematical software**
- N10 Comprehensive works on numerical mathematics and its instruction
- N20 Representation of numbers, rounding and estimation. Theory of errors and computation with approximate values. Conditioning
- N30 Numerical algebra (Iteration methods for the solution of nonlinear equations and systems of linear and nonlinear equations, numerical linear algebra)
- N40 Numerical analysis (Numerical solution of differential and integral equations, numerical integration and differentiation)  
→ interpolation and approximation see N50
- N50 Approximation, Interpolation, extrapolation
- N60 Mathematical programming  
→ operations research see M40

- N70 Discrete mathematics (Finite methods in various mathematical fields, especially used as theoretical foundation in other disciplines)  
 → combinatorics see K20  
 → graph theory see K30  
 → finite geometries see G90  
 → difference equations see I70
- N80 Mathematical software. Collections of computer programs  
 → software for special disciplines see each discipline  
 → computer as a teaching medium see U70
- N90 Miscellaneous (E.g. experimental mathematics)
- P Computer Science**
- P10 Comprehensive Works on Computer Science  
 → Historical reflections see A30
- P20 Theoretical computer science: Data and theory of computation  
 (Data structures, data encryption, coding and information theory, analysis of algorithms and problem complexity, modes of computation and computational complexity, formal languages)
- P30 System software, operating systems  
 (systems programs and utilities, organization and design, reliability, security and protection)  
 → user programs see R70
- P40 Programming languages  
 (language classifications, language constructs and features, processors)
- P50 Programming techniques. Software engineering  
 (Problem analysis, design tools and techniques, software/program verification, testing and debugging, software architectures)
- P60 Hardware  
 (Description of special (micro)computers, computer architectures, network architectures, computer systems organization)  
 → software for networks see P30
- P7 Computers and society  
 (Public policy issues such as data protection, impacts of computers on science and education, electronic commerce)  
 → impacts on mathematics teaching see D30  
 → careers and labour market see A40  
 → computer literacy see Q50
- P80 Miscellaneous
- Q Psychological, pedagogical and didactical aspects of teaching and learning computer science**
- Q10 Comprehensive works
- Q20 Affective behaviour. Personality  
 (Motivation, attitudes, anxiety, feelings, self concept. Skills and abilities. Creativity. Personality traits)
- Q30 Cognitive processes  
 (Concept formation, thought processes, problem solving. Learning)  
 → artificial intelligence see R40
- Q40 Sociological aspects of learning. Communication  
 (Group dynamics. Roles. Social, economic and cultural influences. Social learning)  
 teaching learning processes see Q60
- Q50 Objectives of computer science teaching. Computer literacy  
 (Innovations and trends, curriculum development and research, testing of syllabuses in pilot classes)  
 → syllabuses and curricula see B70  
 → historical reflections see A30
- Q60 Lesson planning. Teaching methods and classroom techniques.  
 Evaluation of instruction (Teaching-learning-processes. Teaching principles. Classroom organization)  
 → computer aided instruction see U50
- Q70 Achievement control and rating.  
 Diagnosis, analysis and remediation of learning difficulties and student errors
- Q80 Teaching units, draft lessons and master lessons
- Q90 Miscellaneous
- R Applications of computer science and computers**
- R10 Comprehensive works, collections of computer programs  
 → CAI see U50  
 → Distance learning see R50  
 → Computer and information science education see Qxx
- R20 Applications in mathematics and mathematical education  
 (mathematical software, computer algebra, educational software for mathematical subjects e.g. geometry software or drill and practice software)
- R30 Applications in natural, behavioural and social sciences, economics  
 → CAI see U50  
 → Computers in mathematics teaching see R20  
 → User programs see R70
- R40 Artificial Intelligence  
 (expert systems, automatic programming, theorem proving, knowledge engineering, learning, language processing, robotics)  
 → cognitive processes see C30, Q30  
 → intelligent tutoring systems see U50
- R50 Data bases, information systems.  
 Telecommunication. Educational uses  
 (information storage and retrieval, information systems applications such as electronic mail or computer conferencing, multimedia information systems, hypertext/hypermedia, online learning)  
 → data see P20
- R60 Graphical data processing, computer graphics  
 (Hardware architecture, picture/image generation, graphics utilities, computational geometry, three-dimensional graphics, image processing, pattern recognition)  
 → see also R40

R70	Document and text processing, administrative data processing, application packages for personal computing	All notations are principally in three places and consist in the first position of a capital letter, in the second position of a digit for additional subdivision and in the third position of a digit to characterize the educational institution:
R80	Recreational computing, computer games	
R90	Miscellaneous	
<b>U</b>	<b>Educational material and media. Education technology</b>	--0
U10	Comprehensive works on instructional materials, educational technology and media research	--1
U20	Textbooks. Analysis of textbooks, development and evaluation of textbooks. Textbook use in the classroom → textbooks for special disciplines see each discipline → learning with texts see also C50	--2
U30	Teacher manuals and planning aids (Teacher volumes, solutions, teaching aids) → comments on syllabuses and edicts see B70 → lesson preparation see D40 → draft lessons and teaching units see D80	--3
U40	Problem books, competition and examination questions → student competitions see B60 → preparation for examinations and achievement control see D60 → teaching problem solving see D50	--4
U50	Programmed instruction, computer assisted instruction (CAI, intelligent tutor systems, courseware design) → educational software see U70	--5
U60	Manipulative materials and their use in the classroom (visualizations, teaching aids, models, educational games, worksheets. Teaching in laboratories) → games see also A90	--6
U70	Technological tools (Computers, calculators, software, mathematical instruments, etc.) Comments on their instructional use → mathematical software see N80 → collections of computer programs see N80	--7
U80	Audiovisual media and their use in instruction (Transparencies, films. Broadcasting and television)	--8
U90	Miscellaneous (Student publications, repetition materials. Mathematical expositions) → reference books see A10	--9