PROJECT HEADLIGHT: A Study on Growing Up in a Computer Rich World

Excerpts from Seymour Papert's Original Proposal to IBM December 7, 1984

1. Introduction

The author of this proposal has been engaged for many years in the task of developing methodologies for the use of computers to enhance learning. Some of these methods are being used today in numerous schools and homes. One of them, the educational language Logo, is being sold as a product by IBM. Others are incorporated as parts of larger wholes in IBM products.

These educational products in the market are a spin-off from our fundamental approach to rethinking the theory and practice of education for a technologically rich society. Not everything we have made is being used. Many of the methods we have been, and still are, developing, are designed for conditions that do not exist in most contemporary schools: they assume a learning environment in which computers are a "freely available resource" much as pencils and paper are today, and they assume that the computer presence has been thoroughly integrated into the culture of that learning environment. The last condition means not only that teachers and students possess what is nowadays know as "computer literacy," but something fuller than this—a genuine computer culture, which includes, beyond knowledge *about* computers, sufficient *fluency with computers* (and with ideas of computation) to use them as a medium to think about other things—about poetry as well as mathematics, and about one's self image as well as about the outside world.

To illustrate the idea of computer culture let me give a personal example. This morning when I sat down at my PC to work at this proposal, my head was still reverberating with a poem I had read last night. Wondering if I could recall it, I found my fingers typing phrases from it on the screen. Soon I made a little discovery, and wondered why it had never occurred to me before. A word processor is an excellent medium for reconstructing a poem from partial memories: put down the fragments you do remember, see how they fit together, see how one fragment stimulates the recall of an extra word or two to complete another, move them around, see how they fit better. Of course, like almost anything one does with a computer, this process is not something entirely "new under the sun." I have often done something similar "in my head," and occasionally with pencil and paper. But, again like many of the best things one does with a computer, the new context gave it a new vividness, a new concreteness.

When the reconstruction process is done with pencil and paper, it is too rigid, too static, too messy with corrections and overwriting. When it is done in the head it is too fluid, one loses the fragments too easily. With the computer, I had a wonderful sense of effectiveness of the process. After a while I had recovered the poem. At the same time I recovered a sense of myself as a "rememberer of poems." I deepened my insight into what it was like, and felt that an ability I have sometimes feared to be slipping with age was still there. In my excitement I forgot for a while about my paper and explored further the possibilities of a PC as a medium for playing with poetry. Soon, I had made yet another discovery. I could use the computer as a medium to represent and play with many aspects of the poem, prosody, patterns of stress and pause and intonation in saying it aloud, and its semantic or syntactic structure. Again, people have done all this with marks on paper, but I can only begin to say here how much more fluid and expressive and easy to work with the computer turned out to be. After struggling with prosody for a while, I found I could recite the poem with a new sense of ease, understanding and even professionalism (imaging myself to be Laurence Olivier!).

Then, suddenly I realized: I had been "hacking poetry" for more hours than I could really afford to take off from working on my proposal to IBM! And so yet another computer phenomenon had crept into my personal incident: the computer's famous holding power which keeps computer people up all night and which, according to critics of computers, "rots their minds." In my case, it improved my mind, improved my understanding of poetry, and even led to some new ideas about the kind of computer system (hardware as well as software) that would make for much better uses of word-processing as an exploratory learning tool. I even think it can be used to help acquire the kind of discipline I eventually used, as you see, to get back to writing the proposal.

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I chose to illustrate an aspect of what I mean by computer culture by using an example drawn from the experience of an adult, myself, in the hope that other adults, the readers of this proposal, might relate to it more directly and more seriously than they would to examples from the lives of children. But what is illustrated is similar to phenomena we have seen in the few experiments in which a genuine computer culture has been able to grow in a school community. The conditions are not often encountered. What happened to me this morning required that I have *plenty of time with the computer*. It is hard to imagine anything of this kind happening if my access to the machine had been for an hour a week at a scheduled time and place. It also required that I had "appropriated" the computer: I was not using it in the way I had been told to use it but rather had become sufficiently fluent with it to use it in an exploratory mode. And it required that I had a certain mindset: for example, it seemed natural to me to use the computer to understand myself better. But when these rare conditions are present children do have similar experiences. They do make discoveries. They do use the computer to achieve a better mastery of tasks they have found difficult and to achieve a better understanding of the learning process itself. Many such incidents are described in the literature on Logo—here we mention briefly two examples of a slightly different kind, where the shared computer culture of teacher and student enhances the teacher's ability to introduce a new idea.

> **Example 1.** Logo experience provides many analogies for traditional mathematical ideas: thus the idea of a variable, which is traditionally introduced via the image of a box containing a number, is made more real when the teacher can talk about how it is like and unlike the mathematically related idea of input into Logo. (Of course, this does not prelude using the old kind of analogy as well. The computer culture should be an enrichment of the traditional culture not a substitute for it.)
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> **Example 2.** When children in a science class at the Computer School in New York learned that a temperature-sensing device could be attached to one of their computers, they proposed a project to find out how cold their gerbils were at night, thereby giving the teacher the opportunity to introduce a variety of ideas, including ideas about graphs and variables and ideas about applying the experimental method to a question that was quite real and personal to the students.

A high density of computers and a high level of computer culture may be rare today, but they will be commonplace in a very near future. This proposal describes a project designed to prepare for that future by simulating, as far as one can in the present, the kinds of learning environments we can expect to see very soon in homes and in schools. It simulates that future by working in schools with a very high density of computers, by occasionally introducing prototypes of computers with capacities ahead of present day standards and by working very hard at raising the computer culture of all participants.

We call it "Project Headlight," to mark the fact that it is intended to illuminate the road ahead as we advance into a rapidly changing future where the presence of computers could lead to much more thorough-going change in education than anything being seen in schools today.

2. Summary of Some Differences Between Project Headlight and Other Research on Technology and Education

Almost all contemporary work on computers in schools is "incremental" in that it studies the effects of introducing computers as an add-on to an otherwise essentially unchanged learning environment. Project Headlight is focused on bigger changes of a sort that will be made possible by falling prices, technological advances and more knowledge. There include a reconceptualized curriculum as well as new instructional methodologies.

Project Headlight is particularly focused on the "high-density" uses of computers. One of its goals is to understand and demonstrate what can be done in situations where the ratio of computers to children is one-to-one or even two-to-one (with one at school and one at home). To appreciate the concept of high density of computers, consider how we take for granted that there has to be a "high-density" of writing instruments. A school in which there was one pencil per classroom would have nothing in common with what happens when every child has a writing instrument. One computer in a classroom may well be better than none, but has little in common with the situation of a computer for every child. In our learning environments computers should be as freely available as crayons now are in the lives of children.

In order to understand fully the very many ways a high density computer presence can enter into the learning process and, more generally, into the life of the learning environment, Project Headlight is committed to the need for a multiplicity of observations. Where most studies focus on one type of observation, such as test scores, or look superficially at a variety such as simple measures of social interactions in classes, number of hours of use of the computer, etc., Project headlight will deploy experts in cognitive and in personality psychology, in ethnography, in psychometrics and, of course, in educational testing to put together varied, in-depth profile of students and of the cultures of their classrooms and homes.

Project Headlight brings to bear three special kinds of expertise which we can confidently assert are not found together in any other contemporary research environment on computers and education:

1) *Theoretical Expertise:* Over the past fifteen years we have developed systems that have "made it out of the door" and into schools, but the uniqueness of these systems is not their worldly success but their foundation on the slow development of a theoretical perspective based on ideas drawn from Piaget, from Artificial Intelligence, from psychoanalysis and from cultural anthropology.

2) *Technological Expertise:* A unique technological context is provided by the MIT Media Laboratory in which educational researchers are in contact with the most advanced technologies.

3) *Expertise in Observation and Evaluation:* Our team members (e.g., Sherry Turkle, Sylvia Weir, Andy diSessa, and myself from MIT as well as Larry Kohlberg from Harvard, and Ted Chittenden of the Educational Testing Service) have each made contribution to the problem of how to observe and understand children's responses to computers in their learning environment. This team of professors together with our team of Ph.D. and Masters students and other visiting researchers, take a holistic approach to education and its sum of separate effects on how

arithmetic is learned, how writing is learned, how social development occurs and how a particular investigator's notion of cognitive growth takes place. We must look at the development of the entire child, the whole personality, and we must look beyond the individual child at the development of the school and even of the relations in the family as well as in the school. To do this it is essential to mobilize a variety of sensibilities: no one person can be sensitive to all the aspects we need to see. Moreover we have not allowed ourselves to be constrained by the values or methods of any one school of thought: behaviorist, or Piagetian or Freudian for example. Instead, we turn the diversity of points of view about education to advantage and bring in observers of different theoretical persuasions in the hope that each will be specially sensitive to special aspects of what might happen. Similarly we insist on having observers of different cultural backgrounds: black and white, artist and scientist, avant-garde and conservative.

3. Some Reasons for Doing This Kind of Research

The evolution of the "computer future" should not be determined by the nature of the technology per se. We must not ask where the computer will take us, or what effects it will have. We must ask where *we* will take the computer, how *we* can shape the computer future. But shaping the computer future in a rational and socially responsible way requires us to see where we are headed, and to be in a position to experiment with alternative techniques before standards of how to use computers become entrenched.

Project Headlight, described herein, is an attempt to simulate the future sufficiently well to illuminate the road ahead. Or, more precisely, since the future cannot actually be simulated, it sets out to create a "test bed" where educational ideas can be developed and tested ahead of their time. Project Headlight will enable us to sharpen ideas about techniques of teaching and learning in a high-density computer culture; it will allow us to experiment with new kinds of technology; and it will guide us in the invention and development of an educational environment of the future. It will also allow us to face a social obligation: an instrument capable of powerfully enhancing human development must be assumed to be capable of damaging it as well. Project Headlight can be an early warning system to alert us to potential dangers in certain uses of the computer for particular individuals.

During the first few years of the "age of the microcomputer," most public comment on computers in education had a euphoric tone. In particular, the press was almost unanimous in presenting the relation between computers and children in a positive light. The infatuation with the "Computer as News" was so unrealistic, that, of course, there was the inevitable disappointment—we note today a tendency to speak of the computer's "failure to live up to its promise." Such backlash obviously has commercial consequences. It also has a potentially profound effect on the field of computers in education. The most obvious is that it may induce a more conservative stance in schools. A more subtle effect is the influence negative attitudes towards computers may have on the learning process itself.

Finally, we mention the equity issue: we fear that the backlash may be used to justify withholding computers from those social classes in most need of educational improvements. Project Headlight is an important counteraction, because (1) it will be conducted in an inner-city school, and (2) it will show a use of computers which will be disappointing to no one. Many uses of the computer in schools show the computer at its weakest, thus engendering disappointment and negative attitudes. Project Headlight will show the computer at its greatest strength.

4. Design and Implementation of Project Headlight

4.1. General Design Goals

The ultimate goal of Project Headlight is to design and implement a learning environment in which a cohort of children from ages 5 or 6 through 10 or 11 can learn in ways more like the experiences we can expect these children's children to have than the ones their parents—and the vast majority of today's children—have had to live through.

By the early nineteen nineties, the computer presence will have reached a level where it will have a dramatic impact on the assumptions underlying today's education, on the opportunity to introduce new educational methods and on the need to improve education. Children will come to school with knowledge, attitudes and sophistications they never had before. And at the other end, the intellectual, emotional, and social needs of the information society will be different from anything we have imagined in the past. It will no longer seem like a possibility to use computers to implement the standard curriculum, an option that many researchers are content to use today.

To plan for that future, there is only one responsible strategy. We must understand as deeply as possible how computers can affect the development of children and use this understanding to rethink the entire educational process. A first step in this direction is to rethink the strategies for educational research. The fact that no one really knows how computers will affect children in the future is not due to a lack of people trying to observe children with computers. Indeed, hundreds of educators and psychologists are mounting experiments, but, to my mind, they are mounting the wrong experiments: *They are trying to understand the effect of tomorrow's computer presence by observing the effect of today's computers under today's conditions.*

Project Headlight proposes to remedy this situation by creating a true "School of the Future," one in which everything will be rethought and, if necessary, redesigned: the curriculum, the methodologies of learning, the social structure. This is an awesome task. One could hardly contemplate doing it in the few years remaining before the future we wish to anticipate will already be on us. However, we do not have to start from scratch. What we propose now is largely pulling together elements that have been built up over the years.

4.2. Foundations in Work Already Accomplished

We have built an exceptional team of people; we are privileged to be able to work in an exceptional technological environment (the MIT Media Laboratory); and the ground has slowly and securely been prepared by the development of systems, technologies and methodologies as is seen from the following brief historical sketch.

The period from the mid-sixties through 1978 was a laboratory phase funded mostly be Federal grants totaling about two million dollars. The central part of our work was the development of computer systems (of which Logo is one together with a variety of "microworlds" and new concepts of integrated software systems for children) and pedagogical methods. Work with children was in small groups, typically four children at a time, under the direct control of MIT researchers from the AI Lab.

In 1979 we began limited experiments in schools, experiments in natural settings where we could guide and observe the growth of a "computer culture" outside of the laboratory in a "natural" school environment. For example, we placed fifty computers in one primary school (Lamplighter in Dallas) where they were mainly used by fewer than three hundred children in grades one through four. At the same time, we continued working on the development of software and pedagogical methods. An important achievement in the period was the development of new, much more varied, observational techniques.

We are now in a third phase and moving close to readiness for the goal of establishing the Experimental School of the Future. The new element of the third stage is building a network of collaborating projects, each of which has taken as its own concern a subset of the many facets of building a totally new learning environment. *The strategy is one of divide and conquer: first develop and debug components of the whole in relative isolation and then work at putting them together.*

The principal members of our network are the following projects:

• The Boston Schools/MIT Project in Boston is a high-density experiment at the fifth-grade level with student to computer ratios at different sites varying between one to one and ten to one. (In order to understand the effects of different densities, all other things being as far as possible the same.) In addition, our MIT team is conducting kindergarten and first grade work in the Boston schools. This project is an MIT research effort operated in collaboration with the Boston Public Schools. The emphasis is on pursuing the following ideas: high density classroom at elementary school level in an inner city environment; initiation of teachers with no computer background into a "computer culture," study in a pre-school setting of acquisition of the written language. The project was set up using a one-time donation of $135,000 and 50 computers.

• The New York Computer School is an "alternative school" in the New York public school system (District 3, which includes West Harlem). Although it has no administrative relationship to MIT it has a close intellectual relationship. The concept grew out of work under the leadership of the author at the New York Academy of Sciences (the author trained several of the teachers, is chairman of the school's research committee, spends two days a month at the school, etc.). The school is adopting ideas in science education developed by Andrea diSessa of MIT, who also meets from time to time with teachers from the school. The emphasis is on the following ideas: development of a "computer consciousness" in a school designated as a "computer school"; integration of computational ideas with standard junior high school curriculum material; development of a small staff of teachers as a community dedicated to educational innovation through computers. This project is supported by the school District 3, by a grant of $360,000 by the NSF to the Institute for Schools for the Future.

• The St. Paul Public School System is deeply involved in an implementation of a system-wide computer plan modified from the New York experience. Here there is a special emphasis on how a slow movement toward a very high-density computer plan acts as a catalyst of change in the school system as a whole. The St. Paul project is particularly concerned with the relationship of parents to the introduction of computers into the schools. This project is supported by a very heavy commitment from the city of St. Paul and from local businessmen.

In summary, we have followed a strategy of building up a "family circle" of pilot projects. These projects are all exceedingly valuable educational enterprises in their own right. They are in no sense subordinated to the purposes of Project Headlight and still less are they dominated by it administratively. Nevertheless, taken together, they have made a contribution to Headlight that would otherwise have cost so much that it would have been strangled by the administrative effort of creating it!

We do not see putting these projects together as merely adding parts to get a whole. For example, our network includes one project working with pre-school children, another working with elementary school children, and a third with junior high-school children. We have good reason to suppose that when children of all these ages are together in one project, where they can interact—phenomena will occur analogous to putting together subcritical masses of plutonium. We are sure we shall see much more than the sum of the parts! For example, the computer lends itself so marvelously better than any traditional school work to children learning from one another that the presence of second graders can be an enormously developmental stimulus for fifth graders, and the presence of fifth graders a source of role models as well as of information for children of all younger ages.

It is our intention to propose to IBM to create in collaboration such a total, computer-rich environment, and to study the development of children in it over a period of five years. In this document we make a more modest proposal which has the goals listed on the next pages.

4.3. Goals for the Next 18 Months

- To advance the family of pilot projects mentioned above.
- To pull together lessons that have been or can be learned from the pilot projects, and to translate these into recommendations for the development of future software and hardware. These lessons bear on such issues as differences in response to computers and in need for special materials related to gender, social background, personality and other psychological and social variables. They also bear on issues of acceptability of computers in schools and in homes by varied cross-sections of the population including some who have up to now been resistant to the personal computer.
- In particular, to isolate from the experience to date prototype software, pedagogic materials and test materials that can be developed into projects for general dissemination into present day school settings as well as for use in the experimental "School of the Future."
- Finally, and perhaps most important, to cooperate with IBM in developing a detailed design for a School of the Future. The design process will be treated as an exercise of value in its own right independently of whether the plan leads to a longer term collaboration between Project Headlight and IBM.

4.4. Categories of Work

The work proposed here falls into six categories:

1) *School Based Work.* Enhancement of on-going projects in certain schools in New York City and in Boston. These are projects in which children already have relatively large degrees of access to computers. (In some classrooms we have placed a computer for every child). These projects (for which we have proposed the name "high-density computer studies"), are already yielding richer information about learning with computers than is obtainable from schools where the density of computers is much lower. In a second year of operation we would extend the integration of the computers into the entire learning process; improve the mechanized collection of data; increase the number of children; introduce a larger number of IBM computers.

2) *Pre-school Work.* Establishing a new computer based nursery school environment. (In our opinion doing this alone would justify the cost of this whole project).

3) *Conceptual and Team-building Work.* An important component of our preparatory work consists of developing methodologies for observation of children with computers and of establishing relationships with individuals and organizations of the highest competence in the relevant human sciences. Our MIT base and our intellectual relationships are allowing us to interest some of the best minds from psychology or ethnography in the study of the effects of computers on children's development. The list of collaborators at the end of this document indicates progress in this direction. But much more progress can be made.

4) *Software Development.* The project would not be possible if it could not draw on advanced software projects at MIT and elsewhere. Developing the necessary software independently would have required not only a very much larger budget but also a virtually impossible job of recruiting collaborators. As it is we have only the relatively minor task of adapting software which may have been developed for slightly different purposes. But although relatively minor, this is a task that requires time and person-power.

5) *Test of New Hardware Ideas.* Some advanced peripherals are being placed in the schools. These include new sensing devices, some new uses of speech and some new "robot toys" and other toys.

6) *Study of Several Aspects of Computer Learning.* Some of the aspects we are interested in exploring are listed below.

Community and Culture: A central aspect of the project is the relationship with the community and with the home. Project Headlight cannot remain within the walls of a school. It must involve parents, families, social clubs, community organizations, etc. in its network.

We have designed some of the pilot studies so as to obtain a preliminary experience with this aspect. In the Quincy school in Boston, we have a fourth-grade class with a computer per child and with enough computers in reserve for each child to take one home as well. It is part of the experimental design that the home phase will begin only when the children are sufficiently proficient to act as experts when they do bring the machines into the family. Also in Boston, we are working with community centers in an attempt to integrate computers into anti-illiteracy campaigns and other community work. In one case the literacy work is in the same building as a day care center for very young children, thus giving us the opportunity to move slowly towards integration of these two aspects of the computer presence in the community.

Curriculum and Content: We do not feel that it is necessary to add here to what we have written in other places. In summary the idea is to implement a "curriculum" in the spirit of the ideas discussed in *Mindstorms,* and elaborated in numerous papers by the author and others from the MIT Logo group. Our record shows our commitment to a curriculum that will be different in methodology but inclusive of all the goals of public schools.

Development of Psychological and Educational Test Instruments: A specific early product of the collaboration with psychologists and ethnographers will be prototype psychological instruments to assess responses to computer based learning environments.

Observational Studies: The point of the project is to observe what happens and it is only by doing this that the test instruments can be developed. What we mean by "observation" certainly includes carrying out the functions called "evaluation" and "observation" in school parlance; but it requires that we go very much further. When a school "evaluates" a new mathematics curriculum it is usually concerned with a specific question: do the students learn math? So are we. But we are interested in very much more: Is this student, as a unique human being, changing in this unprecedented environment? In what ways? What changes? And further, we are interested in what the institution called school might become in the unprecedented presence of powerful tools for learning. We might even say we are interested in what the culture will become...

Note on Complexity of Observational Study Component: The task is large. In our approach to it we are making every effort to draw on all possible techniques for the study of people, and this in turn means that we have to draw a diverse group of specialists into the process.. We consider the following set of special sensibilities quite minimal:

- Several varieties of standard school evaluation studies.
- Studies of personality development.
- Ethnographic studies of the school, the community and the family.
- Piagetian studies of structural aspects of intellectual development.
- Freudian/Eriksonian studies of the growth of the individual psyche.
- Studies on gender and ethnic patterns.

• Studies of institutional change especially in educational contexts.

Most of these perspectives are represented in one or another of our "family circle" of pilot studies. Our team of researchers is composed of people with diverse specialties and sensitivity to the issues presented in this proposal. For example: *Ted Chittenden* of the Educational Testing Service (ETS) is working closely with the New York Computer School on case studies of young readers. *Sherry Turkle* in her book *The Second Self* brought an ethnographic and a psychoanalytic perspective to the study of several of our family of high-density computer projects. She reports in the book also on some aspects of gender and ethnicity. *Sylvia Weir* is engaged in a study of individual differences in intellectual style in Logo learning contexts. We are also working with *Larry Kohlberg* and his students (one of whom will be basing a Ph.D. thesis on our Quincy School project.) We have a solid tradition of collaboration with the Piagetian school in Geneva and are negotiating to bring one of the best young members of their team, *Edith Ackermann,* to MIT on a permanent basis. Another member of the Geneva team, *Andre Bodar,* is already committed to be at MIT for the crucial formative year on a visiting basis. *Andrea Green,* professor of art education at the University of Quebec, did her Ph.D. thesis some years ago at MIT under the direction of the author. She is very conversant with our ideas and methods, has remained in close touch and will participate at least as an advisor in the project.