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ABSTRACT

These four bulletins are each a compilation of references on Activities, Research, and Other Topics Related to Calculator Use. They were originally published at intervals to provide teachers and other interested individuals with sources of information about calculators pertinent to education. Bulletins cover the following subject areas: (1) activities for students, K-12; (2) research reports, K-12; (3) miscellaneous concerns; (4) references at the college and other postsecondary levels: (5) selecting calculators: and (6) curriculum suggestions, K-12. Most of the references cited in each bulletin include annotations. (MP)

REFERENCE BULLETINS FROM THE CALCULATOR INFORMATION CENTER

BULLETINS 25-28

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References on Instructional Activities, Research Reports, and Other Topics Related to Calculator Use

References have been selected from those collected during the past year. They are grouped to aid you in locating materials which you might find particularly useful.

ACTIVITIES FOR STUDENTS, K-12

Bitter, Gary. Count on the Calculator! Teacher 96: 67-68ff; February 1979. Use of calculators for elementary students is recommended, so that they may concentrate on the sense of a problem. Activities on place value, estimation, and operations are suggested.

Blume, Glendon W. A Calculator-Based Unit on Exponential Functions and Logarithms. Computing Teacher 6: 47-48; May 1979. Calculator-based activities are provided, with worksheets on population growth and inflation.

Burt, Bruce C. (editor). Calculators: Readings from the Arithmetic Teacher and the Mathematics Teacher. Reston, Virginia: National Council of Teachers of Mathematics, 1979. Articles from the two journals are reproduced.

Dickson, T. R. The Hand Calculator Handbook. Aptos, California: Alchemy Press, 1978. Calculator algorithms for problems ranging from root finding of equations to trigonometry, surveying, navigation, and finances are included.

Dorn, Carl and Councilman, Samuel. Some Properties of the Calculator Square-Root Function. Mathematics Teacher 73: 218-221; March 1980. This exploration of the square-root function can be used to introduce the notions of limit of a sequence, monotone function, and step function.

Duea, Joan; Immerzeel, George; Ockenga, Earl; and Tarr, John. Problem Solving Using the Calculator. In Problem Solving in School Mathematics. 1980 NCTM Yearbook. Reston, Virginia: National Council of Teachers of Mathematics, 1980. Pp. 117-126. Problems for use with calculators are provided; modifying textbook materials and developing a file are suggested.

Elich, Joseph and Elich, Carletta. Trigonometry Using Calculators. Reading, Massachusetts: Addison-Wesley, 1980. This book is designed for a one-semester or one-quarter course in trigonometry, with calculator use integrated.

Ercolano, Joseph. Fractional Computations on a Calculator. Mathematics Teacher 72: 591-592; November 1979. A procedure is presented for obtaining fractional results on a calculator.

Fisher, Bill. Calculator Games: Combining Skills and Problem Solving. Arithmetic Teacher 27: 40-41; December 1979. Several calculator games involving computational practice are presented.

King, Ronald S. Concurrent Processing with Calculators. MATYC Journal 14: 13-16; Winter 1980. Two types of problems that could be used to develop the idea of concurrent processing with calculators are presented.

Lappan, Glenda and Winter, M. J. "It's What You Do First That Counts ..." School Science and Mathematics 79: 409-414; May-June 1979. Five calculator activities are described; they are designed to explore ordered operations. Suggestions are given on objectives, strategies for solving, and possible extensions or follow-up activities.

Maor, Eli. Polynomial Evaluation on the Calculator: Two Lessons. Didactic Programming 2: 11-13; Fall 1979. The polynomial function is explored using a calculator.

Maor, Eli. A Summer Course with the TI 57 Programmable Calculator. Mathematics Teacher 73: 99-106; February 1980. A six-week course for students aged 8-11 and 12-15 is outlined, and how some topics were explored is described.

Maor, Eli. Some Uses of the Exchange Key on a Calculator. Mathematics Teacher 73: 213-217; March 1980. Several topics with which the exchange key can be used are described: Fibonacci numbers, square roots, and geometric series.

McCarty, George. Display Calculators Bring a New Dimension to Teaching. Audio-visual Instruction 24: 20-21; September 1979. A method of using a display calculator for communicating algorithms in classroom mathematics instruction is described.

Meyer, Phillis I. When You Use a Calculator You Have to Think! Arithmetic Teacher 27: 18-21; January 1980. Ways in which a fourth-grade class used calculators are described.

Mitchell, Charles E. Problem Solving & RPN Logic. Computing Teacher 6: 35-36; May 1979. A calculator using RPN logic is integrated into instruction on problem solving; specific illustrations are included.

Moursund, David. Calculators and Elementary Education, Part 2: Using a Calculator. Computing Teacher 7: 18-23; October-November 1979. Part 3: Problem Solving. 7: 29-36; December 1979-January 1980. Part 4: Functions and Formulas. 7: 20-26; February-March 1980. Three chapters from the book, Calculators and Elementary Education, are presented. Calculator characteristics and problems are included.

Peterson, Gregory K. Cube Roots on a Calculator -- Some More Thoughts. Mathematics Teacher 72: 448-449; September 1979. An alternative method for determining cube roots is presented.

Sackson, Sid. Calculate! New York: Pantheon Books, 1979. Activities for several age levels are included in this book.

Shields, Joseph J. Mini-Calculators and Problem Solving. School Science and Mathematics 80: 211-217; March 1980. How the calculator can facilitate the development of problem-solving skills is discussed.

Snider, Arthur D. The Calculator Evaluation of Transcendental Functions. Didactic Programming 2: 33-35; Winter-Spring 1980. How the pseudo-multiplication and pseudo-division techniques used in calculators to evaluate transcendental functions are based on elementary identities is shown.

Toth, Frank S., Jr. Calculator Experiments for Junior High. Computing Teacher 6: 37-38; May 1979. An experiment on prime factorization is presented.

Waits, Bert K. The Mathematics of Finance Revisited Through the Hand Calculator. In Applications in School Mathematics. 1979 NCTM Yearbook. Reston, Virginia: National Council of Teachers of Mathematics, 1979. Pp. 109-124. A variety of ways are provided to use calculators to assist in teaching consumer mathematics applications.

Waits, Bert K. and Schultz, James E. An Iterative Method for Computing Solutions to Equations Using a Calculator. Mathematics Teacher 72: 685-689; December 1979. Three problems involving iteration for solution are presented.

Wavrik, John. Programmable Calculators for Elementary School Students. Computing Teacher 6: 39-41; May 1979. Storage registers in programmable calculators are discussed.

Woodward, Ernest and Hamel, Thomas. Calculator Lessons Involving Population, Inflation, and Energy. Mathematics Teacher 72: 450-457; September 1979 Two lessons showing how a calculator can be used to help students discover the "rule of 72" and use it to investigate problems are presented.

Yvon, Bernard R. and Downing, Davis R. Math Explorations with the Simple Calculator. Portland, Maine: J. Weston Walch, 1978. This text, appropriate for elementary and junior high school students, presents games, puzzles, problems, and exercises.

Zakariya, Norma; McClung, Margo; and Winner, Alice-Ann. The Calculator in the Classroom. Arithmetic Teacher 27: 12-16; March 1980. Three lessons using calculators in grades 3, 4, and 5 are outlined.

RESEARCH REPORTS, K-12

Balka, Don S. A Survey of Parents' Attitudes Toward Calculator Usage in Elementary Schools. South Bend, Indiana: University of Notre Dame, 1979. Teachers in a workshop sent a 12-item questionnaire to parents and teachers of grades k-9; 334 responses were received. Parents were skeptical about the use of calculators in elementary grades. They agreed that calculators could be used for motivation, and along with paper-and-pencil computation, but expressed moderate disagreement with the use of calculators for homework and were very negative about replacing paper-and pencil computation.

Bitter, Gary. Calculator Teacher Attitudes Improved Through Inservice Education. School Science and Mathematics 80: 323-326; April 1980. No significant difference in attitudes toward calculators was found between primary, middle, and upper grade teachers. A two-hour workshop appeared to improve attitudes significantly.

Chang, Lisa Li-Tze. An Examination into the Effects of Calculator-Assisted Instruction on the Mathematics Achievement and Attitude of Seventh and Eighth Grade Disadvantaged Students. (Cornell University, 1979.) Dissertation Abstracts International 40A: 1323-1324; September 1979. Students (n = 126) in grades 7 and 8 were randomly divided into two groups. For 24 weeks, one group had calculators available during lessons, but not on tests or for taking home; the other group used only paper and pencil. No significant differences between groups were found on computation, concepts, or attitudes; a highly significant difference on problem solving favored the calculator group.

Cohen, Martin P. and Fliess, Robert F. Minicalculators and Instructional Impact: A Teacher Survey. Pittsburgh: University of Pittsburgh, 1979. ERIC: ED 178 360. Teacher attitudes, practices, and perceptions about school policies on calculator use were surveyed. Over 63% were strongly or mildly in favor of using calculators. The need for instructional materials using calculators was apparent.

Conner, Totsye J. Effects of Calculator Use in Elementary School Studied at P. K. Yonge Laboratory School. Gainesville: University of Florida, 1979. Two classes each of kindergarten, second-grade, and fourth-grade students used calculators for 10 months. No significant difference in achievement was found in grades 2 and 4; the kindergarten group using calculators scored significantly higher than the non-calculator group.

Creswell, John L. and Vaughn, Larry R. Hand-held Calculator Curriculum and Mathematical Achievement and Retention. Journal for Research in Mathematics Education 10: 364-367; November 1979. The ninth-grade Fundamentals of Mathematics students using calculators scored significantly higher on immediate tests than students not using them, but no significant retention effects were found.

Engelmeyer, William James. The Effectiveness of Hand-Held Calculators for the Remediation of Basic Multiplication Facts. (University of Maryland, 1978.) Dissertation Abstracts International 39A: 5381; March 1979. Three groups of underachieving seventh graders (n = 193) participated. One group received 15 minutes extra of practice on multiplication facts with calculator feedback. A second group had 15 minutes extra group instruction on the facts, while a third group had only "normal" mathematics instruction. No significant difference in achievement was found between the two extra practice groups.

Fugate, Barbara Riley. An Assessment of Attitudes, Self-Concept, and Mathematical Achievement Resulting from the Use of Minicalculators. (North Texas State University, 1978.) Dissertation Abstracts International 39A: 6531-6532; May 1979. Three fourth-grade and three fifth-grade classes used calculators. Their use did not improve achievement, attitude, or self-esteem.

Krist, Betty J. Using Calculators in Eleventh Grade Mathematics - A Classroom Teacher's Report. Buffalo: State University of New York at Buffalo, 1978. Comments from a teacher using the Math 11 programmable calculator materials developed by Rising et al. are given.

Moser, James M. The Effect of Calculator Supplemented Instruction Upon the Arithmetic Achievement of Second and Third Graders. Technical Report No. 502. Madison: Wisconsin Research and Development Center for Individualized Schooling, September 1979. ERIC: ED 180 764. Four classes in grades 2 and 3 used calculators with the on-going instructional program, while four classes did not have access to calculators. Significant differences favored the second-grade calculator group only on subtraction and the third-grade group only on place value and division; no other differences were significant.

Noone, Jean Abbott. Effects of the Use of Hand-Held Calculators on Mathematics Achievement and Attitude Toward Mathematics of Seventh Grade Students. (University of Virginia, 1979.) Dissertation Abstracts International 40A: 3849; January 1980. Four seventh-grade classes were randomly assigned to groups using or not using calculators for two months. No significant differences were found between groups on measures of achievement and attitudes.

Ogletree, Earl J. and Etlinger, Leonard. Should Hand-Held Calculators Be Used in the Elementary School: A Survey. Chicago: Chicago State University, February 1980. Teacher reactions to how the calculator might be used in schools were obtained. Generally, it was felt that they should not be used until basic facts are learned, although 96% recognized that children can learn mathematics from using calculators.

Pedersen, Dean Anthony. The Effect of the Calculator on the Elementary Mathematics Student. (University of Northern Colorado, 1978.) Dissertation Abstracts International 39A: 4794; February 1979. Students in grades 2, 3, and 6 (n = 309) were assigned to

groups using or not using calculators for eight months. No significant difference in achievement was found.

Reys, Robert E.; Bestgen, Barbara J.; Rybolt, James F.; and Wyatt, J. Wendell. Hand Calculators: What's Happening in Schools Today? Arithmetic Teacher 27: 38-43; February 1980. See also: Wyatt, J. Wendell; Rybolt, James F.; Reys, Robert E.; and Bestgen, Barbara J. The Status of the Hand-Held Calculator in School--Implications for Parents, Teachers and Administrators. Phi Delta Kappan 61: 217-218; November 1979. Results from interviews with 194 elementary and secondary teachers in Missouri are presented. Eighty-four percent said that calculators should be available to children in school. Eighty percent felt that children should master the four operations before using calculators. Almost two-thirds indicated the need for in-service training.

Roberts, Dennis M. The Impact of Electronic Calculators on Educational Performance. Review of Educational Research 50: 71-98; Spring 1980. Thirty-four experimental studies on calculator use are critiqued. Results showed support for the computational benefits of calculator use, but support for conceptual benefits was minimal. Attitude changes were immediate and task-specific. Defective research designs were noted.

Roesch, Carl J. Reflecting the New Computation in Eleventh Year Mathematics. Buffalo: State University of New York at Buffalo, 1978. This reports presents comments and data from a teacher using the Math 11 programmable calculators materials by Rising et al.

Standifer, Charles Edward. Achievement and Attitude of Third-Grade Students Using Two Types of Calculators. (Northeast Louisiana University, 1978.) Dissertation Abstracts International 39A: 5314; March 1978. Nine third-grade classes were randomly assigned to use calculators 8-10 minutes per day for checking and other activities, to use programmed feedback "calculators" 8-10 minutes per day for drill, or to have a traditional paper-pencil approach for 16 weeks. Significant differences favored the calculator group over both others on acquisition and retention computation measures, and the programmed-feedback group over the control group on acquisition. No differences for concepts or attitude were found.

Szetela, Walter. Calculators and the Teaching of Ratios in Grade 7. Journal for Research in Mathematics Education 11: 67-70; January 1980. Students in two seventh-grade classes were randomly assigned to instruction on ratios using or not using calculators for three weeks. No significant differences in achievement or attitude were found between groups on paper-pencil tests.

Toole, Betty Ann Zelig. Evaluation of the Effectiveness of Calculator Assisted Curriculum and Instruction in Ninth Grade General Mathematics Classes. (University of California, Berkeley, 1979.) Dissertation Abstracts International 40A: 3852-3853; January 1980. Six ninth-grade general mathematics classes used a calculator-assisted supplementary curriculum during one-fifth of instructional time, while the control group used the regular curriculum. No significant difference was found between groups except for high-scoring students who used the calculator curriculum.

Townsend, Gloria Childress. The Effect of Programmable Calculator Use on Probability Estimation Achievement and Attitude Toward Estimation of Students in Second Year Algebra. (Indiana University, 1979.) Dissertation Abstracts International 40A: 1936; October 1979. Three Algebra II classes used 10 days to investigate a series of probability exercises. The student-programming group estimated answers and then wrote their own programs to verify their estimates, while a second group used the teacher's program and the control group received results from a hypothetical experiment to verify estimates. Some difference in estimation achievement was noted for the student programming group: attitudes were significantly better than in the control group.

Vannatta, Glen D. and Hutton, Lucreda A. A Case for the Calculator. Arithmetic Teacher 27: 30-31; May 1980. The use of calculators by 38 intermediate-level classrooms in Indianapolis is described. Materials correlating calculator use with textbooks were provided for teachers. Results after two years of use indicated achievement "well above normal expectations" in computation and problem solving.

Weaver, J. Fred. Third Grade Students' Performance on Calculator and Calculator-Related Tasks. Technical Report No. 498. Madison: Wisconsin Research and Development Center for Individualized Schooling, July 1979. ERIC: ED 176 992. Refinements of work with calculator algorithms previously conducted by the author are reported. Work with "chaining" and the doing/undoing property in addition and subtraction was tested with 24 third-grade students. Results indicated the need for further instruction with both ideas. Students were able to manipulate the calculator keyboard, but had difficulty with the conceptualizations of the calculations to be executed.

Weaver, J. Fred; Blume, Glendon W.; and Mitchell, Charles E. Calculator Explorations with Seventh Grade Students: Some Calculator-Inspired Instructional Materials, Observations, and Investigations. Technical Report No. 497. Madison: Wisconsin Research and Development Center for Individualized Schooling, July 1979. ERIC: ED 177 019. Observations and instructional materials from calculator explorations with seventh-grade students from 1976 and 1978 are presented. Algebraic-logic calculators with no operational hierarchies were used; at the end of the year, RPN calculators were introduced.

West, Tommie A. The Effectiveness of Two Drill Strategies (Paper and Pencil, Electronic Calculator) in Facilitating the Learning of Basic Multiplication Combinations with Factors of 7, 8, or 9. School Science and Mathematics 80: 97-102; February 1980. Ninety pupils in grades 4-6 were randomly assigned to calculator, paper-pencil, or control groups for two weeks. The calculator group used a preprogrammed "Matheputer". All groups made gains on multiplication fact tests, but the paper-pencil group improved most.

Wheatley, Grayson H. and Shumway, Richard J. Impact of Calculators in Elementary School Mathematics. Final Report, National Science Foundation Grant No. SED77-18077 July 1979. ERIC: ED 175 720. See also: Wheatley, Grayson H.; Shumway, Richard J.; Coburn, Terrence G.; Reys, Robert E.; Schoen, Harold L.; Wheatley, Charlotte L.; and White, Arthur L. Calculators in Elementary Schools. Arithmetic Teacher 27: 18-21; September 1979. Two classes from each grade 2-6 in five locations participated, with one class at each level randomly assigned to the calculator group and the other to the non-calculator group. Both groups used the on-going program. No significant differences were found between groups; attitudes of the calculator group were favorable.

Zastrocky, Michael R. Development and Implementation of a Diffusion Model Incorporating the Handheld Calculator into a Secondary Curriculum. (University of Northern Colorado, 1979.) Dissertation Abstracts International 40A: 4458; February 1980. The model considered how calculators can be incorporated into a mathematics program. Systems commitment, needs assessment, goals, resources, training, evaluation, and dissemination were discussed.

Zink, Ronald Joseph. The Effects of Using a Programmed Printing Calculator to Improve the Computational Skills of Remedial Mathematics Students in Grades 7-12. (Columbia University Teachers College, 1979.) Dissertation Abstracts International 40A: 4942; March 1980. Students in grades 7-12 (n = 108) used drill-and-practice programs with or without calculators. No significant differences were found between treatments.

Zweng, Marilyn J. Children's Strategies of Solving Verbal Problems. Iowa City: University of Iowa, August 1979. ERIC: ED 178 359. Several findings on calculator use were noted in this study; in particular, average and low ability students used calculators more often than high ability students. They were used most often on division problems.

Priorities in School Mathematics (PRISM). Final Report, April 1980. ERIC: SE 030 577, 030 578. A variety of items on this survey, conducted for the National Council of Teachers of Mathematics, probed reactions to the use of calculators across major content areas by samples of nine populations. Support varied depending on the topic and the sample, with supervisors and teacher educators most favorable toward calculator use.

MISCELLANEOUS CONCERNS

Kiehl, Charles F. and Harper, B. Ann. My Child the Math Whiz! Or Buy Your Child a Calculator. Education 100: 18-19; Fall 1979. An overview of advantages and disadvantages of using calculators is provided.

Moursund, David. It's OK to Use Calculators (A Message to Elementary School Teachers). Computing Teacher 6: 3-5; May 1979. A clear rationale, encouraging teachers to accept and explore uses of calculators in elementary school classrooms. is presented.

Reiling, Mary J. and Boardman, Gerald R. The Hand-Held Calculator Is Here: Where Are the Policy Guidelines? Elementary School Journal 79: 293-296; May 1979. A review of articles on the use of calculators is given, with an emphasis on research conclusions. The need for policy guidelines is discussed, and eight guidelines are suggested.

Rouse, William. The Power Box: A Solution to Calculator Logistics. Mathematics Teacher 72: 516-517; October 1979. A way of packing and carrying AC-powered calculators is described.

Suydam, Marilyn N. Calculators: A Categorized Compilation of References. Columbus, Ohio: ERIC/SMEAC, June 1979. ERIC: ED 171 152. References on calculators published prior to June 1979 are listed, with categories indexed.

Werner, Marijane. The Hand-Held Calculator and Its Impact on Mathematics Curricula. School Science and Mathematics 80: 29-36; January 1980. Suggestions from reports on calculators are presented, including conference recommendations.

REFERENCES AT THE COLLEGE AND OTHER POST-SECONDARY LEVELS

Berg, Gary A. Using Calculators for Business Problems. Chicago: Science Research Associates, 1979.

Biondi, M.; Midoro, V.; and Pescetti, D. Use of Programmable Pocket Calculators in Engineering Introductory Courses. International Journal of Electrical Engineering Education 10: 128; 1979.

Boardman, Harold. Programmable Calculators: Computer Power in Pocket-Size Packages. Popular Science 214: 77; May 1979. Programming with the TI-59 calculator is described; the advantage of the printing capability is noted.

Briggs, William L. Romberg Integration and Extrapolation Methods. Didactic Programming 2: 2-6; Fall 1979.

DuRapau, V. J. and Bernard, John. From Games to Mathematical Concepts via the Hand-Held Programmable Calculator. International Journal of Mathematical Education in Science and Technology 10: 417-424; July-September 1979. Three games involving functions and proof are presented, with the aim of stimulating creative thinking.

Egbert, William E. Personal Calculator Algorithms II: Trigonometric Functions. Didactic Programming 2: 7-10; Fall 1979.

Gold, M. Calculators in Freshman Chemistry - Alternative View. Journal of Chemical Education 56: 526; 1979.

Hector, Judith H. Using a Calculator to Teach Fraction Computation in Basic Arithmetic: Research and Observations. Knoxville, Tennessee, June 1979. ERIC: ED 171 520. Learning calculator-based algorithms produced no difference in computational skill, understanding, attitudes nor length of time to learn when compared with conventional algorithms.

Hohenstein, Louis. How Calculators Can Put Your Accounts in Order. Administrative Management 40: 58-60; March 2979.

Kahan, William M. Personal Calculator Has Key to Solve Any Equation f(x) = 0. Didactic Programming 2: 36-39; Winter-Spring 1980. How the SOLVE key on the HP-34C works is discussed.

Koop, Janice B. Calculators and the Community College Arithmetic Class. MATYC Journal 14: 113-120; Spring 1980. The aims of remedial arithmetic courses for community college students are considered, with reasons for using calculators in such a course given.

McCarty, George. Calculator-Demonstrated Math Instruction. Two-Year College Journal 11: 42-48; January 1980. A demonstration for a calculus class on Newton's method is described, with general principles for planning demonstrations noted.

Miel, George. Calculator Calculus and Roundoff Errors. American Mathematical Monthly 87: 243-252; April 1980.

Packer, Claude Montgomery. The Effects of Hand Calculators on Attitude, Achievement and Retention of Students in College Level Mathematics. (Cornell University, 1979.) Dissertation Abstracts International 40A: 3095; December 1979. Sixty-eight pairs of elementary preservice teachers in Jamaica were randomly assigned to ability groups using or not using calculators for six weeks. No significant differences were found.

Rosser, J. Barkley and DeBoor, Carl. Pocket Calculator Supplement for Calculus. Reading, Massachusetts: Addison-Wesley, 1979.

This bulletin was prepared by Marilyn N. Suydam, Director, Calculator Information Center. Copies of Calculator Information Center bulletins may be made for distribution.

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Reference Bulletin No. 26
August 1980

References on Activities, Research and Other Topics Related to Calculator Use

References have been selected from those collected since Bulletin No. 25 was compiled in May 1980. They are grouped by level (K-12 or post-secondary).

ACTIVITIES FOR STUDENTS, K-12

Bitter, Gary and Mikesell, Jerald. Activities Handbook for Teaching with the Hand-Held Calculator. Boston: Allyn & Bacon, 1980. Activities, grouped by mathematical topic, are given for exploring calculator applications in the elementary and junior high curriculum.

Donovan, George S. and Gimmestad, Beverly B. Trigonometry with Calculators. Boston: Prindle, Weber & Schmidt, 1980.

Lund, Chuck and Smart, Margaret A. Focus on Calculator Math. Hayward, California: Activity Resources, 1979. Single-page exercises involving place value, rounding, and patterns are provided.

Moursund, David. Calculators and Elementary Education, Part 5: Calculator Memory. Computing Teacher 7: 42-50; April-May 1980. The use of the memory of a four-function calculator is detailed. The goal is to understand how the contents of various memory locations change as a calculation is keyed in and executed.

Moursund, David. Calculators and Elementary Education, Part 6: Applications. Computing Teacher 7: 55-60; June-July 1980. Samples of applications of calculators for the elementary school are listed. The applications involve using the calculator to form words, giving insight into machines, deciding when to use mental arithm . . and playing games.

Moursund, David. Elementary School Computer-Related Activities. Computing Teacher 7: 28-31; April-May 1980. Along with a variety of computer activities, three calculator activities are described.

Perry, Robert. How to Choose--and Use--a Programmable Calculator. Popular Mechanics 152: 98-99; September 1979.

Shult, Douglas L. Calculator Assisted Problem Solving, Part 1: Rationale and Research. Computing Teacher 7: 4-8; April-May 1980. Following discussion of the case for using calculators in schools and presentation of recommendations for their use in problem solving, studies of the effect of their use with problem solving are summarized.

Shult Douglas L. Calculator Assisted Problem Solving, Part 2: Classroom Applications. Computing Teacher 7: 40-47; June-July 1980. These calculator activities and applications are designed to build analytical as well as technical problem-solving skills. Calculator games and puzzles, problem solving in the "real world", and basic operations are given special attention.

Stover, Donald W. Where Do These Numbers Come From? Mathematics Teacher 73 288-294; April 1980. How programmable calculators and computers help students gain insight into techniques for finding square roots and calculating functions are detailed.

Toth, Frank S., Jr. A Calculator-Number Base Activity. Computing Teacher 7. 33-34, June-July 1980. A procedure is illustrated which changes a numeral in base eight or sixteen to a base ten numeral.

Wheeler, J.; Brown, L.; Ford, A.; Loomis, R.; and Nietupsk, J. Teaching Moderately and Severely Handicapped Adolescents to Shop in Supermarkets Using Pocket Calculators. Education and Training of the Mentally Retarded 15: 105; 1980.

Math Skills for the Real World: How to Use a Calculator. White Plains, New York: The Skills Group of the Center for Humanities, 1980. Four sets of slides, audiodiscs and tapes, filmstrips, and worksheets provide a sequence for arithmetic, algebra, and trigonometry using a TI-30 calculator.

RESEARCH REPORTS, K-12

Conner, Totsye J. An Investigation of the Use of Hand-Held Calculators by Students in Elementary School. Research Monograph #32. Gainesville: P. K. Yonge Laboratory School, University of Florida, Winter 1980. This report on a study with students in kindergarten, grade 2, and grade 4 (see Conner, 1979, on Reference Bulletin No. 25) includes activities and survey instruments.

MISCELLANEOUS CONCERNS

An Agenda for Action: Recommendations for School Mathematics of the 1980s. Reston, Virginia: National Council of Teachers of Mathematics, 1980. See also: Mathematics Teacher 73: 473-480; September 1980; Arithmetic Teacher 28: 49-54; September 1980. One of eight NCTM recommendations is that "mathematics programs must take full advantage of the power of calculators and computers at all levels." The NCTM acknowledges that computational skills are still necessary, but stresses the need to integrate calculator use at all levels, reinforces their usefulness in problem solving, notes the need for imaginative materials, and emphasizes the key component of teacher education.

Kennedy, R. E. and Goodman, T. A. Know Your Calculator. School and Community 65: 14-15; January 1979.

Suydam, Marilyn N. International Calculator Review. Columbus, Ohio: ERIC/SMEAC, March 1980. Included in this publication are reports from 16 countries on calculator uses in schools, plus a synthesis, a report from the Working Group for the Second International Mathematics Study, and a list of references.

REFERENCES AT THE COLLEGE AND OTHER POST-SECONDARY LEVELS

Clare, Brian W. Evaluation of Cation Hydrolysis Schemes with a Pocket Calculator. Journal of Chemical Education 56: 784-787; December 1979.

Eisner, Milton P. Curriculum Revisions for Technical Mathematics Courses. MATYC Journal 13: 179-181; Fall 1979. The calculator is used to reinforce the concepts of zero and negative exponents, fractional exponents, and trigonometry without the use of tables or interpolation associated with them.

Fearnley-Sander, Desmond. Learning to Calculate and Learning Mathematics. International Journal of Mathematical Education in Science and Technology 11: 111-114; January-March 1980. The solution to the equation $x^x = 3$ is approached by presenting the continuity of a function concept and the monotone convergence theorem in the form of a discussion and a calculator program.

Gallagher, James Joseph and Brandenburg, Richard (Editors). Issues in Science and Mathematics Education: Selected Papers from the Conference Marking the Twentieth Anniversary of Michigan State University's Science and Mathematics Teaching Center. East Lansing: Michigan State University, 1978. ERIC: ED 175 659. Among the papers in this conference report is one on "Using Calculators in Mathematics Classrooms".

Hector, Judith H. The Effects of Calculator Versus Conventional Algorithms for Fractions on Community College Student Computation, Understanding, and Attitude Scores. April 1980. ERIC: SE 030 770. See also: Dissertation Abstracts International 39A: 6605; May 1979. Students in developmental arithmetic courses at two community colleges were randomly assigned to three groups, using the conventional algorithm, the conventional algorithm plus calculators, or an alternative algorithm involving conversion from fractions to decimals with calculators. No significant differences among groups was found for fractional computation, understanding, or attitudes, but significant differences between pre- and posttest scores were found for each measure.

Holdsworth, David K. High-Resolution Mass-Spectra Analysis with a Programmable Calculator. Journal of Chemical Education 57: 99; February 1980.

Hyatt, Herman R. Teaching Arithmetic with Calculators. MATYC Journal 13: 203-204; Fall 1979. Use of calculators to aid students in solving problems in a community college arithmetic course is briefly described.

Lai, Theodore. Calculators in the College Classroom. MATYC Journal 13: 182-183; Fall 1979. A list of references on the use of calculators in college classes is given.

McCune, E. D.; Dean, R. G.; and Clark, W. D. Calculators to Motivate Infinite Composition of Functions. Two Year College Mathematics Journal 11: 189-195; June 1980. Several examples are presented for using a calculator to motivate the concept of infinite composition of fractions, including continued square roots, continued fractions, and infinite products.

Rynone, William John, Jr. An Investigation of the Impact of Specialized Training in the Use of the Hand-Held Calculator on Selected Engineering Technology Students. Unpublished doctoral dissertation, New York University, 1980. Eighty-one freshmen in engineering technology programs were assigned to groups using or not using calculators. The experimental group was given 10-15 hours of instruction to provide requisite skills using calculators. For 13 of 15 practical engineering problems, a greater percentage of the experimental students were correct; thus, the calculator group performed significantly better than the non-calculator group.

Smith, J. M. Advanced Analysis with the Sharp 5100 Scientific Calculator. New York: Wiley, 1979

This bulletin was prepared by Marilyn N. Suydam, with the aid of Donna Bruce and Kathryn McConnell.

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Reference Bulletin No. 27
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References to Calculator Uses in Education

References have been selected from those collected since Bulletin No. 26 was compiled in August 1980. They are grouped by type (activities, research, and other concerns) and by level (K-12 and post-secondary).

ACTIVITIES FOR STUDENTS, K-12

Bitter, Gary. Calculator Corner. Teacher 98: 81; August 1980. 98: 145; September 1980. 98: 111; October 1980. 98: 91; November-December 1980. 98: 101; January 1981. 98: 98; February 1981. 98: 89; March 1981. This monthly feature has provided suggestions and activities on introducing the calculator and using it for addition problems, subtraction, multiplication, division, place value, and percentages.

Block, G. H. Dyscalculia and the Mini-calculator -- The ALP Program. Academic Therapy 16: 175-181; November 1980. Successful calculator experiences in the clinical APL program for elementary disabled learners are described along with a method for dealing with fractions, in which decimal answers are converted to equivalent fractions.

Blume, Glendon W. The Rationality of a^b -- An Application to Calculators. MATYC Journal 15: 55-59; Winter 1981. Using the y^x (or 10^x) key on a calculator for determining the rationality of a^b is investigated. Comments on rational approximations displayed for an irrational number are also included.

Bone, Dorothea D. Sine and Cosine Functions with a Calculator. Mathematics Teacher 73: 521-524, 529; October 1980. Calculator activities are presented that involve discovering patterns of the sine and cosine functions, rounding numbers to the nearest hundredth, plotting points, drawing graphs, and using a protractor.

Channell, Dwayne E. Using Calculators to Fill Your Table. Mathematics Teacher 74: 199-202; March 1981. This activity requires students to construct tables of values for use in solving maximization problems involving area. Three worksheets are provided.

Foerster, Paul A. Students Write Mathematics Tournament. Mathematics Teacher 73: 606-607; November 1980. A calculator event in a high school mathematics tournament is illustrated.

Lichtenberg, Betty K. Calculators for Kids Who Can't Calculate. School Science and Mathematics 81: 97-102; February 1981. A collection of calculator activities for lower-ability mathematics students is presented.

Lund, Charles H. 26 Spirit Masters on Calculators in Geometry and Measurement. Portland, Maine: J. Weston Walch, 1981. This set of 26 supplemental calculator activities is for use with students of varying abilities in grades 5-12.

Moursund, David G. Calculators in the Classroom: With Applications for the Elementary and Middle School Teacher. New York: Wiley, 1980. Activities with an emphasis on problem solving are included.

Musser, Gary L. Using Programmable Calculators to ENLARGE the Problem Solving World of 10-12 Year Olds. Computing Teacher 8: 38-41; No. 1, 1980. Suggestions are made for using programming as a vehicle for teaching problem-solving skills to fourth and fifth graders.

Padberg, Friedhelm F. Using Calculators to Discover Simple Theorems -- An Example from Number Theory. Arithmetic Teacher 8: 21-23; April 1981. Discussed is a method of discovering proofs, involving three steps: (1) guess first, (2) verify on a calculator, and (3) prove by exhausting all possible cases, with the help of a calculator or by algebraic methods.

Rade, Lennart. Random Digits and the Programmable Calculator. In Teaching Statistics and Probability (Albert P. Shulte, Ed.). 1981 Yearbook. Reston, Virginia: National Council of Teachers of Mathematics, 1981. This chapter describes how the programmable calculator, which simulates random experiments, can be used in teaching probability and statistics.

Rathmell, Edward C. and Leutzinger, Larry P. Classroom Activities for Able Students: In Kindergarten, First, and Second Grades. Arithmetic Teacher 28: 48, 53-54; February 1981. Questions and calculator activities designed to challenge bright students in the primary grades are presented.

Sloyer, C. W. Geometric Growth and the Hand-Held Calculator. Mathematics Teacher 73: 610-611, 617; November 1980. A payment-scheme activity is presented that uses the calculator as an investigative tool for generating the sum of a finite geometric series with n terms.

Smith, Susan M. Calculating Algebra. Mathematics Teacher 74: 119-122; February 1981. Three calculator activity sheets are included to reinforce skills in solving linear equations, estimation, and mental computation.

Snover, Stephen L. and Spikell, Mark. Brain Ticklers: Puzzlers and Pastimes for Programmable Calculators and Personal Computers. Englewood Cliffs, New Jersey: Prentice-Hall, 1981. Supplementary problem-solving activities are included.

Teede, Larry D. Using a Programmable Calculator in Vo-Ag. Agricultural Education 52: 17-18; April 1980. The capabilities of the programmable calculator and possible uses by a vocational agriculture teacher are discussed.

Vervoort, Gerardus and Mason, Dale J. Beginning Calculator Math. Belmont, California: Fearon Pitman, 1980. Activities in this book make connections between the calculator's capabilities, mathematical concepts, and applications in realistic problems. The worksheets deal with estimation, problem solving, games, and patterns.

Watson, F. R. Basic Arithmetic with a Calculator (BAC pac). Keele, England: University of Keele, 1980. Available from ERIC/SMEAC (1200 Chambers Road, Columbus, Ohio 43212). This material was produced for use with low-achieving students aged 13 to 15. It is designed to be cut up to form 16 small "topic booklets".

Watson, F. R. Exploring Numbers: Investigations with an Electronic Calculator Series A, B, C. Keele, England: University of Keele, 1979. Available from ERIC/SMEAC. Suggestions are given for using the calculator as a "laboratory" for the exploration of number properties and patterns.

Weaver, J. Fred. Calculators and Unary Operations. School Science and Mathematics 81: 239-248; March 1981. Calculator algorithms are used to illustrate and suggest ways in which calculators can facilitate unary operations at the pre-algebra level.

Wheatley, Charlotte L. Calculator Use in the Middle Grades. School Science and Mathematics 80: 620-624; November 1980. Four calculator activities are presented, dealing with estimation, problem solving, applications, and decimals.

Williams, David E. Calculator Activities. Instructor 90: 154-158; February 1981. Five calculator games for elementary and junior high students are included.

Yvon, Bernard; Yvon, Joann; Yvon, Renne; and Yvon, Bernie. Calculator Fun: 44 Spirit Masters. Portland, Maine: J. Weston Walch, 1980. These duplicating masters were written by students for students at the middle or junior high school level. The time required for completion of the open-ended, independent activities is variable.

Calculator Worksheets. Lexington, Massachusetts: D. C. Heath, 1980. These worksheets are correlated with the Heath textbook series, and can be used for practice, problem solving, enrichment, group work, new approaches to skills, and homework.

RESEARCH REPORTS, K-12

Berry, Herbert. Improving Achievement in Selected Skills of Functional Mathematics with the Use of the Electronic Hand-Held Calculator. (New York University, 1979.) Dissertation Abstracts International 41A: 574; August 1974.

Brey, Rita K. Effects of Problem Solving Activities and Calculators on Problem Solving and Computation in Grade Four. (The University of Michigan, 1980.) Dissertation Abstracts International 41A: 1914; November 1980. Studied were the effects of a planned sequence of problem-solving activities and use of calculators on problem-solving and computational performance. Calculator use did not decrease computational skills. The calculator was useful if the problems were within the scope of the child's paper-and-pencil ability. Those who had used calculators were less afraid than others to attempt difficult problems.

Buchanan, Samual P. Mathematical Problem Solving With and Without a Calculator and Its Effect on Alpha Activity. (The University of Texas at Austin, 1980.) Dissertation Abstracts International 41A: 2981; January 1981. Students in grades 11 and 12 performed mental arithmetic, problem solving without a calculator, and problem solving with a calculator, followed by rest, during which their brain activity was measured. The amounts of alpha activity between problem solving with and without a calculator were not significantly different.

Carpenter, Thomas P.; Corbitt, Mary Kay; Kepner, Henry S., Jr.; Montgomery, M Lindquist; and Reys, Robert E. Calculators in Testing Situations: Results and Implications from National Assessment. Arithmetic Teacher 28: 34-37; January 1981. The 1977-78 NAEP mathematics assessment provided information about performance on routine computation and problem solving when calculators were available. The data indicated that calculators are widely accessible to students at ages 9, 13, and 17. They performed routine computation better with the use of a calculator.

Casterlow, Gilbert, Jr. The Effects of Calculator Instruction on the Knowledge, Skills, and Attitudes of Prospective Elementary Mathematics Teachers. University Park: The Pennsylvania State University, November 1980. No significant differences were found among calculator attitude scores, and the correlations between calculator scores and

mathematics attitude scores were not significant. Those having teacher-guided instruction and practice with the calculator had a higher mean on the computation test, took less time, and had a higher level of proficiency than two other groups had.

Driscoll, Mark J. Calculators in the Classroom. In Research Within Research: Elementary School Mathematics. St. Louis, Missouri: CEMREL, Inc., 1980. Research on calculators is reviewed and suggestions made to elementary teachers on how they can be used effectively.

Elliott, James W. The Effect of Using Hand-held Calculators on Verbal Problem Solving Ability of Sixth-Grade Students. (The University of Oregon, 1980.) Dissertation Abstracts International 41A: 3464; February 1981. One group used the calculator for practice, while the other used paper and pencil. No significant difference was found between groups on a verbal problem-solving test. However, both groups had higher scores on the calculator version of the test.

Gross, Ena. An Exploratory Study on the Use of Calculators and Problem Solving Heuristics with In-Service Elementary School Teachers. (Georgia State University, 1980.) Dissertation Abstracts International 41A: 1451-1452; October 1980. The teachers who had access to calculators employed the heuristic "use successive approximation" more often than students without calculators. Calculators were only beneficial for those problems in which the computation required to solve it really necessitated the use of a calculator.

Krist, Betty J. The Programmable Calculator in Senior High School: A Didactical Analysis. (State University of New York at Buffalo, 1980.) Dissertation Abstracts International 41A: 2982; January 1981. A mathematics class studied materials designed for use with a programmable calculator in grades 11 and 12. The calculator bridged the gap between formal proof and understanding a basic theorem, made discovery a viable instructional strategy, and served as a pedagogical language for student-teacher interaction.

McDonald, Dorothy D. I. Curriculum Units for Hand Held Calculators in General Ninth Grade Mathematics Classes. (The University of Utah, 1980.) Dissertation Abstracts International 41B: 1794; November 1980. Calculator units were developed for use with any standard ninth-grade general mathematics text. Students were encouraged to memorize the calculator keyboard and use it without looking.

Miles, Marion M. A Study of the Interrelationship of the Hand-Held Calculator, Achievement in Mathematical Computation and Problem-Solving, and Attitude Toward Mathematics of Eighth Grade Students. (The University of Mississippi, 1980.) Dissertation Abstracts International 41A: 931; September 1980. Students using calculators could solve as many computational problems as those using paper and pencil. Girls benefited more than boys from using calculators; medium and high ability groups benefited more than low ability groups. Problem-solving ability was not affected by calculator use.

Parkhurst, Scott. Hand-Held Calculators in the Classroom: A Review of the Research. Chicago, April 1981. ERIC: SE 034 540. Recent research on the use of calculators in the classroom was reviewed.

Shively, John C. An Investigation of Effects of the Hand-Held Calculator on the Mathematics Achievement of Students at the Seventh Grade Level. (University of Southern California, 1980.) Dissertation Abstracts International 41A: 2921; January 1981. No significant differences were found between groups using or not using calculators, with respect to mathematical applications and computational skills.

Shult, Douglas L. The Effect of the Hand-Held Calculator on Arithmetic Problem-Solving Abilities of Sixth-Grade Students. (University of Oregon, 1979.) Dissertation Abstracts International 40A: 6179-6180; June 1980. Examined was the effect of calculator use on problem-solving processes. The calculator neither positively nor negatively influenced problem-solving effectiveness.

Standifer, Charles E. and Maples, Ernest G. Achievement and Attitude of Third-Grade Students Using Two Types of Calculators. School Science and Mathematics 81: 17-24; January 1981. Attitudes toward mathematics and the acquisition and retention of mathematical skills were compared for groups using calculators, programmed-feedback devices, or a traditional approach. The calculator group was better than the programmed-feedback group on computational skills and total mathematical achievement.

Wheatley, Charlotte L. Calculator Use and Problem-Solving Performance. Journal for Research in Mathematics Education 11: 323-334; November 1980. The problem-solving performance of sixth-grade pupils using or not using calculators was compared. The processes used by the two groups, computational errors, production scores, and time on task were analyzed. The calculator group used more processes and made fewer errors.

Wiksten, Sif. Children's Learning of Addition and Subtraction Facts. (Rutgers University The State University of New Jersey, New Brunswick, 1980.) Dissertation Abstracts International 41B: 1550; October 1980. One purpose of this study was to obtain information on the effectiveness of training with or without the use of a calculator in acquiring addition and subtraction facts. Children had combinations of simultaneous and successive experiences. They improved equally well with or without calculators.

Exploration of the Use of "Programmed" Calculators in Remedial and Special Needs Math Programs at the Secondary Level. Final Report. New Brunswick, New Jersey: Middlesex County Vocational and Technical High Schools, 1979. ERIC: ED 192 429. This project investigated the effect of placing one programmable calculator in each of five remedial mathematics labs and one in a special needs mathematics classroom. Teachers recommended continued use of the calculator, and regarded it as an effective motivator. Students' attitudes were positive toward use of the calculator, and they experienced "feelings of accomplishment in mathematics."

MISCELLANEOUS CONCERNS

Etlinger, Leonard E.; Krull, Sarah; Sachs, Jerry; and Stolarz, Theodore J. The Calculator in the Classroom: Revolution or Revelation? Chicago: Chicago State University, 1980. ERIC: ED 191 740. Advantages of the programmable calculator and recommendations for its use in the classroom are presented.

Hersberger, James and Wheatley, Grayson. A Proposed Model for a Gifted Elementary School Mathematics Program. Gifted Child Quarterly 24: 37-40; Winter 1980. One section of this article considers the role of the calculator in elementary mathematics classrooms for the gifted, with respect to problem solving, estimation, and concepts.

May, Lola June. One Point of View: Change and Changelessness. Arithmetic Teacher 27: 4-5, 37; May 1980. The impact of the calculator on the elementary and junior high mathematics curriculum is discussed, with recommendations for its use.

Mitchell, Charles E. and Blume, Glendon W. An Introduction to Calculator Logic Systems. Mathematics Teacher 73: 494-499; October 1980. Advantages and disadvantages of logic systems in calculators on the market are discussed.

Moursund, David and East, Phillip. Calculators and Computers in the Classroom: Selected Summaries of Current Education Topics. Know-Pak No. 17. Salem: Oregon State Department of Education, October 1979. ERIC: ED 191 710. The availability and usage of calculators, computers, and related instructional materials is presented.

Reys, Robert E. Calculators in the Elementary Classroom: How Can We Go Wrong? Arithmetic Teacher 28: 38-40; November 1980. Ten misuses of calculators are discussed, with suggestions for improvement.

Shulte, Albert P. Four Essential Forward Steps. Arithmetic Teacher 28: 2; November 1980. The role of the calculator in teaching computation is discussed.

Slesnick, Twila. The Calculator Has Failed Mathematics: A Look Back at Calculators in Education. Computing Teacher 8: 15-17; No. 1, 1980. Current use of calculators in elementary schools is evaluated and myths concerning their place in the curriculum are discussed.

Stolarz, Theodore J. The Programmable Calculator in the Classroom. Chicago: Chicago State University, 1980. ERIC: ED 193 026. Teaching the skills necessary to develop algorithms for programmable calculators is discussed.

Wheatley, Grayson H. Calculators in the Classroom: A Proposal for Curricular Change. Arithmetic Teacher 28: 37-39; December 1980. Two proposals for the elementary mathematics curriculum are addressed: (1) shift from a computationally based curriculum to a conceptually oriented curriculum using the calculator as an instructional tool, and (2) eliminate the teaching of complex computations.

Williams, David E. The Language of Calculators. Arithmetic Teacher 28: 22-25; January 1981. Procedures and instructional advantages for learning the language of different makes and models of calculators are outlined.

Williams, David E. Test Your Calculator IQ. Teacher 68-70; February 1981. A quiz to test "calculator IQ" is presented; it can prepare teachers for the questions about calculators students typically ask.

Worth, Joan. Action for Middle Schoolers. Arithmetic Teacher 28: 2; January 1981. NCTM's An Agenda for Action recommends that the mathematics curriculum take full advantage of the power of calculators and computers. The significance of this recommendation to middle schoolers is discussed.

REFERENCES AT THE COLLEGE AND OTHER POST-SECONDARY LEVELS

Ash, Peter and Robinson, Edward. Basic College Mathematics: A Calculator Approach. Reading, Massachusetts: Addison-Wesley, 1981.

Barnes, John E. and Waring, Alan J. Pocket Programmable Calculator in Biochemistry. New York: Wiley, 1980.

Belstock, Alan and Smith, Gerald R. Consumer Mathematics, With Calculator Applications. New York: McGraw-Hill, 1980.

Carter, L. and Jusan, E. The Pocket Calculator. New York: David McKay, 1979.

Edsall, Karen Sue. The Administration of the Business Calculator Mathematics Curriculum in Relationship to Occupational Needs. (University of Nevada, Reno, 1979.)

Dissertation Abstracts International 40A: 6085-6086; June 1980. One major conclusion is that businesses expect employees to have skills on adding and calculating machines before they are hired. Offering a required course in business mathematics with calculators was recommended.

Leake, Lowell. Some Reflections on Teaching Mathematics for Elementary School Teachers. Arithmetic Teacher 28: 42-44; November 1980. The role of calculators in a mathematics course for preservice elementary teachers is discussed.

Martin, Ann A. The Effect of the Use of the Calculator on Mathematics Anxiety in College Algebra Students. (The University of Oklahoma, 1980.) Dissertation Abstracts International 41A: 2485-2486; December 1980. No significant differences were found in mathematics anxiety between students using or not using a calculator, or between male and female students using calculators.

Merchant, Ronald. Basic Business Math and Electronic Calculators. San Francisco: Star Publishing, 1980.

Merchant, Ronald. A New Approach to Teaching Business Orientated Students. Community College Review 7: 36-39; Spring 1980.

Mullish, Henry and Kochan, Stephen. Programmable Pocket Calculators. Rochelle Park, New Jersey: Hayden, 1980.

Peller, Richard. An Introduction to the Uses of the Programmable Calculator (TI 57). Mount Hermon, Massachusetts: Northfield Mount Hermon School, January 1981. The following calculator programs are included: (1) table of values, (2) numerical approximation to derivative, (3) Newton's method to approximate real zeros, (4) numerical approximation for definite integral, (5) calculation of n!, (6) two approximations to the irrational number e, (7) some interesting sequences and series, and (8) the birthday problem.

Picot, A. Pocket Calculator Program for Least-Square Fitting of Data with Variable Precision. American Journal of Physics 48: 302-303; April 1980.

Riggi, F. Using Simulation on Programmable Pocket Calculators in Computer-Assisted-Instruction. American Journal of Physics 49: 134; February 1981.

Sharma, Man Mohan. A Study of the Use of Hand-Held Calculators and Computer Managed Instructions in Developmental Sections of a College Algebra Course. (Ohio University, 1980.) Dissertation Abstracts International 41A: 3465-3466; February 1981. Four treatments were compared: (1) using the computer managed instructional support system (ISS), (2) using calculators, (3) using both calculators and ISS, and (4) using neither calculators nor ISS. Students in calculator groups achieved significantly better than those in non-calculator groups, and had significant improvement in positive attitudes toward mathematics.

Steinback, Myriam. Calculator-Based Curricular Modules for Two-Year College Remedial Mathematics Courses. (Columbia University, 1980.) Dissertation Abstracts International 41A: 1454; October 1980. A one-term calculator-based course in mathematics for junior college students needing remediation was designed. The calculator-based curricular modules helped some students in problem solving. The calculator seemed to be highly motivational, and gave students confidence to proceed in areas of mathematics they had never before explored.

Warfel, Florence A. The Teaching of First Term Calculus in Relationship to the Development of Electronic Computing Aids. (University of Pittsburgh, 1979.) Dissertation Abstracts International 41A: 146; July 1980. Calculator use in college calculus courses was surveyed and the effects of incorporating electronic aids in teaching calculus was discussed.

Weir, Maurice D. Calculator Clout: Programming Methods for Your Programmable. Englewood Cliffs, New Jersey: Prentice-Hall, 1981.

Wild, Walter J. Euler's Three-Body Problem. American Journal of Physics 48: 297-301; April 1980.

Three Information Bulletins have been made available from the Calculator Information Center (or from the National Council of Teachers of Mathematics) in 1980-81:

No. 8 Uses of Calculators in Secondary Mathematics
by Betty J. Krist

No. 9 Calculator Activities and Games to Play at Home: Grades 4 - 8 - A Letter to Parents
by Glenda Lappan

No. 10 67 Ten-Minute Calculator Activities for Grades 4-8
by Charles Thompson

This bulletin was prepared by Marilyn N. Suydam and Vicky Kirschner, with the aid of Kathryn McConnell.

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Reference Bulletin No. 28
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References to Calculator Uses in Education

References were selected from those collected since Bulletin No. 27 was compiled in April 1981. They are grouped by type and by level.

ACTIVITIES FOR STUDENTS, K-12

Etlinger, Leonard and Ogletree, Earl J. Calculators and Microcomputers for Exceptional Children. Chicago: Chicago State University, May 1981. ERIC: SE 035 005. Some ways to use calculators with handicapped and learning disabled children are suggested.

Olson, Melfried. It's a Factor of Life. Mathematics Teacher 73: 681-684; December 1980. Three calculator worksheets deal with factoring positive integers and prime numbers.

CURRICULUM SUGGESTIONS, K-12

Allenbrand, Bob et al. (Eds.). Course Goals in Computer Education, K-12. Portland, OR: Tri-County Goal Development Project, 1979. ERIC: ED 194 074. Goals involving calculators are included.

Brown, Stephen I. and Rising, Gerald R. The Development of New Curriculum for the New Calculation. Computing Teacher 8: 52-55; No. 2, 1980-81. Discussed are ways the calculator can be used as a tool to explore new curriculum directions such as the nature of thought.

Harcharik, K. Teaching the Correct Use of the Electronic Calculator. Journal of Business Education 56: 187-190; February 1981.

Martino, J. P. A Revolution in Your Hand - Past is Only Prologue for the Hand-Held Calculator. Futurist 14: 59; 1980.

Spikell, Mark A. (Ed.). Programmable Calculators: Implications for the Mathematics Curriculum. Columbus, OH: ERIC/SMEAC, December 1980. ERIC: SE 034 580. This collection of papers was presented at the 1980 NCTM meeting. The articles support the use of programmable calculators and indicate specific ways in which they can be used.

Swartz, Cliff. True Confessions (Using Hand Calculators to Solve Problems in Physics). Physics Teacher 19: 158; March 1981. This editorial makes the point that finding formulas in textbooks, substituting numerical values, and computing answers with a calculator can lead to learning a substantial amount of physics.

Tokar, E. and Ruggles, D. Using Pocket Calculators to Improve the Quality of Teacher-Made Tests. Educational Technology 21: 51-52; February 1981. A procedure is presented for determining test reliability on a calculator.

RESEARCH REPORTS, K-12

Abdelsamad, Omer E. H. Improved Student Problem-Solving Procedure with the Calculator as Validated by Mathematics Experts. (University of Denver, 1980.) Dissertation Abstracts International 41A: 3462-3463; February 1981. Problem-solving strategies were designated for each of the four steps in a problem-solving procedure (14, 32, 4, and 10 strategies, respectively). A questionnaire designed to determine the effective use of calculators in problem solving was completed by 53 mathematics teachers. The calculator was found to be effective for 13 strategies. Overall, the calculator was more effective for carrying out the plan than for understanding the problem.

Abo-Elkhair, Medhat E. M. An Investigation of the Effectiveness of Using Minicalculators to Teach the Basic Concepts of Average in the Upper Elementary Grades. (The Florida State University, 1980.) Dissertation Abstracts International 41A: 2980; January 1981. Two fourth-grade classes were randomly assigned to either a calculator or a non-calculator group, each taught concepts of average. Significant differences on the posttest favored the calculator group. The calculator was an advantage in avoiding computational errors.

Carpenter, Thomas P.; Corbitt, Mary Kay; Kepner, Henry S., Jr.; Lindquist, Mary Montgomery; and Reys, Robert E. Calculators and Computers. In Results from the Second Mathematics Assessment of the National Assessment of Educational Progress. Reston, VA: NCTM, 1981. Pp. 115-132. This chapter presents NAEP data on how students performed on different types of exercises and problems when they used calculators.

Dean, David K. The Effectiveness of Using a Hand-Held Calculator as an Instructional Aid in Teaching the Basic Multiplication Facts to Fourth Graders. (Michigan State University, 1980.) Dissertation Abstracts International 41A: 3929; March 1981. Fourth-grade students from seven classrooms were assigned to three achievement levels. Each class was randomly assigned to use calculators either for all computation or only for checking problems, or was denied use of calculators. No significant differences between groups were found, but teachers reported that the calculator was motivation for students.

Edens, Helen S. Effects of the Use of Calculators on Mathematics Achievement of First Grade Students. Unpublished doctoral dissertation, University of Virginia, 1981. In grade 1, four calculator classes and two non-calculator classes were randomly identified. Teachers in one calculator group were given in-service education on using calculators. All groups used the same worksheets for 30 minutes each day during the 6-week study. The non-calculator group scored significantly higher on the posttest of mathematics objectives and on mathematical concepts than did the calculator group. Students whose teachers had the in-service work scored significantly higher on concepts. Teacher attitudes were more positive toward the use of calculators after the experimental period.

Lewis, Janice and Hoover, H. D. The Effect on Pupil Performance of Using Hand-held Calculators on Standardized Mathematics Achievement Tests. April 1981. ERIC: SE 035 259. Students in grades 4 and 8 (n = 539) received brief instruction on using a calculator. Half of the students at each grade level completed mathematics subtests of the Iowa Test of Basic Skills using a calculator as an option. The same tests were given a second time without calculators. The opposite procedure was used for the other half of the students. Rates of completion at both grade levels were much lower on problem-solving and computation subtests when a calculator was available. However, computation scores increased significantly at both grade levels when calculators were used.

Rabe, Rebecca M. Calculators in the Mathematics Curriculum - Effects and Changes. South Bend: Indiana University at South Bend, 1981. ERIC: SE 035 421. Twenty-six studies and other selected sources were reviewed and annotated to determine the effects of calculator use in mathematics classes and to assess proposed curriculum revisions.

Stewart, James T. Using the Hand-Held Calculator as a Computing Aid for Instruction in Word-Problem Solving with Elementary Grade Students. (University of Illinois at Urbana-Champaign, 1980.) Dissertation Abstracts International 41A: 4634; May 1981. Students in grades 4-6 (n = 146) were divided into four groups: calculator with special or standard materials and non-calculator with special or standard materials. Following daily instruction consisting of 10 problems to solve, a posttest of worded problem-solving ability was given. Students in the calculator/special materials group scored significantly lower than students in other groups. This group, however, completed the instructional materials in a significantly shorter average time than other groups.

Szetela, Walter. A Study of the Effects of Using Calculators for Problem Solving in Grades Three, Five, Seven, and Eight. Vancouver: University of British Columbia, April 1981. ERIC: SE 035 258. Students in grades 3, 5, 7, and 8 were randomly assigned to calculator or non-calculator instruction. At each grade level one teacher taught both groups using regular materials and texts, supplemented by additional materials for the calculator groups. On tests of computational skills and problem solving on which all students used only paper and pencil, there were no significant differences. However, on a problem-solving test where calculators were used, the seventh- and eighth-grade groups using calculators scored significantly higher than paper-and-pencil groups.

Szetela, Walter. Calculator and Paper and Pencil Methods on Problem Solving Tests in Grades Five to Seven. Vancouver: University of British Columbia, April 1981. ERIC: SE 035 257. Students in grades 5-7 (n = 116) were given calculators for use in mathematics classes. They were randomly assigned to one of two modes of completing the problem-solving posttest: using calculators or using paper and pencil. In a second section of the posttest, the groups were reversed, so that all students took a test in both modes. Three of eight comparisons of correct solutions significantly favored the calculator mode of problem solving. On measures of problems attempted and methods correct, all differences were nonsignificant except three favoring the calculator mode.

SELECTING CALCULATORS

Selden, William and Jorgensen, Carl E. Business Classroom and Laboratory Equipment. Business Education Forum 35: 27-46; January 1981.

Printing Calculators. Consumer Reports 45: 295-300; December 1980.

Printing Calculators. Consumers' Research Magazine 64: 33-37; June 1981.

REFERENCES AT THE COLLEGE AND OTHER POST-SECONDARY LEVELS

Butts, Thomas. Fixed Point Iteration - An Interesting Way to Begin a Calculus Course. Two-Year College Mathematics Journal 12: 2-7; January 1981. Suggestions for calculator use are mentioned within a sample lesson teaching fixed point iteration.

Fabrey, Lawrence J. and Roberts, Dennis M. Effects of Calculator Usage and Task Difficulty on State Anxiety in Solving Statistical Problems. April 1981. ERIC: SE 035 001. Undergraduates (n = 128) were randomly assigned to one of four conditions formed by crossing two levels of task difficulty (computationally easy or difficult problems) with two modes of calculation (solving by hand or calculator). When solving problems by hand, there was a larger increase in state anxiety between easy and difficult problems. However, level of anxiety on easy problems solved by hand was not lower than for difficult problems solved with a calculator.

Gaar, Kermit A., Jr. Teaching Modelling Concepts: Enter the Pocket-Size Programmable Calculator. Physiologist 23: 27-29; April 1980.

Hestenes, Marshall and Hill, Richard. Algebra and Trigonometry with Calculators. Englewood Cliffs, NJ: Prentice-Hall, 1981.

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