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Teaching Problem-solving Strategies in Grade Eight Mathematics Mathematical Problem Solving and New Information Technologies Mathematical Problem Solving Implementation Research on Problem Solving in School Settings Mathematical Problem Solving Writing Math Research Papers A History in Creative Problem Solving Teaching and Learning Mathematical Problem Solving PROBLEM SOLVING RESEARCH METHOD AND THEORY- PAPERS PRESENTED AT THE 1ST ANNUAL SYMPOSIUM ON COGNITION. Writing Math Research Papers - 5th Ed. Mathematical Problem Solving Computational Modeling and Problem Solving in the Networked World Children Solving Problems Technical and Professional Writing Problem Solving in Mathematics Education Mathematical Problem Solving and New Information Technologies Effective Problem Solving Handbook of Research on Advancements of Swarm Intelligence Algorithms for Solving Real-World Problems Teaching and Learning of Mathematics Through Problem-Solving Soft Computing for Problem Solving Problem Solving Courts Research Report Advances and Impacts of the Theory of Inventive Problem Solving Operations Research and Artificial Intelligence: The Integration of Problem-Solving Strategies How to Do Research Work How to Solve It Broadening the Scope of Research on Mathematical Problem Solving Mathematical Problem Solving Workbook 3 Promoting Interdisciplinarity in Knowledge Generation and Problem

Solving Mathematical Problem Solving (workbook 6) Mathematical Problem Solving Educational Research and Innovation The Nature of Problem Solving Using Research to Inspire 21st Century Learning Proceedings of Fourth International Conference on Soft Computing for Problem Solving Systematic Complex Problem Solving in the Age of Digitalization and Open Innovation Mathematical Problem Solving Step-by-Step Guide to Problem Solving at School & Work Proceedings of the Second International Conference on Soft Computing for Problem Solving (SocProS 2012), December 28-30, 2012 Multiple Perspectives on Problem Solving and Learning in the Digital Age Problems and Problem Solving in Chemistry Education Problem Finding, Problem Solving, and Creativity

This book provides an insight into the 11th International Conference on Soft Computing for Problem Solving (SocProS 2022). This international conference is a joint technical collaboration of the Soft Computing Research Society and the Indian Institute of Technology Mandi. This book presents the latest achievements and innovations in the interdisciplinary areas of Soft Computing, Machine Learning, and Data Science. It brings together the researchers, engineers, and practitioners to discuss thought-provoking developments and challenges, in order to select potential future directions. It covers original research papers in the areas including but not limited to algorithms (artificial neural network, deep learning, statistical methods, genetic algorithm, and particle swarm optimization) and applications (data mining and clustering, computer vision, medical and healthcare, finance, data envelopment analysis,

business, and forecasting applications). This book is beneficial for young as well as experienced researchers dealing across complex and intricate real-world problems for which finding a solution by traditional methods is a difficult task. This edited volume with selected expanded papers from CELDA (Cognition and Exploratory Learning in the Digital Age) 2009 (http://www.celda-conf.org/) addresses the main issues concerned with problem solving, evolving learning processes, innovative pedagogies, and technology-based educational applications in the digital age. There have been advances in both cognitive psychology and computing that have affected the educational arena. The convergence of these two disciplines is increasing at a fast pace and affecting academia and professional practice in many ways. Paradigms such as just-in-time learning, constructivism, student-centered learning and collaborative approaches have emerged and are being supported by technological advancements such as simulations, virtual reality and multi-agents systems. These developments have created both opportunities and areas of serious concerns. This volume aims to cover both technological as well as pedagogical issues related to these developments. The innovative volume seeks to broaden the scope of research on mathematical problem solving in different educational environments. It brings together contributions not only from leading researchers, but also highlights collaborations with younger researchers to broadly explore mathematical problem-solving across many fields: mathematics education, psychology of education, technology education, mathematics popularization, and more. The volume□s three major themes□technology, creativity, and affect□represent key issues

that are crucially embedded in the activity of problem solving in mathematics teaching and learning, both within the school setting and beyond the school. Through the book's new pedagogical perspectives on these themes, it advances the field of research towards a more comprehensive approach on mathematical problem solving. Broadening the Scope of Research on Mathematical Problem Solving will prove to be a valuable resource for researchers and teachers interested in mathematical problem solving, as well as researchers and teachers interested in technology, creativity, and affect. Interdisciplinary research is a method that has become efficient in accelerating scientific discovery. The integration of such processes in problem solving and knowledge generation is a vital part of learning and instruction. Promoting Interdisciplinarity in Knowledge Generation and Problem Solving is a pivotal reference source for the latest scholarly research on interdisciplinary projects from around the world, highlighting the broad range of circumstances in which this approach can be effectively used to solve problems and generate new knowledge. Featuring coverage on a number of topics and perspectives such as industrial design, ethnographic methods, and methodological pluralism, this publication is ideally designed for academicians, researchers, and students seeking current research on the promotion of interdisciplinarity for knowledge production. Taking a research-based, integrated problem solving approach to technical and professional writing, this volume provides a model that illustrates real working-world solutions to problems that readers are likely to encounter in the workplace. Designed to show that problem solving is a multidimensional process, each chapter begins with a short

scenario case study that deals with theoretical or applied issues of technical and professional communication, thereby preparing users to excel in the professional world. The volume addresses a variety of forms of professionalism and problem solving including technical and rhetorical problem solving, solving problems through research, reports and completion reports, proposals, letters and memoranda's, solving problems through trip reports, feasibility studies, and lab reports, policy statements, manuals, and procedures, as well as solving problems in the professional job search, through document design, and through oral presentations. For business professionals and others who would benefit from enhanced problem-solving skills. This book is a compilation of a selected subset of research articles presented at the Eighth INFORMS Computing Society Conference, held in Chandler, Arizona, from January 8 to 10, 2003. The articles in this book represent the diversity and depth of the interface between ORiMS (operations research and the management sciences) and CS/AI (computer science and artificial intelligence). This volume starts with two papers that represent the reflective and integrative thinking that is critical to any scientific discipline. These two articles present philosophical perspectives on computation, covering a variety of traditional and newer methods for modeling, solving, and explaining mathematical models. The next set includes articles that study machine learning and computational heuristics, and is followed by articles that address issues in performance testing of solution algorithms and heuristics. These two sets of papers demonstrate the richness of thought that takes place at the ORiMS and CSI AI interface. The final set of articles

demonstrates the usefulness of these and other methods at the interface towards solving problems in the real world, covering e-commerce, workflow, electronic negotiation, music, parallel computation, and telecommunications. The articles in this collection represent the results of cross-fertilization between ORiMS and CSI AI, making possible advances that could have not been achieved in isolation. The continuing aim ofthe INFORMS Computing Society and this research conference is to invigorate and further develop this interface. This book is addressed to people with research interests in the nature of mathematical thinking at any level, to people with an interest in "higher-order thinking skills" in any domain, and to all mathematics teachers. The focal point of the book is a framework for the analysis of complex problem-solving behavior. That framework is presented in Part One, which consists of Chapters 1 through 5. It describes four qualitatively different aspects of complex intellectual activity: cognitive resources, the body of facts and procedures at one's disposal; heuristics, "rules of thumb" for making progress in difficult situations; control, having to do with the efficiency with which individuals utilize the knowledge at their disposal; and belief systems, one's perspectives regarding the nature of a discipline and how one goes about working in it. Part Two of the book, consisting of Chapters 6 through 10, presents a series of empirical studies that flesh out the analytical framework. These studies document the ways that competent problem solvers make the most of the knowledge at their disposal. They include observations of students, indicating some typical roadblocks to success. Data taken from students before and after a series of intensive problem-solving courses

document the kinds of learning that can result from carefully designed instruction. Finally, observations made in typical high school classrooms serve to indicate some of the sources of students' (often counterproductive) mathematical behavior. Many students at secondary schools in Kenya have not been performing well in Mathematics. This has forced the Government of Kenya to among other things try to increase the salaries of the teachers, organize In-service Education and Training (INSET) for the trained teachers. However, the situation has not improved much. This research looked at an approach to teaching and learning of mathematics where the learners are fully involved in the learning process. Results showed that the approach improved students confident and the experimental group performed well in problems that required High Order Thinking Skills (HOTS). This shows that curriculum developers and teachers should read the text with a view to implementing the findings in the schools. A strong and fluent competency in mathematics is a necessary condition for scientific, technological and economic progress. However, it is widely recognized that problem solving, reasoning, and thinking processes are critical areas in which students' performance lags far behind what should be expected and desired. Mathematics is indeed an important subject, but is also important to be able to use it in extra-mathematical contexts. Thinking strictly in terms of mathematics or thinking in terms of its relations with the real world involve quite different processes and issues. This book includes the revised papers presented at the NATO ARW "Information Technology and Mathematical Problem Solving Research", held in April 1991, in Viana do Castelo, Portugal, which focused on the implications

of computerized learning environments and cognitive psychology research for these mathematical activities. In recent years, several committees, professional associations, and distinguished individuals throughout the world have put forward proposals to renew mathematics curricula, all emphasizing the importance of problem solving. In order to be successful, these reforming intentions require a theory-driven research base. But mathematics problem solving may be considered a "chaotic field" in which progress has been quite slow. Having strong problem-solving skills can make a huge difference in one's career in the modern knowledge-based economy. Problems are at the center of what we do at work every day. Whether one is developing a vaccine for the flu, creating an antivirus program for the Internet, delivering lifesaving drugs to remote villages, maximizing profits for a company, or understanding the complex structure of our universe, problems are an integral part of our everyday lives. Being an effective and confident problem solver is really important to one's success. Much of that confidence comes from having a good understanding of strategy and the tools to use when approaching a problem. Therefore, it is essential for students to develop the skills and techniques for problem solving at an early age, when they are in elementary school. Mathematical problem solving is often taught as a way to reinforce mathematical concepts, which misses the importance of strategic thinking while solving a problem. Many research articles and books have been written emphasizing the importance of problem-solving strategies. However, the burden of teaching problem-solving strategies is left mostly to teachers and parents, who are expected to develop their own curriculum

and lesson plans for the complex topic of strategy and then teach it to students. This book presents different problem-solving strategies that can easily be used by teachers and parents to teach the subject. The first three chapters present the concepts of number operations, the basic problem-solving strategies, and the unitary method. This is followed by many different problems that students will encounter in their careers. These include lessons that present problems on numbers, age, time and distance, money, work and time, and mixtures. The focus of the book is to start with a problem statement, understand the problem, and then solve it with a known mathematical procedure. Detailed examples are presented in each lesson to show the step-by-step strategy to solve different types of real-life problems. Students often need help learning to write well. This book serves as a student text and a resource for implementing a mathematics research program. The book details how to write a research paper, from pre-writing to presenting the paper. It provides interesting research topics, a bibliography of periodicals and problem-solving books and information about mathematics contests. The use of optimization algorithms has seen an emergence in various professional fields due to its ability to process data and information in an efficient and productive manner. Combining computational intelligence with these algorithms has created a trending subject of research on how much more beneficial intelligent-inspired algorithms can be within companies and organizations. As modern theories and applications are continually being developed in this area, professionals are in need of current research on how intelligent algorithms are advancing in the real world. TheHandbook of Research on

Advancements of Swarm Intelligence Algorithms for Solving Real-World Problems is a pivotal reference source that provides vital research on the development of swarm intelligence algorithms and their implementation into current issues. While highlighting topics such as multi-agent systems, bio-inspired computing, and evolutionary programming, this publication explores various concepts and theories of swarm intelligence and outlines future directions of development. This book is ideally designed for IT specialists, researchers, academicians, engineers, developers, practitioners, and students seeking current research on the real-world applications of intelligent algorithms. The present book is based on the research papers presented in the International Conference on Soft Computing for Problem Solving (SocProS 2012), held at JK Lakshmipat University, Jaipur, India. This book provides the latest developments in the area of soft computing and covers a variety of topics, including mathematical modeling, image processing, optimization, swarm intelligence, evolutionary algorithms, fuzzy logic, neural networks, forecasting, data mining, etc. The objective of the book is to familiarize the reader with the latest scientific developments that are taking place in various fields and the latest sophisticated problem solving tools that are being developed to deal with the complex and intricate problems that are otherwise difficult to solve by the usual and traditional methods. The book is directed to the researchers and scientists engaged in various fields of Science and Technology. Having strong problem-solving skills can make a huge difference in one's career in the modern knowledge-based economy. Problems are at the center of what we do at

work every day. Whether one is developing a vaccine for the flu, creating an antivirus program for the Internet, delivering lifesaving drugs to remote villages, maximizing profits for a company, or understanding the complex structure of our universe, problems are an integral part of our everyday lives. Being an effective and confident problem solver is really important to one's success. Much of that confidence comes from having a good understanding of strategy and the tools to use when approaching a problem. Therefore, it is essential for students to develop the skills and techniques for problem solving at an early age, when they are in elementary school. Mathematical problem solving is often taught as a way to reinforce mathematical concepts, which misses the importance of strategic thinking while solving a problem. Many research articles and books have been written emphasizing the importance of problem-solving strategies. However, the burden of teaching problem-solving strategies is left mostly to teachers and parents, who are expected to develop their own curriculum and lesson plans for the complex topic of strategy and then teach it to students. This book presents different problem-solving strategies that can easily be used by teachers and parents to teach the subject. The first three chapters present the concepts of number operations, the basic problem-solving strategies, and the unitary method. This is followed by many different problems that students will encounter in their careers. These include lessons that present problems on numbers, age, time and distance, money, work and time, and mixtures. The focus of the book is to start with a problem statement, understand the problem, and then solve it with a known mathematical procedure. Detailed examples are presented in

each lesson to show the step-by-step strategy to solve different types of real-life problems. Mathematics research papers provide a forum for all mathematics enthusiasts to exercise their mathematical experience, expertise and excitement. The research paper process epitomizes the differentiation of instruction, as each student chooses their own topic and extends it as far as their motivation and desire takes them. The features and benefits of the research paper process offer a natural alignment with all eight Common Core State Standards for Mathematical Practice. Writing Math Research Papers serves both as a text for students and as a resource for instructors and administrators. The Writing Math Research Papers program started at North Shore High School in 1991, and it received the 1997 Chevron Best Practices in Education Award as the premier high school math course in the United States. Author Robert Gerver's articles on high school mathematics research programs were featured in the National Council of Teachers of Mathematics publication Developing Mathematically Promising Students, the NCTM's 1999 Yearbook, Developing Mathematical Reasoning in Grades K – 12, and in the September 2017 issue of the Mathematics Teacher. This set of papers was originally developed for a conference on Issues and Directions in Mathematics Problem Solving Research held at Indiana University in May 1981. The purpose is to contribute to the clear formulation of the key issues in mathematical problem-solving research by presenting the ideas of actively involved researchers. An introduction provides an overview of each paper. The papers focus on the psychology of mathematical problem solving (R. E. Mayer), knowledge organization (E. A. Silver), implications from

information-processing psychology, (D. J. Briars) building bridges between psychological and mathematics education research (F. K. Lester, Jr.), measuring problem solving outcomes (G. A. Goldin), a model for elementary teacher training in problem solving (J. F. LeBlanc), applied problem solving (R. Lesh, and M. Akerstrom), a concept-learning perspective (R. J. Shumway), and a statement of issues (H. L. Schoen). (MNS) Solving non-routine problems is a key competence in a world full of changes, uncertainty and surprise where we strive to achieve so many ambitious goals. But the world is also full of solutions because of the extraordinary competences of humans who search for and find them. A strong and fluent competency in mathematics is a necessary condition for scientific, technological and economic progress. However, it is widely recognized that problem solving, reasoning, and thinking processes are critical areas in which students' performance lags far behind what should be expected and desired. Mathematics is indeed an important subject, but is also important to be able to use it in extra-mathematical contexts. Thinking strictly in terms of mathematics or thinking in terms of its relations with the real world involve quite different processes and issues. This book includes the revised papers presented at the NATO ARW "Information Technology and Mathematical Problem Solving Research", held in April 1991, in Viana do Castelo, Portugal, which focused on the implications of computerized learning environments and cognitive psychology research for these mathematical activities. In recent years, several committees, professional associations, and distinguished individuals throughout the world have put forward proposals to renew

mathematics curricula, all emphasizing the importance of problem solving. In order to be successful, these reforming intentions require a theory-driven research base. But mathematics problem solving may be considered a "chaotic field" in which progress has been quite slow. Many individuals studying problem solving consider creativity a special type of problem solving. On the other hand, many individuals studying creativity view problem solving as a special type of creative performance. What is truly the role of creativity in problem solving? What is the role of problem solving in creativity? And how are problem solving and creativity related to problem finding? This book addresses these questions, and fills an obvious need for an overview of the research on problem finding. A perennial bestseller by eminent mathematician G. Polya, How to Solve It will show anyone in any field how to think straight. In lucid and appealing prose, Polya reveals how the mathematical method of demonstrating a proof or finding an unknown can be of help in attacking any problem that can be "reasoned" out□from building a bridge to winning a game of anagrams. Generations of readers have relished Polya's deft□indeed, brilliant□instructions on stripping away irrelevancies and going straight to the heart of the problem. A provocative collection of papers containing comprehensive reviews of previous research, teaching techniques, and pointers for direction of future study. Provides both a comprehensive assessment of the latest research on mathematical problem solving, with special emphasis on its teaching, and an attempt to increase communication across the active disciplines in this area. This book offers a collection of cutting-edge research on the Theory of Inventive Problem

Solving (TRIZ). Introduced by Genrich Altshuller in 1956, TRIZ has since been used by engineers, inventors and creators as an essential structured innovation method at businesses and organizations around the globe. The chapters of this book showcase work by selected authors from the 'TRIZ Future' conferences, which are organized by the European TRIZ Association (ETRIA). The chapters reflect an international mix of new ideas on TRIZ and knowledge-based innovation, highlight recent advances in the TRIZ community, and provide examples of successful collaboration between industry and academia. The book first introduces the reader to recent methodological innovations, then provides an overview of established and new TRIZ tools, followed by a collection of case studies and examples of TRIZ implementation in various scientific and social contexts. MySearchLab provides students with a complete understanding of the research process so they can complete research projects confidently and efficiently. Students and instructors with an internet connection can visit www.MySearchLab.com and receive immediate access to thousands of full articles from the EBSCO ContentSelect database. In addition, MySearchLab offers extensive content on the research process itself--including tips on how to navigate and maximize time in the campus library, a step-by-step guide on writing a research paper, and instructions on how to finish an academic assignment with endnotes and bibliography. For freshman through senior-level courses on Critical Thinking, Cognition, or Problem Solving. This brief survey of creative problem solving offers a collection of specific, practical procedures that one should use for various classes of problems - ranging from machines that need

repairing, to mathematical puzzles, engineering problems, poorly defined industrial problems, comprehending lectures and reading, remembering information, invention, and difficulties between people. The principles - which are based on research and theory in cognitive psychology - are applied to problems in daily living and focus on how to overcome one's own limitations in trying to solve a problem. Students thus learn principles for dealing with problems as well as what it is about themselves that can make the problem more or less difficult. The Proceedings of SocProS 2014 serves as an academic bonanza for scientists and researchers working in the field of Soft Computing. This book contains theoretical as well as practical aspects using fuzzy logic, neural networks, evolutionary algorithms, swarm intelligence algorithms, etc., with many applications under the umbrella of Soft Computing. The book is beneficial for young as well as experienced researchers dealing across complex and intricate real world problems for which finding a solution by traditional methods is a difficult task. The different application areas covered in the Proceedings are: Image Processing, Cryptanalysis, Industrial Optimization, Supply Chain Management, Newly Proposed Nature Inspired Algorithms, Signal Processing, Problems related to Medical and Healthcare, Networking Optimization Problems, etc. The mastery of certain skills can only help students succeed in all areas of life, no matter what they do or where they do it. Problem solving is among the most important of these life skills. This book is a comprehensive examination of problem-solving hurdles students may encounter, both in the classroom and on the job site. More than an examination of various problem areas, this book offers the tools and

techniques that will help readers overcome such obstacles and thrive. In order to make the criminal court system more effective there has been a growing trend to have courts participate in what is essentially a rehabilitation strategy. Such courts are often referred to as problem-solving because they are working on root causes of criminal behavior as part of the dispensation of justice. This major shift in the role of the courts means that the court works closely with prosecutors, public defenders, probation officers, social workers, and other justice system partners to develop a strategy that pressures offenders to complete a treatment program which will ultimately, hopefully prevent recidivism. Research has shown that this kind of strategy has a two-fold benefit. It has been successful in helping offenders turn their lives around which leads to improved public safety and the ultimate saving of public funds. This book is the first to focus exclusively on problem solving courts, and as such it presents an overview of the rationale and scientific evidence for such courts as well as individual sections on the key areas in which these courts are active. Thus there is specific attention paid to domestic violence, juvenile criminality, mental health, and more. Throughout, research findings are incorporated into general discussions of these courts operate and ideally what they are trying to accomplish. There is also discussion of how such courts should evolve in the future and the directions that further research should take. "During and since the Great War, interest in research in this country has spread, rapidly, beyond the walls of a few scattered academic chambers and the occasional government bureaus and business enterprises which were first to see the necessity of discovering new light concerning the problems that arose in

connection with their immediate affairs. But this growth in research pursuits has not greatly stimulated the production of literature which serves to answer the question of how to do research work. Such literature as exists, or is being written, seldom explains in understandable terms the fundamental tool of research, method, in relation to the actual procedure of discovering and solving research problems. Most treatments are devoted either intensively to statistical methods or to the description of "psychological laws," presumed to furnish the basis of method in doing things. This book has been written, primarily, to provide the research worker with a method of procedure from the beginning to the end of a research undertaking, and, secondly, to offer suggestions concerning the mental processes involved and statistical devices that may be used in handling the data"--Preface. (PsycINFO Database Record (c) 2010 APA, all rights reserved). Problem solving is central to the teaching and learning of chemistry at secondary, tertiary and post-tertiary levels of education, opening to students and professional chemists alike a whole new world for analysing data, looking for patterns and making deductions. As an important higher-order thinking skill, problem solving also constitutes a major research field in science education. Relevant education research is an ongoing process, with recent developments occurring not only in the area of quantitative/computational problems, but also in qualitative problem solving. The following situations are considered, some general, others with a focus on specific areas of chemistry: quantitative problems, qualitative reasoning, metacognition and resource activation, deconstructing the problem-solving process, an overview of the working memory hypothesis,

reasoning with the electron-pushing formalism, scaffolding organic synthesis skills, spectroscopy for structural characterization in organic chemistry, enzyme kinetics, problem solving in the academic chemistry laboratory, chemistry problem-solving in context, team-based/active learning, technology for molecular representations, IR spectra simulation, and computational quantum chemistry tools. The book concludes with methodological and epistemological issues in problem solving research and other perspectives in problem solving in chemistry. With a foreword by George Bodner. This work surveys research from a range of perspectives in order to examine how children develop problem-solving skills. The author suggests that successful problem-solving is a social process, and that sharing problem-solving - with adults and other children - is vital to a child's development. This book contributes to the field of mathematical problem solving by exploring current themes, trends and research perspectives. It does so by addressing five broad and related dimensions: problem solving heuristics, problem solving and technology, inquiry and problem posing in mathematics education, assessment of and through problem solving, and the problem solving environment. Mathematical problem solving has long been recognized as an important aspect of mathematics, teaching mathematics, and learning mathematics. It has influenced mathematics curricula around the world, with calls for the teaching of problem solving as well as the teaching of mathematics through problem solving. And as such, it has been of interest to mathematics education researchers for as long as the field has existed. Research in this area has generally aimed at understanding and relating the

processes involved in solving problems to students development of mathematical knowledge and problem solving skills. The accumulated knowledge and field developments have included conceptual frameworks for characterizing learners success in problem solving activities, cognitive, metacognitive, social and affective analysis, curriculum proposals, and ways to promote problem solving approaches. This book constitutes the refereed proceedings of the 20th International TRIZ Future Conference on Automated Invention for Smart Industries, TFC 2020, held in Cluj-Napoca, Romania, in October 2020 and sponsored by IFIP WG 5.4. The conference was held virtually. The 34 full papers presented were carefully reviewed and selected from 91 submissions. They are organized in the following thematic sections: computing TRIZ; education and pedagogy; sustainable development; tools and techniques of TRIZ for enhancing design; TRIZ and system engineering; TRIZ and complexity; and cross-fertilization of TRIZ for innovation management. Research Paper (postgraduate) from the year 2017 in the subject Psychology - Miscellaneous, grade: 4.0, , language: English, abstract: This paper provides a brief summary of the versions of creative problem solving and the key scholars who contributed the CPS history and findings of problems we face as mankind learns to find helpful solutions. The original work of Alex Osborn making the creative process more explicit, and the following 50 years of research and development on creative problem solving, have made an important and wide-spread contribution to those interested in the deliberate development of creative talent. Content of the Book The University of Potsdam hosted the 25th ProMath and the 5th WG Problem

Solving conference. Both groups met for the second time in this constellation which contributed to profound discussions on problem solving in each country taking cultural particularities into account. The joint conference took place from 29th to 31st August 2018, with participants from Finland, Germany, Greece, Hungary, Israel, Sweden, and Turkey. The conference revolved around the theme Implementation research on problem solving in school settings. These proceedings contain 14 peer-reviewed research and practical articles including a plenary paper from our distinguished colleague Anu Laine. In addition, the proceedings include three workshop reports which likewise focused on the conference theme. As such, these proceedings provide an overview of different research approaches and methods in implementation research on problem solving in school settings which may help close the gap between research and practice, and consequently make a step forward toward making problem solving an integral part of school mathematics on a large-scale. Content PLENARY REPORT Anu Laine: How to promote learning in problem-solving? pp 3 18 This article is based on my plenary talk at the joint conference of ProMath and the GDM working group on problem-solving in 2018. The aim of this article is to consider teaching and learning problem-solving from different perspectives taking into account the connection between 1) teacher's actions and pupils' solutions and 2) teacher's actions and pupils' affective reactions. Safe and supportive emotional atmosphere is base for students' learning and attitudes towards mathematics. Teacher has a central role both in constructing emotional atmosphere and in offering cognitive support that pupils need in order to reach higher-level

solutions. Teachers need to use activating guidance, i.e., ask good questions based on pupils solutions. Balancing between too much and too little guidance is not easy. https://doi.org/10.37626/GA9783959871167.0.01 RESEARCH REPORTS AND ORAL COMMUNICATIONS Lukas Baumanns and Benjamin Rott: Is problem posing about posing problems? A terminological framework for researching problem posing and problem solving pp 21 31 In this literature review, we critically compare different problem-posing situations used in research studies. This review reveals that the term problem posing is used for many different situations that differ substantially from each other. For some situations, it is debatable whether they provoke a posing activity at all. For other situations, we propose a terminological differentiation between posing routine tasks and posing non-routine problems. To reinforce our terminological specification and to empirically verify our theoretical considerations, we conducted some task-based interviews with students. https://doi.org/10.37626/GA9783959871167.0.02 Kerstin Bräuning: Long-term study on the development of approaches for a combinatorial task pp 33 50 In a longitudinal research project over two years, we interviewed children up to 6 times individually to trace their developmental trajectories when they solve several times the same tasks from different mathematical areas. As a case study, I will present the combinatorial task and analyze how two children, a girl and a boy, over two years approached it. As a result of the case studies we can see that the analysis of the data product-oriented or process-oriented provides different results. It is also observable that the developmental trajectory of the girl is a more continuous

learning process, which we cannot identify for the boy. https://doi.org/10.37626/GA9783959871167.0.03 Lars Burman: Developing students problem-solving skills using problem sequences: Student perspectives on collaborative work pp 51 59 Using problem solving in mathematics classrooms has been the object of research for several decades. However, it is still necessary to focus on the development of problem-solving skills, and in line with the recent PISA assessment, more attention is given to collaborative problem solving. This article addresses students collaborative work with problem sequences as a means to systematically develop students problem-solving skills. The article offers student perspectives on challenges concerning the social atmosphere, differentiation on teaching, and learning in cooperation. In spite of the challenges, the students experiences indicate that the use of problem sequences and group problem solving can be fruitful in mathematics education. https://doi.org/10.37626/GA9783959871167.0.04 Alex Friedlander: Learning algebraic procedures through problem solving pp 61 69 In this paper, I attempt to present several examples of tasks and some relevant findings that investigate the possibility of basing a part of the practice-oriented tasks on higher-level thinking skills, that are usually associated with processes of problem solving. The tasks presented and analysed here integrate problem solving-components namely, reversed thinking, expressing and analysing patterns, and employing multiple solution methods, into the learning and practicing of algebraic procedures such as creating equivalent expressions and solving equations. https://doi.org/10.37626/GA9783959871167.0.05 Thomas

Gawlick and Gerrit Welzel: Backwards or forwards? Direction of working and success in problem solving pp 71 – 89 We pose ourselves the question: What can one infer from the direction of working when solvers work on the same task for a second time? This is discussed on the basis of 44 problem solving processes of the TIMSS task K10. A natural hypothesis is that working forwards can be taken as evidence that the task is recognized and a solution path is recalled. This can be confirmed by our analysis. A surprising observation is that when working backwards, pivotal for success is (in case of K10) to change to working forwards soon after reaching the barrier. https://doi.org/10.37626/GA9783959871167.0.06 Inga Gebel: Challenges in teaching problem solving: Presentation of a project in progress by using an extended tetrahedron model pp 91 – 109 In order to implement mathematical problem solving in class, it is necessary to consider many different dimensions: the students, the teacher, the theoretical demands and adequate methods and materials. In this paper, an implementation process is presented that considers the above dimensions as well as the research perspective by using an extended tetrahedron model as a structural framework. In concrete terms, the development and initial evaluation of a task format and a new teaching concept are presented that focus on differentiated problem-solving learning in primary school. The pilot results show initial tendencies towards possible core aspects that enable differentiated problem solving in mathematics teaching.
https://doi.org/10.37626/GA9783959871167.0.07 Heike Hagelgans: Why does problem-oriented mathematics education not succeed in an eighth grade? An insight in an

empirical study pp 111 – 119 Based on current research findings on the possibilities of integration of problem solving into mathematics teaching, the difficulties of pupils with problem solving tasks and of teachers to get started in problem solving, this article would like to show which concrete difficulties delayed the start of the implementation of a generally problem-oriented mathematics lesson in an eighth grade of a grammar school. The article briefly describes the research method of this qualitative study and identifies and discusses the difficulties of problem solving in the examined school class. In a next step, the results of this study are used to conceive a precise teaching concept for this specific class for the introduction into problem-oriented mathematics teaching. https://doi.org/10.37626/GA9783959871167.0.08 Zoltán Kovács and Eszter Kónya: Implementing problem solving in mathematics classes pp 121 – 128 There is little evidence of teachers are using challenging problems in their mathematics classes in Hungary. At the University of Debrecen and University of Nyíregyháza, we elaborated a professional development program for inservice teachers in order to help them implementing problem solving in their classes. The basis of our program is the teacher and researcher collaboration in the lessonplanning and evaluation. In this paper we report some preliminary findings concerning this program. https://doi.org/10.37626/GA9783959871167.0.09 Ana Kuzle: Campus school project as an example of cooperation between the University of Potsdam and schools pp 129 – 141 The "Campus School Project" is a part of the "Qualitätsoffensive Lehrerbildung" project, whose aim is to improve and implement new structures in the university teacher training by bringing all

the essential protagonists, namely university stuff, preservice teachers, and in-service teachers together, and having them work jointly on a common goal. The department of primary mathematics education at the University of Potsdam has been a part of the Campus School Project since 2017. Thus far several cooperations emerged focusing on different aspects of problem solving in primary education. Here, I give an overview of selected cooperations, and the first results with respect to problem-solving research in different school settings.
https://doi.org/10.37626/GA9783959871167.0.10 Ioannis Papadopoulos and Aikaterini Diakidou: Does collaborative problem-solving matter in primary school? The issue of control actions pp 143 157 In this paper we follow three Grade 6 students trying to solve (at first individually, and then in a group) arithmetical and geometrical problems. The focus of the study is to identify and compare the various types of control actions taken during individual and collaborative problem-solving to show how the collective work enhances the range of the available control actions. At the same time the analysis of the findings give evidence about the impact of the collaborative problemsolving on the way the students can benefit in terms of aspects of social metacognition.
https://doi.org/10.37626/GA9783959871167.0.11 Sarina Scharnberg: Adaptive teaching interventions in collaborative problem-solving processes pp 159 171 Even though there exists limited knowledge on how exactly students acquire problem-solving competences, researchers agree that adaptive teaching interventions have the potential to support students autonomous problem-solving processes. However, most recent research aims at analyzing the characteristics of teaching

interventions rather than the interventions effects on the students problem-solving process. The study in this paper addresses this research gap by focusing not only on the teaching interventions themselves, but also on the students collaborative problem-solving processes just before and just after the interventions. The aim of the study is to analyze the interventions effect on the learners integrated problem-solving processes.
https://doi.org/10.37626/GA9783959871167.0.12 Nina Sturm: Self-generated representations as heuristic tools for solving word problems pp 173 – 192 Solving non-routine word problems is a challenge for many primary school students. A training program was therefore developed to help third-grade students to find solutions to word problems by constructing external representations (e.g., sketches, tables) and to specifically use them. The objective was to find out whether the program positively influences students problemsolving success and problem-solving skills. The findings revealed significant differences between trained and untrained classes. Therefore, it can be assumed that self-generated representations are heuristic tools that help students solve word problems. This paper presents the results on the impact of the training program on the learning outcome of students.
https://doi.org/10.37626/GA9783959871167.0.13 Kinga Szűcs: Problem solving teaching with hearing and hearing-impaired students pp 193 – 203 In the last decade the concept of inclusion has become more and more prevalent in mathematics education, especially in Germany. Accordingly, teachers in mathematics classrooms have to face a wide range of heterogeneity, which includes physical, sensory and mental

disabilities. At the Friedrich-Schiller-University of Jena, within the framework of the project Media in mathematics education it is examined how new technologies can support teaching in inclusive mathematics classrooms. In the academic year 2017/18, the heterogeneity regarding hearing impairment was mainly focussed on. Based on a small case study with hearing and hearing-impaired students a problem-solving unit about tangent lines was worked out according to Pólya, which is presented in the paper.
https://doi.org/10.37626/GA9783959871167.0.14 WORKSHOP REPORTS Ana Kuzle and Inga Gebel: Implementation research on problem solving in school settings: A workshop report 207 On the last day of the conference, we organized a 90-minute workshop. The workshop focused on the conference theme Implementation research on problem solving in school settings. Throughout the conference, the participants were invited to write down their questions and/or comments as a response to held presentations.
https://doi.org/10.37626/GA9783959871167.0.15 Ana Kuzle, Inga Gebel and Anu Laine: Methodology in implementation research on problem solving in school settings pp 209 – 211 In this report, a summary is given on the contents of the workshop. In particular, the methodology and some ethical questions in implementation research on problem solving in school settings are discussed. The discussion showed how complex this theme is so that many additional questions emerged. https://doi.org/10.37626/GA9783959871167.0.16 Lukas Baumanns and Sarina Scharnberg: The role of protagonists in implementing research on problem solving in school practice pp 213 – 214 Based on seminal works of Pólya

(1945) and Schoenfeld (1985), problem solving has become a major focus of mathematics education research. Even though there exists a variety of recent research on problem solving in schools, the research results do not have a direct impact on problem solving in school practice. Instead, a dissemination of research results by integrating different protagonists is necessary. Within our working group, the roles of three different protagonists involved in implementing research on problem solving in school practice were discussed, namely researchers, pre-service, and in-service teachers, by examining the following discussion question: To what extent do the different protagonists enable implementation of research findings on problem solving in school practice?
https://doi.org/10.37626/GA9783959871167.0.17 Benjamin Rott and Ioannis Papadopoulos: The role of problem solving in school mathematics pp 215 – 217 In this report of a workshop held at the 2018 ProMath conference, a summary is given of the contents of the workshop. In particular, the role of problem solving in regular mathematics teaching was discussed (problem solving as a goal vs. as a method of teaching), with implications regarding the selection of problems, its implementation into (written) exams as well as teacher proficiency that is needed for implementing problem solving into mathematics teaching.
https://doi.org/10.37626/GA9783959871167.0.18 The purpose of this book is to introduce and explain research at the boundary between two fields that view problem solving from different perspectives. Researchers in operations research and artificial intelligence have traditionally remained separate in their activities. Recently, there has been an explosion of work

at the border of the two fields, as members of both communities seek to leverage their activities and resolve problems that remain intractable to pure operations research or artificial intelligence techniques. This book presents representative results from this current flurry of activity and provides insights into promising directions for continued exploration. This book should be of special interest to researchers in artificial intelligence and operations research because it exposes a number of applications and techniques, which have benefited from the integration of problem solving strategies. Even researchers working on different applications or with different techniques can benefit from the descriptions contained here, because they provide insight into effective methods for combining approaches from the two fields. Additionally, researchers in both communities will find a wealth of pointers to challenging new problems and potential opportunities that exist at the interface between operations research and artificial intelligence. In addition to the obvious interest the book should have for members of the operations research and artificial intelligence communities, the papers here are also relevant to members of other research communities and development activities that can benefit from improvements to fundamental problem solving approaches. This survey book reviews four interrelated areas: (i) the relevance of heuristics in problem-solving approaches why they are important and what research tells us about their use; (ii) the need to characterize and foster creative problem-solving approaches what type of heuristics helps learners devise and practice creative solutions; (iii) the importance that learners formulate and pursue their own problems; and iv) the role

played by the use of both multiple-purpose and ad hoc mathematical action types of technologies in problem-solving contexts what ways of reasoning learners construct when they rely on the use of digital technologies, and how technology and technology approaches can be reconciled.

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