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ABSTRACT

An overview of the Mathematical Problem Solving Project, MPSP, is given. The goals, organization, and history of the project are described and the progress toward those goals is discussed. The outcomes of the project are stated, a brief diary of activities given, and a listing of technical reports made. (MP)

MATHEMATICAL PROBLEM SOLVING PROJECT

A Project of the

MATHEMATICS EDUCATION DEVELOPMENT CENTER

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MATHEMATICAL PROBLEM SOLVING PROJECT

FINAL REPORT

MATHEMATICAL PROBLEM SOLVING PROJECT:
Problem Solving Strategies and Applications
of Mathematics in the Elementary School

John F. LeBlanc, Director
Donald R. Kerr, Jr., Assistant Director

May, 1977

National Science Foundation Grant PES 74-15045

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FINAL REPORT

MATHEMATICAL PROBLEM SOLVING PROJECT

OVERVIEW

Goals, Organization and History

The overall goal of the Mathematical Problem Solving Project (MPSP) was to improve the problem-solving performance of children in grades 4, 5, and 6. While problem solving is generally recognized as an important component of the school mathematics curriculum, it has not in the past received the attention of researchers and developers that other components such as concepts and basic skills have. MPSP sought to investigate ways of improving problem-solving performance across various types of problems. The emphasis was on improving the processes used in solving different kinds of problems, not on developing skill with solving one particular kind of problem.

In seeking its overall goal MPSP identified seven more specific goals. These were:

- to conceptualize a model of the problem-solving process,
- to develop instructional materials and techniques consistent with the problem-solving model and to engage classroom teachers in the development and trial of these materials,
- to evaluate the effect of these materials on the problem-solving performance of children,
- to collect and organize observations and conjectures related to children's problem-solving activities,
- to design and carry out a dissemination model,
- to explore the use of the hand calculator in child problem solving,
- to explore the possibility of developing appropriate problems which use real applications of mathematics.

The second part of this overview which is entitled "Progress Toward Goals" will discuss the progress of MPSP toward meeting the seven goals.

The organization of the MPSP is somewhat unusual in that the project was to be carried out at three centers:

- The Mathematics Education Development Center at Indiana University to which the grant was awarded and which had responsibility for overall project leadership as well as primary responsibility for the conceptualization of the problem-solving model, for the planning and implementation of the evaluation and for research and inquiry.

- The University of Northern Iowa Center which had primary responsibility for the developing of instructional materials and pilot-testing them at the Malcolm Price Laboratory School.

- The Oakland Schools Center (Oakland County, Michigan) which had primary responsibility for the classroom trials of the materials and for the development of the dissemination model.

The project leadership consisted of a board of directors (George Immerzeel of the University of Northern Iowa; David Wells of Oakland Schools; John LeBlanc, Maynard Thompson, George Springer and Donald Kerr of Indiana University). John LeBlanc and George Springer were coprincipal investigators. George Springer was director during the first nine months of the project. John LeBlanc was director for the remainder with Donald Kerr serving as acting director for part of that time. The National Council of Teachers of Mathematics was a cosponsor of the project and was expected to serve as a vehicle for dissemination. The three centers provided MPSP with a blend of leadership representing all of the phases of mathematics education which were relevant to the project's goals. MPSP had a national advisory board made up of distinguished mathematicians and mathematics educators from across the country. This board (John Kelley, Eugene Nichols, James Gray, Jeremy Kilpatrick and Robert Dilworth) took a very active interest in the project and at the two meetings with the project directors provided valuable counsel and advice. The board was not utilized to its fullest potential for reasons which will be described below.

MPSP was originally funded by the National Science Foundation in August, 1974. The organization and goals of the project were predicated on the idea of a 4-5 year period of exploration and development. The funding of the project was terminated at the end of its second year. As might be expected, considerable energy was spent during the first year in getting the activities at the three centers coordinated. During the second year the demands of the NSF on the project and the procedures of the NSF related to the project's funding bordered on harrassment. As a result, a large portion of the energy of the MPSP leadership was diverted from the pursuit of the project's goals. Since a major effort was made to isolate the impact of the problems of organization and funding on a few individuals so that other staff members could pursue the goals, progress was made toward the seven goals. But it should be noted that the progress was incomplete.

Progress Toward Goals

Model for Problem Solving:

At the beginning of the project an extensive search of problem-solving literature was conducted. The intention was to build the activities of MPSP on existing research. A partial summary of that literature search appears in Technical Report I, Part A, a paper by Norman Webb entitled "A Review of the Literature Related to Problem-Solving Tasks and Strategies Used by Students in Grades 4, 5, and 6." One use of the information from the literature search was to form the basis for a conjectured model of the problem-solving process. Having conjectured such a model, it was to be a long-term activity of the project to refine and expand the conjectured model on the basis of experience gained and research conducted by the project. The paper by Frank K. Lester entitled "Mathematical Problem

Solving in the Elementary School: Some Educational and Psychological Considerations" (Technical Report I, Part B), deals with the literature directly related to models for problem solving and proposes a model based on that literature. In the paper the models of Dewey, Polya, Newell and Simon, Wickelgren and others are reviewed and used as the basis for a conjectured six-stage model. The six stages of the conjectured model (1. Problem awareness; 2. Problem comprehension; 3. Goal analysis; 4. Plan development; 5. Plan implementation; 6. Procedures and solution evaluation) are stated, explicated and analyzed in the light of existing research and what preliminary project experience was available at that time. It is pointed out that the stages are seldom pursued sequentially and that they do often overlap.

The value of a model for the problem-solving process is that it provides a framework for organizing the problem-solving behavior of individuals. It can also provide the teacher with a framework for organizing problem-solving instruction instead of viewing it as a series of isolated tricks. John F. LeBlanc has translated the conjectured model and classroom experience gained in the project into the teacher's point of view in a paper entitled "You Can Teach Problem Solving!" (Technical Report I, Part C), which is to appear in the Arithmetic Teacher. The paper provides practical illustrations for the elementary teacher.

The refinement and extension of the conjectured model continues to this day. While some of the conjectures which will be reported below speak to questions concerning the model, no subsequent paper dealing directly with the refinement of the model has been written. It might be noted here that the need for at least two models has been identified. The first is a descriptive model of the problem-solving process, and the second is an instructional model which highlights those points where instructional intervention is called for.

Instructional Materials:

It seems logical to explore, conjecture, and verify prior to developing materials. However, the current state of research suggests that formal verification of important generalizations concerning child problem solving are likely to be many years in coming. Moreover, experience suggests that an interaction between developmental and investigative efforts tends to enhance each and, in particular, serves to focus each on the realities of the schools. There is also the, possibly unfortunate, pressure at all stages of a funded project to have something concrete and with evident face validity to show for time and money spent. In the light of these considerations and of the fact that several of the project staff had considerable experience with child problem solving prior to the beginning of funding, it was decided to begin materials development immediately. The idea was not to develop a large quantity of materials but rather to develop and refine prototypes which, if warranted, would serve as the basis for a later developmental thrust.

MPSP pursued two distinct instructional strategies in its materials development. One instructional strategy was to identify skills and processes which would be useful in solving problems and teach those skills and processes directly so that they could be used in problem solving. The second instructional strategy was to provide problem-solving experiences and then to look back on the experience and analyze the skills and processes used. The two modules developed by the staff at the University of Northern Iowa and the one module developed by the teachers and staff at Oakland Schools were designed to teach specific skills and processes (using a guess, making a table, and organizing a list) for solving problems and then provide experience with using the skills and processes on carefully selected problems. Each of the three modules

consists of an instructional booklet, a student's problem deck and a teacher's problem deck. The modules were developed, pilot-tested, revised, tried, revised, etc., during the two years of the project. Considerable experience and insight was gained in the module development process and is reflected in the modules which appear as Technical Report II, Parts A, B, and C. The details of the development and the trial of the modules appear in Technical Report III. It was generally found that children could do and enjoyed doing the modules. Moreover, teachers saw value in child work with the modules and found evidence of growth in attitude and competence as a result of work with the modules.

The developmental activities at Indiana University were based on the premise that an effective way to learn problem solving is to solve problems. Part of this development involved exploring effective ways of delivering problem-solving experiences to children in an appropriate atmosphere and observing the effects of such experience on child performance. A problem-solving bulletin board was developed, tried, refined and retried. On the bulletin board were problems, hints, examples of how other children had solved the problem, and extensions of the problem. It was found that after relatively short exposure to the bulletin board and despite wide variation in teacher management of the exposure, children exhibited a marked increase in the evidence of processes used on problems. The details of these developmental activities appear in Technical Report II, Part D, "Learning to Solve Problems by Solving Problems."

As was indicated earlier the three modules and the problem-solving bulletin board were intended to be prototypical probes into effective materials and procedures for delivering problem-solving experiences to children. More will be said later concerning the implications of these developmental efforts for future investigations into problem solving.

The project took every step to ensure that its developmental efforts were reality-based. As a consequence the developmental activities at all three sites were carried out with frequent pilot trials with children and by staff members who had extensive experience with children. At the Oakland Center groups of teachers were identified and were involved intensively with the project. During the first year one group of twelve teachers worked with the Oakland staff to develop a draft of the Organizing Lists module which they subsequently tried with their classes. This group of teachers also tried the first version of the module Using Guesses to Solve Problems. For the second year of the project two more groups of teachers were identified. The three groups of teachers tried different versions of the three modules during the year, providing valuable feedback to developers and providing valuable experiences to the Oakland staff concerning the implementation of the modules. Further information concerning the work with the teachers at Oakland appears in Technical Report III and in the discussion below on developing a dissemination model.

The reality base of the project was also tested in a number of presentations that were made by staff members at NCTM meetings throughout the country. Several staff members presented an all-day workshop at the Annual Meeting of NCTM in Denver in April 1975.

In summary, MPSP has developed three modules which children can do and enjoy doing, which teachers feel have value for children, and which develop processes and skills which seem to be important for problem solving. In addition, MPSP has developed a format and procedures for delivering problem-solving experiences to children so that the experience can be analyzed and can be the source of growth. Moreover, these developmental efforts have been based on extensive interaction with teachers and children.

Evaluation:

The MPSP evaluation had a short-term and a long-term dimension. In the short-term it was important to collect as much information as possible concerning the module trials in order to aid the module developers in their work and in order to provide a record of the trials. The details of these formative evaluation efforts are given in Technical Report III. The long-term concern was to develop evaluation instruments and procedures that were sensitive to MPSP goals in order to form the basis of summative evaluation of the final outcomes of MPSP. The progress that was made along this dimension is reported in Technical Report IV, "Summative Evaluation."

In general, the formative evaluation team collected information in any way that it could. Quizzes were constructed for each module which were designed to test the module objectives. Records of time spent on each module activity, of cards used in each card deck, of implementation formats employed, of teacher reactions, etc., were kept. Tape-recordings were made of teacher debriefing sessions. Most of the information gleaned from this data was communicated informally to the module developers and then synthesized into Technical Report III. Most of the difficulties identified in these trials were eliminated as a result of module changes. Often the need for these changes was anticipated by the module developers and confirmed by the results of the formative evaluation. In general, each version of each module was well-received and judged favorably by teachers and children. But in every case opportunities for improvement were identified and taken.

The summative evaluation efforts during the first year of the project consisted of searching for and developing appropriate instruments in the areas of problem-solving achievement, problem-solving processes used,

and attitudes toward problem solving. The search was complicated by the fact that the kind of problems being used by MPSP are not typical of those tested by existing instruments. A multiple-choice subscale of one NLSMA instrument was identified as having problems in the spirit of MPSP problems. A search was conducted of the major standardized achievement tests, and the problem-solving portion of the Stanford Achievement Test was judged most acceptable. A multiple-form problem-solving survey was developed and refined. An attitude questionnaire was developed. These instruments and the procedures of administering them and analyzing the data were pilot-tested during the second year of the project. Generally, it was found that the NLSMA subscale and the problem-solving survey showed some sensitivity to MPSP goals. The attitude questionnaire had satisfactory test characteristics (see Appendix F to Technical Report IV), but it did not seem to be sensitive to any changes effected by MPSP.

In addition to formative and summative evaluation efforts, a pilot venture was undertaken to explore means of measuring the use of specific problem-solving processes. This effort was in support of the module objectives of developing these processes in children. Development was begun of a paper-and-pencil instrument to elicit the use of certain strategies and skills in solving a problem. This development was not completed. A brief report of it appears in Technical Report V, "Process Evaluation."

MPSP felt that a successful implementation of any materials developed would have to be accompanied by a change in classroom teacher views of what kinds of problems are important and appropriate for children. It was also felt that teachers would change their views concerning problem solving if they were exposed to the MPSP materials and procedures. To

test the latter hypothesis a teacher problem-sort task was developed. The task was administered to teachers at Oakland on a pretest-post-test basis in order to measure any change in the teachers' perceptions of the kinds of problems that are appropriate to use with children (Sort Task T1) and the teachers' perception of the kinds of problems children would want to do (Sort Task T2). It was found that teachers' perceptions did change in the direction of MPSP-type problems. A report of the development, administration and outcome of the teacher problem-sort task appears in Technical Report VI, "Report on the Problem-Sort Tasks for Teachers."

Conjectures:

The staff of MPSP anticipated several years of intensive experience with child problem solving. Having reviewed the research literature in this area, it was clear that there was not a cohesive body of research to provide direction and guidance in problem-solving instruction in the elementary school. One of MPSP's long-range goals, therefore, was to generate and refine a list of conjectures related to problem solving which could serve as a resource to researchers both on and off the project. Such a list of conjectures has been begun (see Section G of Technical Report II, Part D). There was no opportunity to validate or refine the list. Probably the most striking and potentially useful conjectures have to do with the impact of relatively unguided experience on problem-solving performance and the importance of problem complexity as an index of problem difficulty.

Dissemination Model:

It was planned that at a certain point MPSP would have a set of materials which had been pilot-tested and on which substantial use data would be available concerning successful implementation formats.

At that point it would be important to have evolved a set of procedures for orienting teachers to the use of these materials. Two kinds of dissemination were planned for MPSP. One was informal, through presentations at meetings such as NCTM name-of-site meetings. As indicated above, this had already begun. The other kind of dissemination that was planned was a formal plan for in-service work with a school district which planned to implement project materials. Explorations were carried out with in-service teachers in the Oakland Schools in conjunction with the module trials. These explorations are reported in Technical Report III. For each module, four in-service sessions were held. The first one was to orient the teachers and the remaining three were to collect data from the teachers concerning the effectiveness of the module. There were three groups of teachers being used. Observations were being collected concerning how much orientation to MPSP goals and materials was required for successful implementation of the materials. The natural next step would have been to pilot-test in-service procedures on a completely new set of teachers.

Hand Calculators

The view of MPSP was that the hand calculator is a tool that can be utilized in solving certain kinds of problems. It has the advantage of making problems with large or messy numbers tractable for children. The hand calculator may also make certain children more willing to experiment with problem solutions. Three booklets were developed for working with the hand calculator (see Technical Report VII, "Hand Calculator Materials"). One booklet provides experiences for children to acquaint them with the calculator and its functions. Another actually focuses on problem solving using the calculator. In addition to the booklets certain problems in the modules were identified as ones where a hand

calculator would be useful. They are marked with a calculator in the upper right-hand corner (see Technical Report III). The project did purchase some calculators and extensive work was done with children using calculators at both the University of Northern Iowa and Oakland.

Real-World Problems:

Different kinds of mathematics problems are appropriate for different goals. Exercises such as 3 + 2 = ?, $\begin{array}{r}39,\\ +45\end{array}$ and $8\overline{)391}$ appear in the curriculum to develop skill with certain algorithms. The problems in the MPSP modules were chosen because they emphasized the use of certain processes (strategies, tools, and approaches) which were to be developed in children. There is the need for problems which bridge the gap between these skill and process problems and the use of mathematics in the real world. These problems need to develop skill with problem definition, with mathematical modeling, with data collection and with answer interpretation. The need for these problems has been recognized by some educators. It has also been recognized that it is very difficult to develop such problems that are also doable by elementary school children. MPSP agreed to conduct a probe in the direction of identifying and pilot-testing a bank of such problems. Technical Report VIII, "Miniprojects and Applied Problems," gives the beginnings in that direction, including several problems and a report of the pilot-testing of those problems.

<u>Outcomes</u>

The project did make substantial progress toward achieving each of the seven goals. Even though the project work was not completed, there are outcomes from the project which have value and which should further the overall goal of improving the problem solving of children in grades 4, 5 and 6. Some of these outcomes are described below.

The project has produced, pilot-tested and refined student and teacher editions of three modules (Using Guesses to Solve Problems, Using Tables to Solve Problems and Organizing Lists). Formative evaluation suggests that children can do these modules; that children enjoy doing them; that teachers find value in having children do them; and that children experience growth in doing them. Fortunately, the development activities at the University of Northern Iowa are being continued under a Title IVc grant from the Iowa Department of Public Instruction.

MPSP learned that children can solve problems which require certain problem-solving processes. Furthermore, MPSP learned that children can be taught these processes directly. MPSP also came to believe that experience with problem solving which is analyzed subsequently can enhance the use of problem-solving processes.

What MPSP has learned points up some important and potentially productive areas of research concerning problem solving for children. One intriguing area has to do with the relative effectiveness of non-intervention problem-solving experiences for children. Significant growth was observed in a variety of classrooms as the result of undirected experiences with certain kinds of problems. How much potential this kind of experience has, how this experience can be built on for even greater growth, and how to implement these experiences in the schools are questions that should and probably can be answered. In other words, one should investigate the hypothesis that children learn to solve problems by solving problems.

MPSP received considerable exposure in the mathematics education community. During the existence of the project, the attention given to problem solving by the mathematics education community increased noticeably. Individual research in problem solving is widespread;

several other projects have dealt in part with problem solving. The number of talks at NCTM meetings on problem solving rivaled and even surpassed in some cases the number on the metric system. It would not be fair to entirely credit MPSP with this growth of interest in problem solving, but some credit is surely due.

An article will soon appear in the Arithmetic Teacher which makes a model of the problem-solving process accessible to the practicing teacher.

The problems from MPSP modules have made their way into commercially published elementary school text series. This will result in a change in the blend of problems in textbooks. Some future texts will have an increased percentage of the process-type problems which were the focus of much of the MPSP development.

Every project changes the people who work on it. MPSP employed several mathematicians, mathematics educators and doctoral students. One doctoral student is currently completing a dissertation on the interaction between the degree of visuality of an individual and the performance of that individual on spatial problems. For the others on the project, the experience gained in working on MPSP and the materials developed by MPSP have become integrated into their professional lives. Their activities and those of professionals around them will be permanently influenced by MPSP.

It should be noted in closing that MPSP was the first and only major project concerned with child problem solving. This is a very important area and warrants the protracted and concentrated exploration that only a major project can provide.

A BRIEF DIARY OF ACTIVITIES OF THE MATHEMATICAL PROBLEM SOLVING PROJECT

December 1972 - Winter 1977

December, 1972

Request from Dr. L.O. Binder at M.I.D. Section of N.S.F. for suggestions for the curriculum needs of the country.

Discussions began about curricular needs by the faculty at the Mathematics Education Development Center (M.E.D.C.).

January, 1973

Meetings held at the M.E.D.C. to formulate a proposal to N.S.F. These meetings involved Kerr, LeBlanc, Springer, and Thompson.

February, 1973

Prospectus for a curriculum project submitted to N.S.F. suggesting the preparation of materials designed to improve the problem-solving abilities of students and to introduce more applications of mathematics.

March, 1973

Request from Dr. Binder at N.S.F. to organize a conference on school mathematics.

Submitted a proposal for Conference on K-12 Curriculum to N.S.F.

April, 1973

Grant for $21,700 received from N.S.F. to hold a conference on school mathematics. The specific conference plans were formulated and the participants were invited. Snowmass, Colorado, selected as site and June 21-24 as dates.

May, 1973

Snowmass Conference participants submitted comments on the mathematics curriculum. These were edited and distributed in summary form to all the participants. The program for the meeting was distributed.

June, 1973

The Snowmass Conference on the K-12 mathematics curriculum was held at the Crestwood Lodge from June 21-24.

July, 1973

Retreat at Brown County State Park for one weekend attended by Kerr, LeBlanc, Lester, Maki, Rhoades, Springer, Thompson, and Trafton to write the report of the Snowmass Conference. The report was prepared for distribution.

August, 1973

Plans were formulated at the M.E.D.C. for K-12 curriculum project on problem solving and applications of mathematics.

N.C.T.M. Board appointed a committee consisting of Immerzeel, LeBlanc, and Wells to plan N.C.T.M.'s involvement in curriculum development.

September, 1973

Meetings took place among the group at the M.E.D.C. and the N.C.T.M. committee to make plans for curriculum development. It was becoming evident that a joint effort might be advantageous.

Ad hoc N.C.T.M. committee meeting on problem solving in Washington, D.C. attended by Immerzeel, LeBlanc, Wells.

October, 1973

Received a Grant-in-Aid for $1500 from I.U. for travel to plan project. The N.C.T.M. Committee and M.E.D.C. group met at I.U. to plan a cooperative effort in curriculum work (Immerzeel, Kerr, LeBlanc, Springer, Thompson, Wells). Work on the preparation of the proposal began.

November, 1973

Work on the preparation of the proposal continued. Trip to Washington, D.C., to meet with Binder and Woodby to discuss proposal.

December, 1973

Submitted proposal to N.S.F. for project on problem-solving strategies and applications of mathematics in the schools.

February, 1974

Trip to Washington, D.C., to speak to Woodby about changes in proposal. Meeting of Policy Board in Indianapolis to agree upon revised proposal reducing scope of project. Revision of proposal started.

March, 1974

Revised proposal submitted to N.S.F. in which project is restricted to grades 4-6 and to problem solving and use of mini-calculators. Trip to Carnegie-Mellon in Pittsburgh to visit Newall, Hayes, etc., by Kerr, LeBlanc, and Springer. Grant of $25,000 received from N.S.F. to hold summer conference. Plans for Conference at Oakland Schools in June formulated.

April, 1974

Trip to Oakland Schools in Pontiac, Michigan by Kerr and Springer to plan for Conference. Invitations for Oakland Conference sent out and speakers invited. Advisory Board appointed: Dilworth, Gray, Kelley, Kilpatrick, Nichols, Pollack.

May, 1974

Preparations for the Oakland Conference continued. Recruitment of staff for the project begun, and Norman Webb hired at I.U. and Stuart Choate at Oakland Schools.

June, 1974

Oakland Conference held from June 23-27. First Advisory Board Meeting held after the Conference at Oakland Schools with Kelley, Kilpatrick, Dilworth, and Gray present. Lauren Woodby from N.S.F. also present.

July, 1974

Position papers were requested from five of the participants of the Oakland Conference. These were Dale Seymour, Richard Shumway, John Kelley, Carole Greenes, and George Immerzeel. Preparations were being made at each center for the project activities.

August, 1974

Staffs assembled at each of the centers. At I.U.: Norman Webb, Frank Lester are project faculty and Tom Hudson, Randy Charles, Fadia Harik, and Barbara Moses are project associates working with Kerr, LeBlanc, Springer, and Thompson. Charles Kalme and Richard Mayer of psychology department also take part. At U.N.I.: George Immerzeel, Jack Wilkinson, and Jack Tarr are project faculty. At Oakland: Dave Wells and Stuart Choate are project faculty.

Grant from N.S.F. received for $187,000 until August 15, 1975.

Proposal to conduct two workshops at April meeting of N.C.T.M. submitted to N.S.F.

September, 1974

Five position papers received.

At I.U.: Lists of problems and strategies prepared. Problem-solving bibliography assembled. Moved to new building at 814 E. Third Street. Plans for student interviews begin. Policy Board meets at I.U. September 9-10. Interviews of individuals and groups of students.

At U.N.I.: Classroom teaching begins, problem sets assembled and classified. Plan for structure of module formulated. List of strategies prepared.

At Oakland: Classroom teaching begins by Wells and Choate trying problem-solving strategies for children. Lists of problems assembled and tried. Proposal for workshops withdrawn from N.S.F.

October, 1974

Plans for Advisory Board Meeting made at LaSalle Hotel in Chicago for November 24-26. Mr. Gerald Lueke of Texas Instrument Company visits to discuss loan of calculators to project. Francis Archambault visits all three sites to consider external evaluation project for N.S.F.

At I.U.: Small group and individual interviews conducted to observe problem solving by fifth-graders. Visit by Stuart Choate to I.U.

At Oakland: Ten teachers recruited to prepare for classroom trials in in-service program. George Immerzeel attends first meeting with teachers to orient them.

At U.N.I.: Interviews conducted, classroom teaching of problem-solving strategies continues. Work on module begins.

November, 1974

Advisory Board Meeting at LaSalle Hotel in Chicago from November 24-26 followed by a meeting of four directors of N.S.F. projects with Jim Wilson on November 26.

At I.U.: Interviews continue and teaching of problem solving to groups of seven or eight students begun. Need for certain mental habits or attitudes observed. Research and writing programs planned. Visit by Larry Hatfield.

At U.N.I.: Teaching and interviews continue. Work on module continues with plans for December completion of first draft for use in Oakland Schools.

At Oakland: In-service program continues. Visit from Springer and Webb. Teaching by Wells and Choate continues with trials for problems and problem-solving strategies. In-school testing of Hand Calculator booklet.

Plans for Spring N.C.T.M. workshops submitted to program.

December, 1974

Visit to U.N.I. by Stuart Choate, John LeBlanc, Frank Lester, and Norman Webb to review modules being written at each center.

Proposal for evaluation submitted to N.S.F. by Fran Archambault. Copy sent to each center for information and reaction.

Proposal submitted to Jim Wilson at N.S.F. to add travel to four staff meetings, reproduction of materials, and purchase of hand calculators.

Also, letter sent by John LeBlanc to Jim Wilson explaining the personnel decisions at the I.U. center.

January, 1975

Proposal to Jim Wilson resubmitted adding John LeBlanc's half-time salary from January to August, 1975.

Visit of Fran Archambault to I.U. center, January 13-15.

Project Staff meeting in Pontiac on January 20-21. Fran Archambault present for evaluation. U.N.I. materials on Guess and Test introduced to the teachers. Preliminary discussion of ideas related to Organized Lists.

February, 1975

John LeBlanc, George Immerzeel, Frank Lester, and Norman Webb meet in Northern Michigan, January 30-31, for two-day work session.

Visit by Professor Trimble from Ohio State University to work on Fran Archambault's evaluation, February 6-7, in Bloomington. Professor Trimble also visited Pontiac site (February 13-14) and Cedar Falls site (February 17-18).

Tryout of Guess and Test at Oakland Schools.

March, 1975

Tryout of first section of Pattern Finding module with one class of fifth-grade students in Bloomington.

Field testing of the readability part of the categorization scheme with individual students in Bloomington.

Fran Archambault and Mary Montgomery visit I.U. on March 3-4.

March 6-7, MPSP Staff Meeting and Policy Board Meeting at I.U.

Informal tryout of Organized Lists in Oakland classes.

April, 1975

David Wells, Stuart Choate, John LeBlanc, George Immerzeel, John Tarr and teachers meet at Oakland to get reaction to trials of the materials. Plans made for Denver, NCTM meeting. Plans also made for proposal.

Problem-solving workshop and hand calculator workshop given at the Annual NCTM meeting, April 23.

Presentation of paper "An Exploration of Mathematical Problem-Solving Processes" by Norman Webb at the Annual AERA meeting in Washington, D.C.

May, 1975

Organized Lists module revised at Oakland.

Collection of data for study of the relationship of dimensions of the problem statement to the comprehension of the problem.

Frank Lester and Norman Webb attended research workshop on problem solving in mathematics education at the University of Georgia. Frank Lester presented a monograph, "Problem Solving Strategies and Applications of Mathematics in the Elementary School."

John LeBlanc and Donald Kerr to Chicago, May 11-12 for Directors' meeting.

June, 1975

Meeting to discuss evaluation issues of MPSP was held in Bloomington, June 9 and 10. David Wells and Stu Choate from Oakland schools and members of the I.U. Center attended. Preparation of problem-sort task for Oakland teachers.

Teacher Workshop was held at Oakland, June 16-19. The new teachers attended for three days and the old teachers attended for 4 1/2 days. George Immerzeel was present at the workshop.

MPSP staff meeting was held in Bloomington, June 23, 24. David Wells and Stu Choate from Oakland, George Immerzeel from U.N.I., Jim Wilson from NSF and members of I.U. Center attended. Analysis of Organized Lists module.

Revision of Guess and Test module.

July, 1975

Materials and evaluation instruments development was continued.

Development of miniprojects and applied problems begun.

Max Bell visits I.U., July 29-30.

Feedback to developers on Organized Lists module.

August, 1975

New staff members were added to each center:

At U.N.I.: Joan Duea and Earl Ockenga
At Oakland: Doug MacPherson
At I.U.: Arthur Stengel, Marilyn Hall, and Linda Proudfit

Revision of Organized Lists continues at Oakland.

Developmental work on the Estimation and Tables modules was begun at U.N.I.

Jack Wilkinson and Stu Choate gave problem-solving talks at N.C.T.M. regional meeting in Honolulu.*

September, 1975

All staff members from each center attended the Wagon Wheel Workshop, Rockton, Illinois, September 14-19.

Evaluation materials for Organized Lists trial prepared.

Joseph Payne became project NSF liaison.

Tryout of Guess and Test with 4th- and 5th-grade students in Bloomington; suggestions made for revision.

October, 1975

Pretesting in Oakland Schools begun.

First tryout of Organized Lists module begun at Oakland using 19 classes.

U.N.I. finalized the Estimation module (teacher edition, student booklet, and problem deck).

John LeBlanc to Eugene, Oregon, October 9-13.

At I.U., began working with 3 student groups (6 per group) two times a week on a regular basis. Miniproject on paper conservation tried in Bloomington school, October 28-November 20.

Visit to Oakland by Norman Webb to observe pretesting and first in-service meeting for Organized Lists module, October 14, 15.

Visit to I.U. by George Immerzeel to discuss the evaluation of the Estimation module, October 29.

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* Other talks have been given at various times by different staff members.

Visit to Oakland by Norman Webb and Randy Charles to observe classes using Organized Lists module and to finalize forms to be used in evaluating the Estimation module, October 29-31.

Began tryout of project problems with one group of six students at I.U.

Development of Tables module continues at U.N.I.

November, 1975

Paul Rosenbloom visits I.U., November 3-4.

Tryout of Estimation (Guess and Test) module begun in Oakland using 11 classes, 8 new teachers and 3 old teachers.

Tryout of Estimation module begun in lab school at U.N.I. with two classes, one 6th grade and one 4th grade. Draft of Tables module available.

Advisory and Policy Board meeting at Holiday Inn--Downtown Atlanta, November 17-19.

Analysis of pretest data and data from Organized Lists trial, with feedback to module developers.

Prepare materials in response to ten questions from NSF for second ad hoc review of project.

December, 1975

Analysis of data from Estimation trial and feedback to developers.

January, 1976

Bulletin board problem materials developed. Problems tried with 4th-grade students at Elm Heights School, Bloomington.

Revision of Estimation and Organized Lists modules.

LeBlanc, Kerr, and Webb to Oakland, January 20-22, to prepare for evaluation of Tables module trial.

February, 1976

Tables module trial February 4-March 17 with 17 classes at Oakland.

Received notification from NSF of August, 1975, funding.

First pilot-test of bulletin board problems at Grandview School, Bloomington.

Second trial of revision of Estimation module, February 17-March 31, using ten classes.

Major revision of Organized Lists.

March, 1976

Feedback to developers on Tables trial. Revision of Tables module.

Wells, Immerzeel, Kerr, Cote meet in Chicago re: termination proposal and budget, March 15-16.

Interviews of teachers and students after first bulletin-board problems tryout.

April, 1976

Preparation of materials for second pilot of bulletin-board problem format, and trial at Clear Creek, University and Arlington Heights Schools, Bloomington, April 13-May 18.

Norman Webb, Art Stengel, Randy Charles, Barbara Moses, and Linda Proudfit to Oakland for teacher and student interviews, April 26-28.

May, 1976

Final trials at Oakland of Using Tables (with ten classes), Using Guesses (with eight classes), and Organizing Lists (with nine classes).

Webb, Kerr to Oakland, May 12, to prepare for administration of post-tests.

Interviews of teachers and students re: second pilot-test of bulletin-board problems. Data analysis and preliminary work on report.

June, 1976

Administration of post-tests to children. Post-test of teacher problem-solving sort task.

Organization and analysis of post-test data.

July, 1976

Organization and analysis of post-test data.

Preliminary report on miniprojects written.

Final revisions of all modules.

Preparation for termination of project.

August, 1976

Continuation of close-down.

Vacations for much of staff.

Fall and Winter, 1976-77

Preparation of final report.

LIST OF TECHNICAL REPORTS WHICH ACCOMPANY THIS OVERVIEW

TECHNICAL REPORT I: Documents Related to a Problem-Solving Model

A. "A Review of the Literature Related to Problem-Solving Tasks and Strategies Used by Students in Grades 4, 5, and 6," by Norman L. Webb

B. "Mathematical Problem Solving in the Elementary School: Some Educational and Psychological Considerations," by Frank K. Lester, Jr.

C. "You Can Teach Problem Solving!" by John F. LeBlanc (to appear in the Arithmetic Teacher)

TECHNICAL REPORT II: Instructional Materials

A. "Using Guesses to Solve Problems

B. "Using Tables to Solve Problems"

C. "Organizing Lists"

D. Learning to Solve Problems by Solving Problems

TECHNICAL REPORT III: Module Development and Formative Evaluation } App A BCD

TECHNICAL REPORT IV: Summative Evaluation

TECHNICAL REPORT V: Process Evaluation

TECHNICAL REPORT VI: Report on the Problem Sort Tasks for Teachers

TECHNICAL REPORT VII: Hand Calculator Materials

A. "Calculator Handbook"

B. "Getting to Know the Calculator"

C. "Problem Solving: Opening the Door Using the Mini-Calculator"

TECHNICAL REPORT VIII: Miniprojects and Applied Problems