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ABSTRACT

The primary emphasis of the D.C. SSPACE program, which introduced computers and previously developed computer curricular materials into the secondary schools of the District of Columbia and studied the adoption process, was on adoption and not development. The program is described from its initial funding under the Human Resources Research Organization to the change-over of program management by the participants themselves. This report includes detailed usage information, an outline of program development, the project's impact on teachers and students, and monitoring details. Attendance and achievement data are offered in support of the focus of the program, and recommendations for continuing development of the program are outlined. (RAO)

FR-ED-78-11

Final Report

D.C. SECONDARY SCHOOLS PROJECT FOR ADOPTING COMPUTER-AIDED EDUCATION
(D.C. SSPACE Program)

Submitted to:

National Science Foundation
Division of Grants and Contracts
1800 G Street N.W.
Washington, DC 20550

August 1978

Human Resources Research Organization
300 N. Washington Street
Alexandria, VA 22314

NATIONAL SCIENCE FOUNDATION
Washington, D.C. 20550

SUMMARY OF COMPLETED PROJECT

Form Approved
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4. GRANT NUMBER	5. BUDGET DUR. (MOS)	6. PRINCIPAL INVESTIGATOR(S)	7. GRANTEE ACCOUNT NUMBER
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8. SUMMARY (Attach list of publications to form)

The purposes of the program were (1) to introduce computers and already developed computer curricular materials into the secondary schools of the District of Columbia, and (2) to study and make explicit the process of adopting the computer-based materials. The four schools involved in the program were Woodrow Wilson, Dunbar and Eastern High Schools, and St. Anselm's Abbey School, a private school.

Two sets of activities were performed, corresponding to the two components of the project: (1) facilitating the adoption and change process, and (2) studying this change process. The basic policy of the project was to introduce computers into the curriculum through the use of curricular materials which had already been developed elsewhere.

The study was designed to provide a systematic, yet flexible, method of gathering, analyzing, and presenting information bearing on a wide range of complex and interrelated factors that are active in the adoption process. The researchers decided that to focus on purely technical or cost factors would be to ignore the most critical factors in the adoption of educational innovations. Attitudes, values, roles and interpersonal relationships were addressed in order for the study to reflect the real process of change, even though such "objective" measures as student grades, attendance, computer usage, or costs are also meaningful. A four-level conceptual framework was adopted for the study. The four "levels of reality" were: (1) the institutional (school) environment; (2) the project environment; (3) the curriculum environment; and (4) the learning activities. Although specific objectives for computer use were determined at each school, there was one adoption goal to the project as a whole: to have the computer-based curricula well enough established by the end of the project period so that these activities would continue after project funding and support ended.

A complete description of project findings can be found in Chapter V of this report. The findings below are extracted to provide the reader with a synopsis of the study's more important results, conclusions, and recommendations.

1. Number of users increased from approximately 780 in the first year to approximately 1500 in the second year.
2. Number of user schools increased from 4 to 12 in the second year.
3. The Superintendent agreed to provide continued support for the instructional computing program in the D.C. Public Schools.
4. St. Anselm's Abbey School established its own network with their extra ports while continuing to exchange programs and ideas with the other original project Schools.
5. The original project teachers established, on their own, a popular training workshop for new, interested teachers.
6. Where data were obtained systematically, the results clearly show improvement in the quality of student achievement and attendance.

9. SIGNATURE OF PRINCIPAL INVESTIGATOR/ PROJECT DIRECTOR	TYPED OR PRINTED NAME	DATE
Robert J. Seidel	Robert J. Seidel	AUG 1978

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SUMMARY OF COMPLETED PROJECT

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8. SUMMARY (Attach list of publications to form)

Summary (Cont'd)

7. Despite the initial focus of the project on adoption rather than development, over 50% of the programs used in the second year alone were developed from scratch and 12% were modified by the project teachers. Teachers felt the need to tailor most materials to their pedagogy.

8. Release time was not sufficient for the teacher as an incentive to continue work.

9. As HumRRO relinquished authority, no management leader emerged within the project schools. The lack resulted in the dormancy of post-project plans for instructional computing in the D.C. SSPACE Project Schools.

10. It was not feasible to develop, during the project life, a necessary basic skills package which could have benefited all schools in the District.

Recommendations:

If instructional computing is to continue to help D.C. Public Schools:

1. A strong, politically aware person is needed to coordinate instructional computing in the D.C. Schools. Preferably, this individual should be an instructional person with computing literacy and with the authority of the Superintendent's Office behind him/her.

2. There is a need to establish some data recording standards so that instructional effectiveness can easily be measured and programs improved.

3. A District-wide computing literacy program is needed if the value of instructional computing is to be perceived.

4. Remedial computer-based math and reading packages should be obtained or developed and made accessible to all elementary and secondary schools.

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D.C. SECONDARY SCHOOLS PROJECT FOR ADOPTING COMPUTER-AIDED EDUCATION (D.C. SSPACE Program)

SUMMARY

PURPOSE

The SSPACE program was sponsored by a grant awarded to the Human Resources Research Organization (HumRRO from the National Science Foundation (Office of Technological Innovation in Education.)[1] The purposes of the two-year program were (1) to introduce computers and already developed computer curricular materials into the secondary schools of the District of Columbia, and (2) to study and make explicit the process of adopting the computer-based materials. The four schools involved in the program were Woodrow Wilson, Dunbar and Eastern High Schools, and St. Anselm's Abbey School, a private school.

ORGANIZATION AND STAFFING

To facilitate the conduct of this cooperative venture, a Board of Directors was established to provide overall guidance to the project. The Board was chaired by Mr. Maurice Jackson, Principal of Woodrow Wilson High School. The principals of the other three participating schools were members of the Board: Ms. Phyllis R. Beckwith, Dunbar High School; Mr. William J. Saunders, Eastern High School; and Father Michael Hall, St. Anselm's Abbey School.

Other members of the Board initially included two nationally known experts in computer-based education: Dr. Sylvia Charp of the Philadelphia School System, and Dr. Thomas Dwyer, Principal Investigator for Project SOLO (in the Pittsburgh School System). The Principal Investigator from HumRRO, Dr. Robert J. Seidel, was the seventh member of the Board. (Mr. Jackson of Wilson High was Co-Principal Investigator of this study.)

[1] Grant No. TIE-74-19456

HumRRO provided a Director of Support, Ms. Carol Kastner, who was responsible for the day-to-day operations to implement the computer-based materials in the schools. Additional HumRRO support personnel helped teachers and student assistants at each school accomplish their project-related activities. A designated HumRRO staff member was on hand daily to help each participating school.

Each school had a "chief" teacher involved in the project, as well as one or two "user" teachers designated by the principals to participate. These teachers were released one-fifth time to work with the project during the first year, integrating the computer-based materials into their courses. Additional interested teachers were brought into the project during the second year.

The system configuration was designed to be expandable. Each school had 8 computer terminals. Woodrow Wilson High School had a Hewlett-Packard 2000F access system with 16 ports dedicated to remote users at the other schools and a capacity for 8 additional ports. This capability was not fully utilized, since Dunbar and St. Anselm's also had access to their own computers, Hewlett-Packard 2000E's. At any one time, ports were available into Wilson. Dunbar's 2000E had a capacity of 16 simultaneous users, eight of which were utilized. An additional port cost approximately $30/port/month for telephones and data sets. Planning for a ratio of 2 terminals/port gave the capability for an additional 16 remote terminals into Dunbar.

THE GENERAL APPROACH

Two sets of activities were performed, corresponding to the two components of the project: (1) facilitating the adoption and change process, and (2) studying this change process.

Adoption Process

It was a basic policy of the project to introduce computers into the curriculum through the use of curricular materials which had already been developed elsewhere. (That is, the primary emphasis of this project was on <u>adoption</u>, not <u>development</u>.) While it was expected that there would be some problems in integrating materials "from the outside" into the educational programs of the four schools, the principals agreed that it was far more feasible to use such materials initially than to begin developing new materials specifically for their schools.

<u>Study Approach</u>

The study was designed to provide a systematic, yet flexible, method of gathering, analyzing, and presenting information bearing on a very wide range of complex and interrelated factors that are active in the adoption process. The researchers decided that to focus on purely technical or cost factors would be to ignore the most critical factors in the adoption of educational innovations. Attitudes, values, roles, and inter-personal relationships needed to be addressed if the study were to reflect the real process of change, even though such "objective" measures as student grades, attendance, computer usage, or costs are also meaningful.

A four-level conceptual framework was adopted for the study. The four "levels of reality" were: (1) the institutional (school) environment; (2) the project environment; (3) the curriculum environment; and (4) the learning activities.

Although specific objectives for computer use were d[illegible]ined at each school, there was one adoption goal to the project as a [illegible] That goal was to have the computer-based curricula well enough established by the end of the project period so that these activities would continue after project funding and support ended. Thus, early and continuous post-project planning as an integral activity of the joint effort (including administrative, financial, and educational mechanisms) was established. It was hoped that these plans would insure that withdrawal of federal and HumRRO support would not result in deterioration of the educational programs that had been established in the project. This necessary planning function to effect a smooth turnkey transition from external to internal management and operation began at the start of the grant period. Informal memoranda were a continuing product of management meetings such that on an interactive basis, a self-sustaining coherent plan emerged. The HumRRO Principal Investigator and Director of Support met with the principals at a minimum of once a month (every two weeks for the first three months) and the Board of Directors met quarterly. HumRRO support personnel met with the teachers bi-weekly.

The production of the new plan was to be the primary responsibility of the principals with support provided by the HumRRO staff. HumRRO staff formulated the Draft Plan in early 1976. Detailed budgeting and final preparation of the New Coherent Plan was completed by the Board of Directors, and submission was made in April, 1976 to the Superintendent, Office of State Administration of the D.C. School System.

PRINCIPAL FINDINGS

A complete description of project findings can be found in Chapter V. The findings described below were extracted to provide the reader with a synopsis of the study's more important results, conclusions, and recommendations.

1. Number of users increased from approximately 780 in the first year to approximately 1500 in the second year.

2. Number of user schools increased from 4 to 12 in the second year.

3. The Superintendent agreed to provide continued support for the instructional computing program in the D.C. Public Schools:

- An account was established to pay for both computer and terminal maintenance.
- It was agreed that an instructional computing coordinator would be appointed out of the central D.C. School System offices.

4. St. Anselm's Abbey School established its own network with their extra ports while continuing to exchange programs and ideas with the other original SSPACE Schools.

5. The original SSPACE project teachers established, on their own, a popular training workshop for new, interested teachers. By the end of HumRRO participation in the project there was an increase to 38 participating teachers--or over 300% from the initial cadre in just two years.

6. Where data were obtained systematically, the results clearly show improvement in the quality of student achievement and attendance.

7. Despite the initial focus of the project on adoption rather than development, over 50% of the programs used in the second year alone were developed from scratch and 12% were modified by the SSPACE teachers. Teachers felt the need to tailor most materials to their pedagogy.

8. Release time was not sufficient for the teacher as an incentive to continue work.

9. As HumRRO relinquished authority, no management leader emerged within the project schools. This lack has resulted in the dormancy of post-project plans for instructional computing in the D.C. SSPACE Schools.

10. It was not feasible to develop during the project life a necessary basic skills package which could have benefited all schools in the district.

Recommendations: If instructional computing is to continue to help D.C. Public Schools:

1. A strong, politically aware person is needed to coordinate instructional computing in the D.C. Schools. Preferably, this individual should be an instructional person with computing literacy and with the authority of the Superintendent's Office behind him/her.

2. There is a need to establish some data recording standards, so that instructional effectiveness can easily be measured and programs improved.

3. A District-wide computing literacy program is needed if the value of instructional computing is to be perceived.

4. Remedial computer-based math and reading packages should be obtained or developed and made accessible to all elementary and secondary schools.

Discussion of the findings which led to these recommendations is found in Chapter IV of this report. This report is organized as follows:

I. Brief Historical Background of SSPACE

II. Support and Coordination Activities

III. Monitoring the Adoption Process

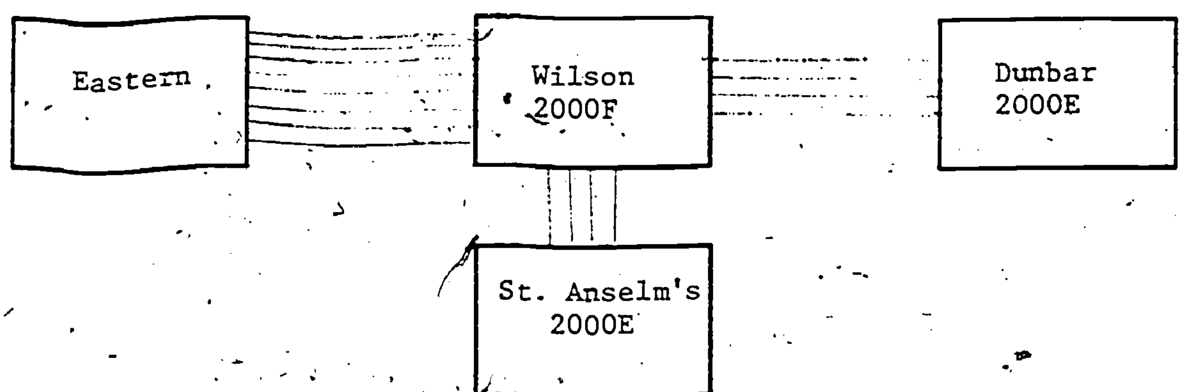
IV. Attendance and Achievement Data

V. Recommendations/Suggested Models

BRIEF HISTORICAL BACKGROUND OF SSPACE

COMPUTING EQUIPMENT

In July, 1974 the Human Resources Research Organization (HumRRO) was awarded a grant from the National Science Foundation to establish instructional computing in four District of Columbia schools. HumRRO's specific goals in this project were: (1) to assist in implementing instructional computing in the classroom and (2) to study the process of adopting computer-based materials. The project began with the purchase of two Hewlett-Packard (H-P) 2000E's and one 2000F time-sharing systems. Site preparation at each school (Wilson, Dunbar and Eastern High Schools, and St. Anselm's Abbey School) was completed by September and the systems were installed by October. The original network configuration among the four schools is shown below.



Each of the lines above represents a port reserved on the Wilson computer. The four schools received eight terminals each. The terminals at Wilson and Eastern were connected only to the 2000F at Wilson. Both Dunbar and St. Anselm's can tie into the Wilson computer on four of their terminals or can use all eight on their own 2000E. Each of the computers purchased has the capacity to be upgraded to include more ports and larger storage to accommodate an increase in users.

PROGRAM MANAGEMENT

Management of the project was initially assumed by HumRRO; overview responsibilities were assumed by the Board of Directors composed of participating schools' principals and the HumRRO Principal Investigator. HumRRO's approach to the project management was "turnkey." In practical terms, this means that the HumRRO personnel worked with the school system to set up procedures for dealing with instructional computing and eventually the school system itself would incorporate the changesto accommodate the innovative use of the computers by the end of the grant period. The turnkey procedure, ideally would be phased in as the project progressed. For the first year of the project, principal management was performed by HumRRO staff. HumRRO's management continued in the second year, despite efforts to have School System personnel take on major functions. The School System assumed some of the minor responsibilities such as computer maintenance. However, the long-range planning and establishing the computer program as a viable District of Columbia program continued to be handled by HumRRO. A complete discussion of HumRRO's roles is included in a later section of this report.

WORKSHOPS

In August, 1974, eleven teachers participated in a three-week workshop conducted by HumRRO. Teachers were introduced to the available instructional computer materials, techniques for evaluating their appropriateness to course objectives, and to the numerous methods employed in using the computer in the classroom. The teachers also received instruction in the BASIC computer programming language and learned how to operate the computers and teletypes. Following sampling of the computer materials available on the H-P computers, teachers selected programs for their use in the 1974-75 school year. In addition, some teachers created their own programs to fulfill the needs and desires of their students. In the opinion of the HumRRO staff, the teachers' abilities to program in BASIC and evaluate existing instructional computing materials were superior and continued to improve throughout the school year.

After a year of using programs which were not completely satisfactory, the teachers requested a second workshop which would focus primarily on development of new programs. HumRRO presented BASIC instruction daily and offered advice to the teachers in the development of their programs. During the three-week workshop in July, the teachers produced a staggering number of programs (99) to be used in the next school year.

In August, 1975, the three project teachers from Wilson High School conducted a two-week workshop for Wilson teachers interested in learning about instructional computing. Ten teachers new to the Project attended the workshop where they learned BASIC and were able to sample programs available on the computer. HumRRO assisted in the teaching of BASIC and in presenting an overview of instructional applications of computing.

Project teachers from Dunbar and Wilson conducted workshops at their schools during July and August, 1976. Seven interested teachers attended Wilson's workshop; Dunbar had ten teachers. The workshops included sampling of programs already developed, instruction in BASIC and experimentation of the Instructional Dialogue Facility (on the Wilson system). Teachers attending the workshops expressed desire to use the computer in the 1976-77 school year. Data on usage, of course, are not presently available. However, it is significant to note that the total number of participating teachers in the SSPACE Program increased over 300%, from eleven to 38, after only two years of its existence. As an indicator of success for the turnkey approach, it is even more important that this increased involvement of teachers was based largely on self-motivated initiative.

CLASSROOM COMPUTER USAGE -- 1974-1975

Introduction of the computer and computer-related curricular materials was started on a small scale during the 1974-75 school year. Most of the teachers in the program focused on computer usage in one of their classes, with other classes receiving briefer exposure. In some instances, students not assigned to a project teacher used the computer for drill and practice in basic mathematical operations.

The following table shows student computer involvement at the four SSPACE schools.

School	No. Teachers	No. Classes	No. Students
Wilson	3	11	246
Dunbar	3	12	310
Eastern	2	4	74
St. Anselm's	3	8	147
Total	11	35	777

Project teachers used computer-based materials in their classes in a number of different ways. The materials selected and the way they were used was a function of the teacher's personality and the type of class being taught. Several approaches taken by project teachers are outlined below.

1. Use Existing Programs. The teacher selected an existing program, frequently from the Huntington II or Hewlett-Packard library materials. The program was put on their system and used "as is" at the appropriate point in the course.

2. Modify Existing Programs. The teacher selected an existing program but found that it would not run properly on the system or he/she objected to the content of the program in some way. The program was modified to meet student needs.

3. Develop New Programs. The teacher surveyed existing programs to find ones that were appropriate for his/her class. If none was appropriate, the teacher wrote a new program.

When the project began it was expected that teacher use of computer-based materials would be primarily to use existing programs as is and to modify existing programs. What actually happened was the greater than half the programs teachers tried to use were their own. As Table 1 indicates, degree of usage of existing programs was highly variable across teachers. At a summer workshop held at Wilson (July 14 - August 1, 1975) nine of the project teachers developed a total of 99 programs for use in the coming year. A breakdown of classroom computer usage follows.

	1974-75	%	1975-76
Total Programs Used	217		
New Programs Developed	115	53	99 (as of 8/1/75)
Existing Programs Modified	26	12	
Existing Programs Used As Is	76	35	

Table 1.

Teacher	Course	Total Programs Used	New Programs Developed	Existing Programs Modified	Existing Programs Used As Is
Wilson HS					
Barwick	PSSC Physics	8	1	1	6
Clark	Algebra-Trig Intensive	14	14	0	0
Story	Chemistry I	30	3	13	14
Total		52	18	14	20
Dunbar HS					
Alexander	Intro to Office Machines	14	4	1	9
Kahng	First Half Elem Algebra	24	18	3	3
Sidewater	Applied Math	33	30	2	1
Total		71	52	6	13
Eastern HS					
Manning	Algebra 2	20	9	3	8
Street	Bookkeeping	6	6	0	0
Total		26	15	3	8
St. Anselm's					
Bergeron	Algebra 2	7	7	0	0
Fahy	American Literature	4	1	3	0
Henkels	Physics I	57	22	0	35
Total		68	30	3	35

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1975-76 SCHOOL YEAR

All of the original project teachers continued their computer usage in the second year of the project. Some of the teachers received the same classes to teach; some had new classes altogether. In addition, non-project teachers at each of the schools also became involved with the computer. St. Anselm's system expansion to six schools increased their computer usage. A joint effort between HumRRO and SSPACE produced a week-long computing literacy course for 10th graders at Wilson. The computer club at Wilson has over fifty student members who are interested in all sorts of computers and applications. HumRRO participated in teaching a course entitled "Applications of Computers in Learning" which was offered by the Educational Technology Department of Catholic University. Twenty-four teachers from eight schools in Washington enrolled in the class which utilized the Wilson computer facilities. Highlights of the teachers' course projects are presented in Chapter III.

Conservative estimates of computer usage indicate that approximately 900 students used the system this year during their classes.[1] This number does not include the schools on the St. Anselm's system, because estimates of usage are not available. Wilson had 410 users; Dunbar had 200; Eastern had 140; and St. Anselm's had 150. Wilson increased its number of users by 67% over the first year; Eastern by 89% and St. Anselm's continued at almost 100% student participation. Dunbar decreased its use by 35% during the second year. The reasons are not obvious, but the school was in a state of re-location to another site during this time. Also, there seemed to be a teacher morale problem concerning adequate release time.

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[1] We are sure that more teachers and students used the computer than we are aware of.

Programs were written and modified throughout the school year. Development efforts during the year yielded fifty-seven new programs in various subjects. Students at Dunbar have written quiz programs on their favorite subjects for other students to use. Many of the students who learned programming last year were invaluable in helping their teachers write materials for their classes.

RELEASE TIME

Because of provisions in the National Science Foundation grant, during the first year of the project participating teachers were relieved of one-fourth of their teaching duties. Teachers spent their release time in the computer room either creating or modifying programs or assisting students on the computer. In addition, many of the teachers opened the computer room for student use before and after school.

Release money also provided for other growth experiences for SSPACE teachers. Half of the teachers traveled to Philadelphia in October 1974, for a demonstration of programs being developed by teachers in the Philadelphia Public Schools. Three teachers attended the Association for Educational Data Systems (AEDS) Annual Meeting and a Hewlett-Packard Users Group meeting in April, 1975, in Virginia Beach. One of the teachers from Eastern traveled to Denver to see the Math Curriculum Project and she attended a conference on Computers and Math in Phoenix, Arizona.

Student assistants were also provided by the grant. Each teacher recruited one or two of his or her students who showed zeal for the computer. Responsibilities of student assistants varied among teachers; some students were on hand in the terminal rooms to help students sign on and off, access programs and write programs. Other assistants developed new programs in accordance with teacher-formulated specifications. At Wilson High School, the student assistants became so adept at programming that they actually operated the computer and wrote sophisticated programs for both students and teachers to use. Details of a student assistant questionnaire are in Chapter IV, Level 4.

During 1975-76 release time was not provided for most of the teachers because of staffing and budget problems in the D.C. School System. In addition, the teachers at Wilson had, in some cases, twice as many students as they had had the previous year. This resulted in a lack of planning time. We feel the lowered release time has been a major deterrent to the development of new programs during the year. It is HumRRO's contention that reallocation of teacher time for computer curriculum development is a critical factor in the successful implementation of such an innovative educational technology. Further discussion of our findings is presented later in this report.

HUMRRO'S ROLES

Monitoring the Adoption Process

In addition to HumRRO support personnel who were responsible for the project management, a HumRRO study team was responsible for studying the adoption of computer-based materials throughout the National Science Foundation grant period. The HumRRO plan for monitoring adoption is multi-leveled. We feel that comprehensive understanding of the adoption process is possible only through monitoring of the innovative project as it touches and is influenced by relevant parts of the entire school system. The monitoring, therefore, extends from the Superintendent's office down to the individual teacher and his or her students. To permit systematic examination we divided our study into the following areas:

Level 1: System Environment. This level examines the school system and the relations of project principals, teachers and students to the entire D.C. School System.

Level 2: Project Environment. In this level the communication networks of all project personnel (including HumRRO and the hardware vendors) are examined.

Level 3: Curriculum Environment. This level focuses on the teachers and the implementation of the materials into their curricula.

Level 4: Learning Activities. The student's achievement, attitude towards, and use of, the computer materials is examined in this level.

Experience in using the four-level approach has shown that the levels are not completely independent. However, conceptually this method of examination provides comprehensive coverage of the factors which affect or potentially affect the student's use of computers in a class. For future formative evaluation purposes in similar projects, this approach also yields a pragmatic assignment of most activities and events relative to the various levels. Chapter IV contains measures and instruments from all four levels.

Included in our four-level approach is a set of assumptions we formulated at the onset of the project which we hoped would highlight project activities. In this report we list the assumptions and describe what transpired to either confirm or negate the assumptions.

HYPOTHESES

As mentioned earlier in this chapter, HumRRO initiated the SSPACE Project with some fundamental hypotheses about the adoption process and how it would progress throughout the grant period. These are listed below. Later in the report the discussion will be expanded to include our modified hypotheses as the project progressed.

Level 1: System Environment

A fundamental philosophy of HumRRO in this grant was that project management would be turnkey. That is, HumRRO would help to establish basic relationships and procedures which would later be assumed by members of the school system (from the school board to the students). We visualized a gradual process which was to take place over the course of the project in a systematic manner. This process would insure continuity of the program so that it would become a natural part of the school system curriculum. Some functions we recognized as being more easily incorporated with the existing school system structure. Other project issues would require extensive prior negotiations, explanations and the cooperation of project participants with school system representatives. Specific items considered were:

1. Increased direct communication between teachers at different project schools would be necessary to facilitate the process of adoption.

2. Private and public schools would be linked together, sharing resources and keeping one another informed of any problems encountered and progress made within the respective school systems.

3. At the end of the grant period, the two school systems would assume overall management and fiscal responsibility for those portions of the SSPACE Program accountable to their respective sectors, public and private. Examples of fiscal responsibilities are: computer and terminal maintenance, release time, if any, related computer supplies.

4. School Board awareness and involvement would be attained by the end of the grant..

5. An open-ended question was whether or not and in what form the "electronic school system" established between public and private school systems by SSPACE would continue.

6. The SSPACE Program would naturally expand to include community members.

Level 2: Project Environment

Initial hypotheses held at the project level included the following.

1. Each school entered the project with different goals and methods of computer usage. The differing computing environments will demand unique management schemes and schedules to be responsive to the unique needs of teachers and students.

2. The hardware and software vendors would be sensitive to the unique needs of the varied educational environments in which they placed their products.

3. Student assistants, trained early in the project, could provide the day-to-day support required for terminal operations.

Level 3: Curriculum Environment.

The background premises for this level are below, followed by specific hypotheses.

1. A major premise in this level was that the project teachers would have different backgrounds and educational philosophies.

2. Their implementations of the computer into the curricula would probably be different from one another's and would reflect their backgrounds and philosophies.

3. Despite individual teacher differences, the teachers would have goals in common and would work together to achieve their goals. Specific hypotheses follow.

(a) Teacher computing expertise, training and attitudes will affect computer usage and its effectiveness.

(b) HumRRO would be a resource for teacher selection of computer materials and suggest data items for collection.

(c) As teacher confidence with programming grows, a teacher will be less satisfied with existing packages and will want to develop his/her own instructional applications.

(d) Teacher computing attitudes will affect student attitudes.

(e) While integrating computer usage into their classes, teachers would add new course objectives dealing with the computer.

Level 4: Learning Activities

Assumptions about student learning activities are below.

1. Computer usage will affect student opinion of the class.

2. Student motivation to learn is increased through involvement with computer-based learning materials (CBLM).

3. Intensity and variety of computer use will increase with successful student achievement.

Chapter II

SUPPORT AND COORDINATION ACTIVITIES

BOARD OF DIRECTORS

The function of the Board of Directors of the SSPACE Program is to provide overall guidance and determine project policy. Some of their concerns this past year have been relationship to the school board, to the local community, and project expansion. Originally, the Board was chaired by Maurice Jackson, Co-principal Investigator of the Program. The other members included the principals of the other three schools, Dr. Seidel, and two nationally known experts in educational computing (see Figure 1).

First Year
Board of Directors

Maurice Jackson (Chairperson)

William Saunders
Phyllis Beckwith
Father Michael Hall
Robert Seidel
Thomas Dwyer
Sylvia Charp

Figure 1

It became apparent that the consultants from outside Washington had served the purpose of initial motivation. They had neither the time nor the interest to attend meetings; thus, they could not regularly provide continuing valuable guidance to the project. Consistent with a goal of the project, to expand to involve the community, it was decided to replace these experts with community members who could work more closely with the project and enjoy the benefits of its success. Harold Belcher, a parent and computer scientist, and William Spaulding, city council member and chairman of its education committee, were chosen to serve one-year terms (see Figure 2).

Second Year
Board of Directors

William Saunders (Chairperson)

Phyllis Bechwith
Father Michael Hall
Gloria Adams
Dorothy Brown
Robert Seidel
Olivia Parker
Harold Belcher
William Spaulding
Vincent Story
David Sidewater
Nancy Colodny

Figure 2

The above shift to a local focus was accompanied during the project's second year by unfortunate changes in key personnel. Chairmanship of the Board was transferred to William Saunders, Principal of Eastern when Maurice Jackson went on leave for one year. William Saunders was soon promoted to a regional assistant superintendency, but continued to participate and provide direction to this Board. This instability of Board leadership was harmful in that it was more difficult for HumRRO to ease out of the directional role and give responsibility for the project to the school system personnel. An additional significant factor contributing to instability during the second year was the promotion of Mr. Vincent Reed to Superintendent of the D.C. School System. Mr. Reed, as Assistant Superintendent of the State Office, had shepherded the SSPACE Program in dealings with the fiscal and managerial arms of the school system during the first year. Under his guidance, the then Superintendent, Dr. Barbara Sizemore, became a SSPACE ally and authorized System funds to pay for computer maintenance during the second year of the program. The rapport between Mr.Reed, Mr. Jackson and Mr. Saunders was an important force to the success of SSPACE.

To compensate for the personnel fluctuations, during the second year of the program additional D.C. School System personnel were invited to attend Board meetings. Our hopes were that their presence and interest would stimulate the school system to make more immediate and positive decisions concerning the future of the project. This strategy was only partially successful since attendance of system personnel was sporadic. Other than HumRRO personnel, a "natural" chairman for the Board did not emerge during the second year. Two project teachers became members of the Board during the second year of the project, and their experience and knowledge provided valuable input for decisions. Student participation on the Board was suggested and a decision will be made in late 1976.

Although the Board meetings provided one of several links among all four schools, the meetings, at least during the second year, primarily involved public school business, e.g., submission of a budget, expansion, equipment purchase. St. Anselm's eatablished a private school network and was concerned with different issues. This network is discussed in the following section. The private schools do have a community representative, Nancy Colodny, on the Board for the coming year.

It is currently planned that the Board of Directors will continue to function after the end of the grant period. HumRRO organized a meeting in September 1976. At that time, all responsibility was turned over to the school system, although HumRRO personnel continued as ex-officio members of the Board throughout the 1976-77 school year.

USERS AND SYSTEM DESCRIPTION

During the second year of the project, eight additional schools became users of SSPACE resources. McKinley and Ballou, public secondary schools, began to access the Wilson system. This was possible without any modifications to the Wilson system. Neither St. Anselm's nor Dunbar fully utilized their ports on Wilson, preferring to use their own computers.

St. Anselm's, like Dunbar, had the capability to expand from 8 to 16 users by adding only data sets to their computers. After approval from the National Science Foundation, St. Anselm's with their extra ports was able to service on a cost-recoverable basis to additional private and parochial schools. They thus created another network. Six schools, Georgetown Day, Field, Maret, Visitation, Sidwell Friends and McNamara joined the network during the second year. Five additional customers are tied in for the 1976-77 school year. The St. Anselm's teachers manage the entire network, providing both technical and educational support to the other schools. After 14 months of internal discussion in the D.C. School System central office, the Wilson system was finally upgraded in September 1976, to run a more sophisticated operating system, the 2000 Access System, and to quadruple its storage space for instructional applications.

System Usage

Usage of the computers increased during the second year of the project. The following table describes the second year level of activity.

School	No. Teachers	No. Classes	No. Students
Wilson	5	12	410
Dunbar	4	10	200
Eastern	3	7	140
St. Anselm's	3	10	150
Total	15	39	900

No specific usage figures are available for the six schools in St. Anselm's network or for McKinley or Ballou, but estimates show that total usage of the three computer systems involved approximately 1500 students. Thus, the projection of increased student use made in the first Annual Report to the National Science Foundation seemed to be reached (p. 4 of Annual Report, September 30, 1975).

POST-PROJECT PLANS AND COORDINATION

A primary focus for the Board of Directors throught the second year was to plan for the time when HumRRO would no longer be responsible for the project and the School System would manage all functions. To prepare for this, the School System was requested to create a project account and provide the funds for telephones, maintenance of the computer systems and new equipment orders (National Science Foundation continued to provide funds for the maintenance of terminals) after the first year. This occurred, but the process was slower than originally anticipated and resulted in significant changes in planning. The Board submitted to the D.C. Schools a written plan for the third year of the project, a job description for a project coordinator and a budget. It was informally approved by the school system and we were assured that someone, most likely a current project teacher, would be detailed to the system to manage the project. Presently, no action has been taken. Individual schools, therefore, have been forced to make arrangements for the management and operation of their computer programs. For example, Dr. Vincent Story has been released for 80% of his time during the 1976-77 school year to manage the Wilson system. His time will be available to other schools for a fee. Dunbar High School has set aside a special fund for supplies in the event the budget is never formally approved at the system level. Dunbar has also hired a teacher who has an extensive background in instructional computing to develop a computer science curriculum. In addition, Dunbar is changing its educational philosophy to fit the open school environment of its new building and, therefore, its management plan for computer usage. Although we assume that the verbal assurances from the central office will materialize, the delays are potentially detrimental to the momentum and expansion of the project. We hope that the Board of Directors will continue to take an active role in spurring action from the System after the grant period.

St. Anselm's has continually demonstrated the desire and ability not only to manage a large network but to support it financially. We predict that their system will continue to grow and flourish in the future and that they will continue to lessen the ties to the Wilson computer system to become an independent network.

Various ideas for project expansion have been explored during the second year. These include evening programs offering remedial reading and high school equivalency under the Adult Education Department, elementary school participation, and using computer-assisted instruction for handicapped populations. Although no decisions have been made, these ideas are still being pursued. Discussions continue to be held with appropriate personnel in the Superintendent's office and at the various schools.

STAFF DEVELOPMENT COURSES

In the fall of 1975 the project teachers stated that an incentive was needed for additional teachers in their schools to become involved with computing. They suggested that a course offering graduate credit would provide such an incentive. Dr. Stuart Milner, a professor in the Educational Technology Department at Catholic University, offered a course that he could easily tailor for teachers using the SSPACE computers. Initially, the staff development department of the D.C. Public Schools was planning to provide tuition for teachers, but this proposal was tabled until the next fiscal year. The final arrangement was for teachers to pay half, with the SSPACE Project paying the remainder. Teachers from non-project schools were required to pay full tuition. Twenty-three teachers from eight schools enrolled in the course which met weekly at Wilson High School. Each teacher received 3 graduate credits for completing the course. Distribution of teachers by schools is as follows:

School	No. of Teachers
Dunbar	7
Wilson	4
Georgetown Day	4
Holton Arms	2
McKinley	2
Eastern	2
Anacostia	1
Gordon Jr. High	1

The course touched on many aspects of instructional computing, but concentrated on BASIC programming and developing programs or modifications of existing programs for use in the classroom. Many of the final projects were of excellent quality and will be used throughout the SSPACE Project next year. The range of projects included chemistry, consumer games, satellite tracking for orbital mechanics, surveying, stock market simulations, energy relationships in biology, matricies, geometry theorems, a career information system, a library retrieval system, programs for identifying the parts of speech and using them in sentences, and management applications for physical education teachers. Copies of the programs and documentation may be obtained through HumRRO.

During the second year HumRRO personnel provided mini-courses in computing literacy for eighth graders at Eaton and Hardy elementary schools, and for two sophomore English classes at Wilson High School. Outlines of these courses are available to project teachers on request. The topics covered included introductions to computer hardware, programming in BASIC, and using a computer terminal to play computer games, sampling existing courseware, and writing simple programs.

TRIPS

In addition to the individual trips described in the Case Studies section, the teachers traveled as a group to Philadelphia to visit Dr. Sylvia Charp, study the curricula she and her staff have developed and get a closer look at the management of a large public school project. The trip was disappointing because the project in Philadelphia was not willing to give their courseware without charge to teachers outside their system.

HumRRO support personnel also attended several Hewlett-Packard Users Group meetings and a NAUCAL Conference to exchange ideas ans search for curricular materials for the SSPACE teachers. They also visited the TIES project in Minnesota.

MEETINGS

In addition to the quarterly Board of Directors meetings, the HumRRO staff also met regularly with the principals and the project teachers. The purposes of the monthly teachers' meetings were to review new programming techniques, starting curricular materials and experiences using them, air problems and discuss their solutions, coordinate project activities among schools, and gather evolution data. The principals meetings concentrated on project management problems such as teacher release time, computer room security, scheduling, and the future of the project, as well as data collection. At times the teachers and principals met as a group to improve intra-school as well as project communications.

HumRRO staff and other participants have also met throughout the project's second year personnel in the D.C. Public School State Office for the purpose of insuring the smooth transfer of the SSPACE program responsibility to the Central System.

HumRRO organized occasional meetings with project personnel and vendors to iron out maintenance problems. Briefings were held each year for the Superintendent of the D.C. Schools. Meetings were also held with other branches of the school system (e.g., special education, career development, and adult education) to discuss the possibilities of expanding the project into these areas.

SITE PREPARATION

Preparation of the schools for installation of the computer systems was done during the summer of 1974. Major construction work, electrical wiring and air conditioning were necessary at both Wilson and Dunbar to insure security of the computers and provide separate environments for students to work. Site preparation at the other two schools was minimal. It was necessary to hire outside contractors for this work rather than relying on D.C. School System personnel.

WORKSHOPS

One of HumRRO's major support roles in this project was to train the school system personnel to use computer-based curricular materials, and manage the operation of the computer systems themselves. Initially, three teachers from each of the schools (except Eastern) were selected for this responsibility. HumRRO organized an initial workshop in the summer of 1974 (see Chapter II, Workshops) for teachers, with selected sessions for principals as well. In addition to instruction by HumRRO personnel, several experts were invited to conduct sessions in this workshop. Two teacher/developers from the

Huntington II Project spent three days instructing the teachers how to use, modify and implement the Huntington simulations in the classroom. Dr. Thomas Dwyer and one of his teachers provided instruction on BASIC programming and Hewlett-Packard provided instructors to teach their computer-assisted instruction (CAI) authoring system (IDF) and an introduction to the math drill-and-practice curriculum and its associated management system.

Follow-up workshops were conducted at each school by Hewlett-Packard on the operation of the computers. These took place in September and October as soon as each computer was installed and operational.

During the summer of 1975 the teachers requested a workshop which focused on the development of new curricula and advanced programming in BASIC. HumRRO personnel provided direction and instruction throughout this workshop. An experienced user of the Hewlett-Packard CAI authoring system also worked with the teachers for several days. Student "experts" were available to answer programming questions and operate the computer.

After these workshops the teachers were able to organize training for other interested faculty in their schools. The HumRRO staff provided guidance and some instruction for these sessions. Similar to the other workshops funds were provided (from release time money) to pay the teachers an honorarium for attending. These workshops are described in Chapter II. In addition, the teachers at Eastern are planning a workshop for English teachers for early 1977 using the programs developed at St. Anselm's in spelling, vocabulary, parts of speech and grammar.

Chapter III

MONITORING THE ADOPTION PROCESS

THE HUMAN ELEMENT IN THE ADOPTION PROCESS

In our previous work on the adoption of computer-based learning materials in education, we discovered that quite clearly the most significant element in whether or not materials innovations are (a) adopted, (b) implemented and (c) incorporated into the warp and woof of the fabric of any educational system depended clearly upon key personneland organizational mechanisms. In our DC SSPACE Project we attempted to aid the process by continually meeting with the administrators and teachers in order to heighten their awareness of the various needs related to adoption. In addition, we met with the DC School System personnel on a periodic basis. In the latter case, we established rapport with the associate superintendent for State Programs in the District of Columbia. The complex interplay of personalities and levels within the school system was heightened by the inclusion of a private parochial school as one of the four test sites for the SSPACE Program. (The key personnel at the start of the SSPACE program were two of the high school principals. The public school principal was politically adept and knowledgeable concerning the ways to overcome resistances and accomplish purposes of the project within the administrative structure of the school system. He was also extremely influential with the associate superintendent for state programs. Through his personality many doors were opened to gain support for the program at the district level.

Secondly, the Headmaster of the private school also was a driving force in the project and, together with the public school principal noted above, was able to influence our sponsor concerning the motivation of the participants.

In addition, he served as a catalyst for motivating the remaining principals and the teachers within his own school.

The associate superintendent for state programs was also extremely interested in the use of the computer as a means for upgrading the educational status of the students within the inner city. It was because of his rapport with the public school principal noted above that we were able to influence the then superintendent of the school system to set aside monies for maintenance of the computers when the time came for the DC public schools to take over responsibility for the hardware in our project. During the first year of the project, these personal relationships were extremely important in the accomplishment of adoption and commitment on the part of the administration of the DC public school system. Unfortunately, one driving force was removed immediately upon award of the grant. The private school Headmaster was given a new assignment. What this did was to bring in a new administrator who, while he was interested in the project, nevertheless did not have the same commitment of being an architect for the initiation of the program. He also had a personality which perhaps did not blend as well with the other highly motivated principal. During the second year of the project, the second motivating force was lost when the public school principal, who was one of the architects of the program, left on sabbatical and was not available for the duration of the second year. Finally, the third complication which was an irony occurred. This was the promotion of the previous associate superintendent of state programs to the position of superintendent of the DC school system. We say "ironic" because while the potential power of the new superintendent increased the likelihood of influence for the program within the school system, the new superintendent now had a much broader set of programs, projects, and responsibilities over which he had to preside. This, therefore, made it more difficult for him to give as much time and attention as he might have liked to to the DC SSPACE Program.

These three occurrences placed much more of a burden on the HumRRO staff to continue responsibilities at a time when the turnkey nature of the project demanded that the school system personnel themselves begin to undertake an increasing amount of responsibility and authority for the continuance of the program.

The results of these occurrences are difficult to document specifically. However, it was clear to us that a number of items which could have made the routinization of CBLM innovation into the high schools were hindered. For example, no one really pushed for continued release time for the participating teachers in the project. Perhaps even more important, no one seemed to fathom the bureaucratic morass of the DC public school system with the result that the previously agreed-upon account for maintenance of the computer and subsequently for the student terminals took some 18 months to see the light of day through the DC bureaucracy. With the continued difficulties in the public school portion of the program, it became increasingly apparent that the private parochial participating school had needs unique to its own existence and not in common with the public schools. Finally, towards the end of the project the parochical school's Headmaster saw fit to decline participation in the project Board of Directors meetings. The parochial school went out on its own successfully. It sold time on its computer and to this day has a very viable albeit self-contained network of participating schools. The public schools, on the other hand, never did manage to take sufficient initiative to generate a proposal for presentation before the School Board in order to maintain continuance and commitment of the computer-based instructional project as part of the school system's overall program. HumRRO, therefore, drafted a proposal which was then modified by the project Board of Directors and sent through the school system central accounting. Originally, this proposal preparation was to have been done by the project participants with the HumRRO staff acting as advisors.

One of the significant features for success as we perceive it during the course of the project was the appointment of Director of Instructional Computing by the DC public school system. This was proposed by HumRRO in the draft proposal, but was not acted upon officially at the time that the HumRRO participation ceased at the end of the project (1 December 1976). It was promised by the school superintendent at a meeting in his office on November 24, 1976, that such an appointment would take place. At our last review of the situation, such an appointment was not yet in existence.

An extremely important feature to the successful adoption of CBLM is the recognition by the local administrator personnel (i.e., principals and assistant principals) that the cadre of teachers who are handling both the development of new materials and the training of additional teachers require sufficient release time from their other duties so that the added responsibilities involving the use of the computer are not perceived as added on requirements to their regular duties. The CBLM requirements must be made a normal part of the teaching day. This means perforce a release time equivalence to the preparations and conduct of computer-based learning materials in the teaching process. Moreover, the teachers should be given incentives to participate in the adoption of the new program. Real release time is one meaningful incentive. Others should be explored actively. All of these items were found to contribute tothe difficulty in and lack of promise for the continuance of the DC SSPACE program as an active viable incorporated part of the DC school system following HumRRO's withdrawal.

A major approach to monitoring the adoption process involved the use of a transactional evaluation technique. We have found that this technique is particularly applicable in our experience concerning the uses of computers in education. Repeatedly we have found that the problems in successful implementation of computer-based learning has depended upon the human elements involved in any project, rather than the technical problems of coding of instructional materials, providing sophisticated hardware, etc., etc. The technique is particularly useful as an evaluative aid when the decision-making environment within which a program is introduced may be perceived as requiring radical alterations, such as the purchase of computers, impact upon department structure when individualized instruction using the computer takes place, scheduling of students on the terminals, housing of the terminals, mundane problems, etc.

Transactional Evaluation (T.E.) is a technique to foster a formal, explicit set of relationships of roles, problems, and possible solutions amongst project members and between the project team and the implementing environmental users. Because T.E. obtains its data from participant opinions having potentially highly charged emotions, it is essential that the technique be applied by an independent evaluation team. Since opinions are solicited through active discussion, it generally is not feasible to use in groups of more than 20-30 participants.

Transactional Evaluation gives a snapshot of what has happened in a project to date in that it shows the state of the human system at a point in time. A collection of these "snapshots" provides an overview related to human issues in implementing a program. In this sense, the result of T.E. could be called a summative evaluation of the project system. On the other hand, in dealing with the perceptions of the various project members and others, one can also focus on the means by which problems can be overcome and solutions evolved for improving the relationships and disambiguating the lack of clarity amongst the persons in terms of the way in which the program is to be used or the way in which the people are to relate to one another using the program. Then to this extent we could consider T.E. a form of formative evaluation. (For details of T.E. procedures, see Seidel, 1978.)

Analysis of the adoption process per se started with application of T.E. in August, 1974, at the Teacher Training Sessions. It included the playing of roles (e.g., administrators, parents, teachers and students) by each of the designated participants, and obtaining statements concerning the perceived goals by each person, as well as potential problems in meeting these goals and potential solutions for overcoming the problems. With the aid of this questionnaire we were able to focus on anticipated difficulties in the adoption process.

The teacher attitude data were obtained four times last school year: August, January, April and May. A fifth questionnaire was administered on the last day of the teacher workshop at Wilson High School (August 1, 1975). The results show that as the year progressed teachers became less concerned about scheduling students and involving the community in computer activities and other teachers in the project. The teachers became more concerned with implementation of computer-based instruction to complement existing curricular materials in January and April than they had been a year ago (August 1974). In May the desirability of achieving widespread computing literacy by implementing computer science in all subjects lessened considerably from August and January. The teachers also had renewed interest in involving new teachers and having a project newsletter in May.

The most recent transactional evaluation asked the teachers to list their major <u>accomplishments</u> and <u>disappointments</u> in the project to date and their expectations for the project in the coming year. We changed the words and satisfactorily counteracted a growing dissatisfaction with repeated T.E. administrations.

The major accomplishments agreed upon by most of the teachers had to do with computing literacy for themselves and their students and with this literacy, thus an appreciation for the curricular advantages of using the computer to enhance their teaching.

The disappointments are similar to problems revealed in the previous transactional administration. The most interesting finding is that the disappointments over the past year were principally confined to problems at each of the schools, rather than overall problems or disappointments in the project. For example, there were a number of arguments at one of the project schools amongst the teachers and this was reflected in one of the statements submitted where two of the project teachers agreed with that problem of petty arguments, two were neutral and the remainder disagreed with that statement. A major area of disappointment which was almost unanimous (7 out of 9 teachers responded) related to equipment failures (not unusual in a new system implementation). No one expressed any disappointments concerning the project structure. We infer that the organizational arrangements across schools public and private, and with the cooperation of the administration, seem to work out rather well. Earlier worries about commitment from principals, and release time faded. Apparently the organizational arrangements took hold and the interrelationships of the personnel on the project became extremely favorable.

Transactional Evaluation was used with the participating Principals as well. Initial concerns of the Principals similarly related to familiarization with both the equipment and with the position of the project within the schools. The data from the Principals also reflected a shift away from original concerns about implementation to other concerns now with post-project planning for integration of the project within the school system.

Chapter IV

ATTENDANCE AND ACHIEVEMENT DATA IN SSPACE-RELATED CLASSES

It has been the intention of the SSPACE Program from the outset to go beyond the measurement of what is by now a generally accepted enthusiasm on the part of the users of computer-based curricular materials in various school settings. The onus is on the technology to show the value in such meaningful terms as achievement, motivation, attendance or other methods of improvement at the level of the student in order that computer usage may be justified in any school setting. While our data are not completely analyzed as of this date, we do have sufficient indications that the goals of increased motivation, achievement and gain in productivity are, in fact, being attained.

The overall attendance data have been analyzed from the three public schools as follows. We compared, within classes, the absenteeism of the 1973-74 academic year with that of the current academic year with the participating teachers in the SSPACE Program. Our initial anlayses were confined to the participating teachers as opposed to examining an effect of all teachers who may have participated but were not originally assigned to the project. Even though the latter data would have been useful, the most important analysis at the outset is the examination of the effects that the addition of the computer materials had in the same course of instruction given by our participating teachers.

Following the collection of absenteeism figures, we calculated the cost to the DC School System per day, per student. (This figures is $8.43.) We computed the average numberof days of increased attendance between last year and his year for the student population (N = 630) within the

SSPACE Program. We interpret this increase in attendance as a cost productivity gain and relate it to the value of using the computer in the classroom. Multiplying the figure for each school times \$8.43 and summing across schools, we obtain a net productivity gain of \$30,790.07. (See the table below.)

Woodrow Wilson
+ 2.29 x \$8.43 x 246 = \$ 4,748.96
Dunbar
+ 12.71 x \$8.43 x 310 = \$ 33,215.04
Eastern
- 11.5 x \$8.43 x 74 = \$ -7,173.93

Cost Productivity Gains
($\bar{x}$ Attendance Gain x \$8.43 x No. students/school)

The interpretation of this dollar figure as an increase in productivity is based on the fact that the daily cost per student exists whether the student is in school on a given day or not. Therefore, any increase made in the attendance of a student in a classroom results in an increase in the productivity of the dollars allotted by the School System.

In the SSPACE Program we may infer that with the use of the computer-based materials, the increased productivity of our participating students was approximately \$30,790.

Obviously, increasing the attendance of the students does not guarantee an increase in their learning. But, at the very least, this does say that the students were motivated to stay in school, a factor resulting in the use of the taxpayer's dollar in the pursuit of the goals for which the money was intended.

Before moving to a discussion of the achievement data, it would be worthwhile to extrapolate for a moment from the existing findings as to what kind of productivity gain would be possible were we to make full use of the current equipment configuration in the SSPACE Program. To begin, as many as 1500 students could be served by the current computer configurations at Dunbar and Woodrow Wilson High Schools. If we were to assume that the same kind of a gain could be achieved with the 1500 students as has been achieved with the 630 students to date, we could easily, on a conservative basis, double the amount of productivity shown in the current year. Thus, $60,000 would be an estimated projected cost Productivity Gain within the same configuration. If we were to carry this further and estimate the possible gain for the total number of students in all the secondary public schools in the District of Columbia (on approximately 24,000 students), we could conservatively project a Productivity Gain on the order of $1 million. It is also possible to speculate further on the projected gain for the entire District of Columbia School System if computers were to be used at all levels and not just that of the high schools. It would be foolish at this point to go that far. Needless to say, the projected Productivity Gain would be in millions of dollars.

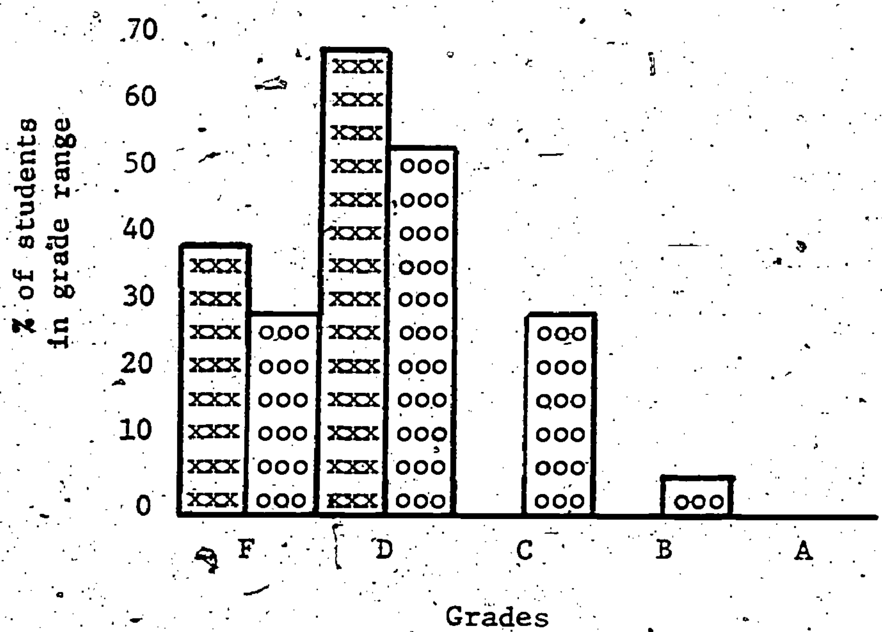
We recognize clearly that there are some potential novelty effects and that there are limitations based upon the fact that we have volunteer teachers involved in our project. Nevertheless, the data that we have gathered to date do illustrate what could be gained given a coherent approach to incorporating computer-based learning materials in the curricula of the D.C. School System. This required—as has been noted in our project proposal—consideration of the attitudes and motivations of all the participants within such a program, including the principals, teachers, students and the various D.C. system administrators. If the use of the computer is introduced in a very systematic way with the participation of all concerned, it clearly can cause a substantial gain in motivation and the potential for learning among the students.

In practical terms, it is reasoned, therefore, that the Productivity Gain yielded by use of the computer in the SSPACE Program in and of itself is greater than, and would therefore pay for, the maintenance costs for the equipment on an annual basis.

The other data to be reported in this section illustrate that the related achievement also has improved and shows the worth of using the computer in the classroom. Evaluation of achievements with the use of the computer as an augmentation to instruction is incomplete. However, a complete analysis is available from one of the project teacher's courses at Dunbar High School. Other data will be subjected to similar analyses and will be reported in due course. These results are extremely useful to illustrate the manner in which we are analyzing our achievement data and what can be accomplished given a very careful integration of computer materials in the classroom.

The instructor in question teaches applied consumer math and has written approximately 15 computer programs in BASIC for use of his students. The programs include such topics as estimation of percentages, the solving of proportions, and remedial subtraction and addition. Programs were also organized around topics such as the use of credit and the types of problems consumers might encounter in everyday use of mathematics. Therefore, it has extremely practical value for high school students. This use of the computer in the curricula of the SSPACE Program classes has been chosen as our example because it presents a unique opportunity for interpreting the value of computer-based curricular materials. In this course, the subject matter (e.g., use of credit and consumer procedures) is self-paced; normally, without computer involvement. Therefore, students are accustomed to finishing sections at different times, with the more accomplished students receiving additional materials with which to work. In the current instance, the students moved from the Credit Section to the next section of the course as they successfully completed their unit test. Those students who successfully finished the unit test first formed a group of 14 students who did not have any computer-aided materials. The teacher noted the areas of difficulties which these students had experienced and wrote computer programs to enable practice problems to be used for those students still to finish that section. Thus, the next group of students who finished had computer problems with which they could supplement this work as they went through the Credit unit. The students who had the computer-aided supplementary problems did significantly better on the unit test for Credit materials than did those who had no computer experience. This may not be too surprising in view of the fact that the students having the computer problems had extra practice. However, what is unique is the fact that the cumulative grade-point average of the students who had the computer practice was much, much lower than that of the students who did not have the computer as an aid to their study during the Credit unit. As might be expected from other educational research and practical experience, the faster students generally had a history of better achievement. However, in this instance, the students with the better history of achievement were surpassed by the students who had a deficiency of achievement. This was accomplished simply by adding computer practice problems to the repertoire of the Credit unit. The same finding held in the unit on Consumer Procedures; that is, the students with a deficient history of achievement more than compensated for this when given the opportunity to practice more problems by using the computer during their study of the unit.

Stated in another way, the value of the computer to this curriculum was that it not only eliminated the previously held advantage of the so-called better students, it in fact enabled the so-called poorer students to do better on tests related to the unit where the computer was involved. The finding takes on even more significance if we note that no students in the computer-aided group had a cumulative grade average greater than D. Twenty-five percent of the non-computer group had a cumulative grade average of C or better. The figure below summarizes averages for these two groups.



xxx = computer group
ooo = non-computer group

Thus, given a proper integration of computer-based materials into a curriculum, it can indeed aid the poorer student to do much better than the previous history of his/her grades would indicate. Taken together, the data analysed from the first year's efforts in the SSPACE Program illustrate that, given an integrated coherent approach to incorporating computers into the curricula of a secondary school within the D.C. system, motivation can be enhanced to the point of increased productivity or, stated another way, a better return on the taxpayer's investment per-student-day in school. And, secondly, the preliminary achievement data confirm that not only is motivation increased by the student, but that the so-called poorer student can benefit markedly from the use of the computer in the classroom.

During the last year of the project, responsibility for data collection and continuing implementation of the computer in the curricula was turned over to the schools. HumRRO concentrated on advisory services, helping with workshops, changing the character of the SSPACE Board, overseeing hardware maintenance, and attempting to gain commitments for continuity through the central offices of the D.C. Public School System. This resulted in very little meaningful data recording by the teachers. The materials that follow were the only usable second-year data.

Analysis of Test Data in an Accounting Class

Elizabeth Street of Eastern High School developed six programs for students in her accounting classes. The programs drill students on their knowledge of accounting terms used in the text. Usage of the programs (ACCT1,3,4,5,7) was optional (ACCT2 was required).

Test scores for students taking the optional programs prior to the test were significantly higher than those of the students who did not use the program (see Table 1).

We also looked at the relationship between use of the computer (number of programs taken), attendance, and grades within the course (see Table 2). All six programs were part of the first advisory period, so the first comparison was made using grades at the end of that section of the course. A strong relationship (r_{xy} = .758) was found between number of programs taken and grade in this advisory period. Another factor influencing grade is number of days absent from class (r_{yz} = -.646)--the greater the number of absences, the lower the grade. However, by partialling out (or taking into account) this factor, there still remains a strong relationship between use of the computer and grade ($r_{xy \cdot z}$ = .62). This partial correlation indicates how much of a relationship there is between grade and number of programs taken, if the rate of absenteeism was held constant.

Even though the accounting programs were used only during the first section of the course, we examined the relationship between their use and grade in the course. The same analysis was performed relating number of programs used, grade, and absenteeism. As can be seen in Table 2, the strong relationship between grade and computer use was slightly attenuated (r = .658), but its significance diminished with abseenteeism accounted for (r = .50).

Table I.

Program	N Taking Program (Test)	Mean Test Score	S.D.	N Not Taking Program	Mean Test Score	S.D.	Mean Difference Test (t)
ACCT1	22	93.55	6.201	8	69.75	25.28	2.63 $p<.05$
ACCT2	40	83.25	14.212				
ACCT3	17	86.29	17.705	23	48.87	19.037	6.4 $p<.01$
ACCT4	20	90.5	12.763	15	73.33	20.412	2.87 $p<.01$
ACCT5	20	89.7	7.505	17	62.24	18.298	5.79 $p<.01$
ACCT7	18	94.22	8.026	12	79.67	21.06	2.29 $p<.05$

First Advisory Period (n=43)

$r_{yz} = \underline{.758}$

$r_{xz} = \underline{.573}$

$r_{yz} = -\underline{.646}$

$r_{xy \cdot z} = \underline{.62}$

$r_{yz \cdot x} = -\underline{.42}$

Course (n=37)

$r_{xf} = \underline{.657}$

$r_{xa} = \underline{.575}$

$r_{fa} = -\underline{.546}$

$r_{xf \cdot a} = \underline{.50}$

$r_{fa \cdot x} = -\underline{.30}$

x = number of programs taken

y = grade in first advisory period

z = number of days absent in first advisory period

f = final grade in course

a = number of days absent in course

Table 2. Correlational Analysis

Chapter V

RECOMMENDATIONS/SUGGESTED MODELS

The SSPACE Program began operation on the four premises listed below. Our recommendations for undertaking a program such as SSPACE will be grouped under these four premises.

1. Computing literacy is important to our citizens because of the pervasive applications and uses of computers in our science, business, government, industrial production and financial activities and institutions.

Participants of the SSPACE program firmly believe that computing literacy should become an integral part of a school system's instructional program. To have a successful literacy program it is necessary for the school system to support computing literacy by providing funds for a coordinator to oversee and schedule literacy instruction. A slot in the curriculum must be arranged so all students can be scheduled for some exposure to the computer. In addition to the school system's support of SSPACE, involvement of the Board of Directors and the community in formulating a total literacy program is advantageous.

We feel that computing literacy can be implemented in a variety of ways. Our suggestions follow.

- For a more cost/effective use of the computers, they should be available 24 hours a day. The security problems of the schools would have to be investigated for this to happen. However, 24 hour/day computer usage could make programs available for the entire community. Both remedial programs (math, GED, reading) and computer literacy could be taught as well as conventional BASIC programming. The project coordinator could schedule all courses so that back-ups, long waiting lines or underusage could be avoided.

- Junior high students could be scheduled for computing literacy courses so that they would be ready for instructional computer usage in their later school years. These courses could be taught by the coordinator or other students. For instance, the computer clubs at the high school could have as one of their activities teaching literacy as one of their major functions. This would ease the time pressure on teachers to teach students besides the ones in their classes. In addition, the coordinator could organize and teach workshops for new and interested teachers, therefore, relieving current project teachers of this responsibility

- Computing literacy does not have to consist of a one-time exposure. It is reasonable to have a semester (or trimester) long computing literacy course for which credit would be given. This course could meet once a week or more often, depending on computer availability.

- Community members literate in the uses of the computer could teach literacy on a voluntary basis. The project coordinator could schedule the volunteers' times for classes.

2. Actual instructional use of computers in our public schools has been extremely limited, due to a number of obstacles to innovation and adoption of computers into the curriculum.

Recognizing the obstacles to computer usage is the first step in devising a plan for instructional computing in a school system. To avoid problems encountered by other schools, HumRRO focused its efforts on extensive teacher training. This could only have been accomplished because teachers were given release time and teachers were willing to receive training during their summer vacations. Only during the summers do teachers have the time and energy to devote to spreading computer use to other teachers and in using the computer enough to feel competent about using it in their classes. Obstacles to integration of instructional computing in the curricula as experienced by SSPACE are discussed below.

Release time in the first year of the project provided the time for teachers to both work on their own and work with HumRRO and other SSPACE teachers. During the second year, teacher quotas and larger class enrollments eliminated release time for most SSPACE teachers. This made computer implementation difficult. The lack of release time in the school structures contributed to other difficulties. For example, SSPACE teachers were not as successful in spreading computer use to other teachers as they had hoped to be. In addition, scheduling use of the computer room was an enormous problem when time was limited.

We feel that another obstacle to computer usage is the lack of recognition of teacher efforts in computing. Some solutions to this problem are: graduate credit for computer training, pay incentives, staff development credit, and special awards. The SSPACE teachers should be applauded for their perserverence and creativity in instructional computing. They should feel that their efforts have contributed positively to the entire school system.

Often in the project, administrators at the schools did not get involved enough to fully understand the problems facing the project. For instance, having the computers directly in the schools requires additional teacher time for effective management. The operations required of the teachers need to be appreciated by admonistrators and integrated into their daily schedules.

SSPACE teachers have had to deal with the frustration of equipment being inaccessible--often for long periods of time. Sometimes the equipment could not be used right when a teacher planned extensive usage. Alternative lesson plans had to be developed quickly to handle this problem. Maintaining student enthusiasm at these times is often difficult if not impossible. There is nothing more disheartening to a student than being promised computer time and then not being able to come through on the promise.

Some of the schools develop-d what we call a "computer bum syndrome." Certain students tended to "hog" the computer and students who were not as pushy or as literate with computers were not able to use them as often as they wished. This problem, we feel, stems from a lack of scheduling and management of the computer rooms. Our teachers just were spread too thin to be able to completely handle all problems which occurred.

3. The prerequisite, low-cost computer hardware, software, terminal devices, instructional methods, and instructional materials are now well developed and commercially available.

Early in the project the SSPACE teachers discovered that the existing "canned" programs were not readily applicable to their courses. The reasons for this are that programs have been developed for use with texts and topics not used by SSPACE teachers and programs exist for a different caliber student than the SSPACE student. Therefore, much more materials development was carr--d out than was originally planned. In addition, many of the programs which were in the Hewlett-Packard system libraries have been modified by the teachers. Developmental and modification efforts (by our teachers) were a major activity and consumed a large portion of both their release time (if they had any) and their personal time.

We feel that regardless of the computer hardware, software, and terminals chosen that any computer system will have limitations. Modifications of some sort will have to be made (whether it is to the software or the modes of implementation). To assume that any system will offer all of the features desired by all of the teachers using it is naive. Teachers, administrators, and students will have to learn to accept the limitations or features that they did not anticipate.

It should be recognized by both teachers and primcipals that implementing any computer program, whether it already exists or is developed in-house is a time-consuming activity. Time should be allocated in the implementation plan for full familiarity with the materials and modifications if deemed necessary. Inherent limitations of the system chosen should be highlighted so that alternatives can be developed or investigated.

There are many factors to consider in choosing an instructional computing system. Besides costs, the expansion possibilities, maintenance packages, initial technical and educational support and the amount of commitment to instructional computing by a vendor should be considered.

The educational support provided by vendors is a factor not to be dismissed lightly. Naive usere require explanations of possible applications of programs in the curriculum. We feel that the type of support needed for effective computer usage is missing from most vendors. HumRRO personnel found it necessary to discuss program usage at length on numerous occasions and to follow-up on our discussions with the teachers. It is necessary to have an individual responsive to these needs on a full-time basis especially in the early stages of implementation.

4. Adoption of computers into the curriculum of the secondary school is a complex process involving many more changes than simply learning technical skills and changing a lesson plan; rather the many kinds of factors involved include administrative, financial, attitudinal, social, political, and organizational factors.

Our study of SSPACE computer usage focused on all of the factors mentioned above. Some of the more important factors we found in establishing computing are discussed below.

Frequent communication among the schools and teachers in the project was an absolute necessity. The mechanisms employed for keeping one another informed of our activities were meetings and a newsletter. Minutes of every meeting held were compiled and distributed to all SSPACE participants. The newsletter was begun primarily to keep track of all of the materials development undertaken. Because of the communication routes developed it was possible for SSPACE teachers to cooperate in the development, debugging and testing of new materials. Cooperation was established between the provate and public school as well. In effect, the teachers at the various schools served as nodes in a network which spanned the entire city.

Despite the laudable efforts of the SSPACE schools to manage their own systems, there were many times when the HumRRO staff found it difficult to discover who was in charge of operation of the project. We feel that the power of SSPACE participants within the school system was too dispersed at times to be effective. The program needed a coordinator with a budget and power at the central level. While HumRRO was still involved in SSPACE, the central system saw no necessity to put someone in charge. A coordinator is necessary for the supervision of the instructional computing curriculum and management of the various maintenance contracts required for th- equipment. We cannot stress the importance of establishing and renewing maintenance contracts on a timely basis. Without firm commitments to keeping contractual relationships with the vendors, the systems cannot be utilized to their full potentials.

Teacher and administrator training are very important factors in the adoption of computers. School systems must be willing to allow teachers release time to prepare for the computer and in the selection/development of computer materials. We are greatly pleased that our efforts to convince the schools o- this have resulted in one teacher's 80% release time for computing activities. At the same time, it should be recognized that student time is often given willingly without the enticement of pay. Students should not be overlooked in planning the scheduling and teaching of computing. The 24 hour availability of the computers is another resource which is built into the existing computer systems.

Teachers often accuse computers of being impersonal and dehumanizing. Because of this negative bias inherent in the naive user, it is of utmost importance to obtain a clear idea of the pedagogy/teaching philosophy of every teacher involved with the computer. The teachers invariably use the computers with different goals in mind. These goals should be solicited ahead of time in writing so that teacher training time can be responsive to teacher needs and desires. Goals should be solicited throughout the training periods to ensure that training continues to be effective.

Safeguards should be employed to avoid building up the expectations and hopes of all participants before the systems are completely debugged and run smoothly. Our teachers experienced undue frustrations and disappointments when trying to implement their plans in the midst of hardware and software instability. The need for instituting changes in plans when schedules are not adhered to should be stressed. Time for crashes and other minor setbacks should be figured into schedules and accepted as an integral part of using computers.