LOGO IN MAINSTREAM SCHOOLS

THE STRUGGLE OVER THE SOUL OF AN EDUCATIONAL INNOVATION

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ABSTRACT

Technologies do not follow some predetermined and inevitable course from their context of production to their context of use, and technologies used in schools are no exception. Rather, technologies and their use in the classroom are socially contextualised. They are often appropriated in ways unanticipated by their developers, locking into institutional arrangements and reflecting elements of the prevailing social relations in and around the particular context(s) of application. Through the discussion of a particular technology (the Logo programming language) as a case study in educational innovation, this article demonstrates how the use of technologies in schools is *socially shaped*. The paper looks into the place that Logo occupied within the institutional and organisational cultures of US and UK mainstream schools after its introduction in the early 1980s. It discusses the ways in which Logo was received in the educational arena and was implicated in the politics of educational innovation at a time of conservative restoration.

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1. INTRODUCTION

Technologies do not follow some predetermined and inevitable course from their context of production to their context of use, and technologies used in schools are no exception. Rather, technologies are inserted in a context where they remain both the object and subject of struggles over meaning; a particular technology is not so much "implemented" in schools as "re-created", not so much "reproduced" as "produced". Technologies are often appropriated in ways unanticipated by their designers, locking into institutional arrangements and reflecting elements of the prevailing social relations in and around the particular context(s) of application.

Through the discussion of the Logo programming language as a case-study in educational innovation, this paper demonstrates that technologies and their use in the classroom are socially contextualised and indeed *socially shaped* [1]. The paper looks into the place that Logo has occupied within the institutional and organisational cultures of US and UK mainstream schools since the early 1980s. It discusses the ways in which Logo was received in the educational arena and was implicated in the politics of educational innovation at a time of conservative restoration. It illustrates how Logo was "read" and appropriated differently by different social groups and individuals in pursuit of their goals in their day-to-day experience of schooling, yet largely within the constraints imposed by the broader social and political context.

The main body of the empirical data informing this study was gathered through semi-structured interviews with the original developers of Logo on a study trip to the USA in 1995. In addition, a number of key-players in the evolution of Logo in the US context (and internationally at a later stage) were interviewed. Data was also collected by classroom observation, discussion with teachers

and pupils, analysis of videotaped classroom activity with Logo and analysis of classroom talk about work with Logo in UK classrooms in 1995 and 1996. In addition, semi-structured interviews were conducted with a number of people who were significantly involved in the evolution of Logo in the UK and internationally (some of them former or active teachers in UK schools at the time of the interviews).

2. WHAT IS LOGO?

Logo is the name for a philosophy of education and for a continually evolving family of computer languages that aid its realisation (Abelson, 1980:1). Specifically designed for and dedicated to education, Logo was initially developed during the post-Sputnik era of reforms in US education as an alternative to the prevailing technocentric and behaviourist notions of computer-aided instruction of the time. The first version of Logo was developed in 1966 by Seymour Papert, Daniel Bobrow and Wallace Feurzeig at the Educational Technologies Laboratory of *Bolt, Beranek & Newman* (BBN), a R&D company in Cambridge, Massachusetts.

The new language (which has thereafter been extensively modified) was originally designed as an interactive tool for constructivist learning. In the mind of its initial developers, Logo was much more than a procedural programming language for the teaching of mathematics. It was the material embodiment of a radical educational philosophy which had been developing alongside (and sometimes in tension with) the technological artefact itself. Logo was seen as a potential vehicle for the transformation of education. Wallace Feurzeig, the leader of Logo's initial development team at BBN, remembers:

We had the hope that this would be transformational... we were interested not only in mathematics... And the hope was that this was going to really revolutionise education. It was a very different view about what computers and programming and kids were all about from what people were doing with other technologies like CAI or with BASIC... The hope was that Logo would really get kids to think in a more fundamental way about thinking in all kinds of contexts, to become strategic thinkers, to become more involved in designing and building knowledge (Feurzeig, interview).

This view of Logo as a potential vehicle for an educational revolution was shared by all those involved in its initial development, yet to different extents. Evidence suggests that there was no

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complete consensus within the early Logo team as to what the language should be applied to and as to the position of the language in relation to the curriculum and existing school structures. Two main tendencies developed within the team; in this paper we will call them *reformers* and *revolutionaries* respectively.

2.1. THE APPROACH OF THE REFORMERS

Some members of the early Logo team wanted Logo to be used throughout the curriculum from elementary school through college and graduate school to augment courses, to provide new kinds of experiences, to enable students to engage in many different areas as opposed to simply studying about them. From this perspective, Logo was seen as an appropriate interactive tool to help children do formal thinking very early, but within the existing school reality. George Lukas, a young doctoral researcher at that time and member of the early Logo team who subsequently became professor of Computer Science at the University of Massachusetts Boston, recalls:

We were interested in augmenting the curriculum at lots of different levels...as opposed to the idea that Logo was a revolutionary new idea which would be the centre of the curriculum (Lukas, interview).

For the reformers, therefore, a necessary condition for the success of innovative Logo activities was the development of an appropriate "Logo culture" among teachers, the provision of appropriate teacher training, the design of appropriate curricula and teaching materials. Overall, reformers tended to view Logo as a tool with great potential which should be introduced into schools and assist grassroots educational change from within, they were more interested in projects that would be more acceptable by existing standards. For them, Logo should penetrate traditional schooling through a process of evolution rather than revolution.

2.2. THE APPROACH OF THE REVOLUTIONARIES

Some other members of the early Logo team (including Papert himself) tended to adopt a fundamentally different view of Logo. For them, Logo was incompatible to existing forms of schooling, it was an anti-school project, something which was against school in its traditional form. Seymour Papert remembers:

At a certain point I did not think of school as saveable, I did not think that school was a proper learning environment... Originally in my head it [Logo] was an anti-school thing... Logo was the cleanest example of an anti-school use of the computer, of a use of the computer very different from anything that happened in the school (Papert, interview).

The revolutionaries saw Logo as a computer environment where children should be encouraged to do things in completely new ways, rather than as an environment which could make traditional teaching more efficient or attractive. They rejected traditional approaches as conservative and alienating and argued that children could use Logo to learn through discovery methods, through heuristic, intuitive, qualitative and experiential approaches pursuing their own goals and ideas. Rather than viewing Logo as a new tool within the existing curriculum, they saw it as a revolutionary anti-school idea which could potentially bring about radical change in existing perceptions of schooling, teaching and learning and more generally in society and culture. In this sense, their claims for Logo were overtly political in a way that was more extreme and potentially confrontational than the radicalism of their reformist colleagues. Logo for them was an *alternative* to existing school systems. The revolutionaries made it clear from the beginning that Logo (as originally conceived) "was not going to work" in ordinary schools, that such an innovation would not be compatible with existing school structures and the organisational culture of conventional schools.

Despite this dire prediction, Logo was introduced into a large number of mainstream US and UK schools in the early 1980s following the availability of microcomputers. What happened then? How was Logo received and how did it evolve? How did teachers react and how did they use it? What did "Logo" come to mean at the level of practice? Were the ways in which Logo was taken up in line with the expectations of its developers. If so, why and with what consequences? If not, how did they differ?

Did the educational megachange envisaged ever happen? How did Logo interact with its social, political and organisational context of use?

3. A BRIEF SUMMARY OF THE EVOLUTION OF LOGO: THE PENDULUM SWING

In the first few years of its development -and given that schools did not yet have microcomputers- Logo remained a research idea shared among a number of research centres around the world interested in education. During that time, a number of school-based research projects were set up and versions of Logo were experimentally tested in a small number of <u>atypical</u> elementary and secondary schools involving only a very small number of teachers. It was perhaps the Lamplighter project (1979-1982) more than other which showed that an appropriation of Logo near to that envisaged by its developers was possible within conducive local environments which value alternative approaches to teaching and learning. The project was an interesting case study illustrating clearly the important role of the local institutional context of use in shaping the outcome. It provided a concrete example showing that within specific locations providing a fertile context, radical ideas can be successfully utilised.

By the early 1980s, Logo was no longer a marginal, private experiment. Following the introduction of micro-computers into schools, it became available to a large number of US and UK mainstream classrooms. At the same time, the publication of Papert's book *Mindstorms* in 1980 made Logo (and its philosophy for education) known to a world-wide audience and offered an alternative, radical vision for education which caught the imagination of a large number of educationalists. Few educational books in recent times have generated as much activity -and controversy- within education as *Mindstorms* which had a phenomenal commercial success selling over three quarters of a million copies. Within months of its publication, pro-Logo and anti-Logo lobbies had developed on both sides of the Atlantic. It is important to mention here that the response to *Mindstorms* and the way in which Logo was taken up in the two countries was significantly different. Generally speaking, the US approach tended to view Logo and the ideas around it more along the lines of the revolutionary scenario, as a cultural revolution in thinking about schooling and learning. In the UK context, where the progressive elements of education were more firmly established and under the influence of the

Edinburgh[2] Logo project, who saw themselves very much as in the reformist camp, Logo was seen by some curricular reformers at least, as a new method to be integrated with existing materials and methods.

Mindstorms appealed to a number of "progressive" teachers in both countries who –in the echo of the revolutionary 1960s and 1970s- were (still) looking for ways to bring about radical educational change. John Berlow, who worked closely with Papert as editor of *Mindstorms*, recalls:

…because of Seymour's breadth of interest and perspective- a lot of teachers took it up as a new kind of way into progressive educational reform... The influence of progressive education was still alive. Logo was seen as a way to give some kind of backbone to progressive education (Berlow, interview).

Molly Watt, a former maths teacher, Logo teacher-trainer and curriculum developer in the US, remembers:

I think that he [Papert] was a better spokesperson. In a way he was like Martin Luther King who wasn't the only one in the Civil Rights movement - a lot of people espoused those beliefs and those ideas and put their bodies on the line but he was the most eloquent spokesperson. And I read *Mindstorms* at least fifty times (Molly Watt, interview).

The early 1980s witnessed the emergence of a "Logo community" among educationalists in the US and the UK and elsewhere -especially elementary school teachers- a community of excited teachers seeking to materialise the radical messages of *Mindstorms*. To those teachers, Logo was more confirmation than revelation; it was not a new movement itself but, rather, an expression of already existing ideas connected to their social and political radicalism. One participant in this movement recalls:

I already shared the educational ideas underpinning *Mindstorms*, [it] didn't change the way I thought about education... It gave me a sense that there was a possibility to operationalise in education the ideas that I already agreed with... So what I found in *Mindstorms* was not a new educational philosophy; I found a way of putting into effect the educational philosophy I already believed in (anon, interview).

The excitement was significantly higher in the US where, in many cases, Logo advocacy became infused with messianic zeal among some early Logo enthusiasts who saw it as a panacea for the ills of

an educational system in crisis. A large number of (mainly elementary) school teachers were said to have caught the "turtle fever". A community of radical teachers emerged and Logo became their symbol, a metaphor for using the computer to break out of the traditional ways of doing things in schools. Logo was seen as a liberating solution to the authoritarian conservatism of traditional classroom instruction:

Papert's ideas in *Mindstorms* resonated with the philosophical stance of educators who believed in child-centred environments. For those who translated this approach to mean child-directed activities within the environment, Logo offered them a new opportunity to provide rich (especially mathematical) experiences. The mathematics reforms of the 1950s and 1960s introduced into schools in the 1970s fell short of the mark. Thus in many open-education classrooms Logo became another chance (Solomon, 1986:131).

In this context, the introduction of Logo in US and UK schools was initially not a centrally organised educational reform; it was a grass-roots innovation which existed almost exclusively in the classrooms of Logophile teachers most of whom employed it as a way to change existing educational arrangements and orientate them towards child-centred and open-ended exploratory learning. However, we will show in section 6 that soon after this initial, unofficial and semi-autonomous phase, Logo was included in the official school policies of both the US and the UK. From an experimental tool in the classrooms of dedicated enthusiasts, Logo became "part of the curriculum". This marked the beginning of a deviation away from Papert's original intentions of "educational megachange" (bypassing school) to the direction of evolution rather than revolution.

In reality, since 1980 we witness a contradictory and rather problematic effort to capture and contain this somewhat utopian and romantic conception of *education* within the institution of *schooling*. In the following sections we will show that in this effort, Logo was most often rejected, marginalised, normalised or altered to fit the norms of existing educational structures.

By the mid-1980s, a pervasive backlash against Logo was already in place in the US, where Logo was denounced as having "failed to deliver what it promised". Why did this happen? A number of positions have emerged in the Logo literature as candidates in the quest to explain the pendulum swing against Logo[3]. Yet, most of these accounts have limited explanatory power as they discuss

the introduction of Logo only as a matter of implementation. In so doing, such accounts fail to shed light on deeper structural relations underpinning the introduction of Logo as an educational innovation. Our own interpretation of the pendulum swing against Logo goes beyond functionalist accounts to discuss two main factors which worked in isolation as well as together to mute the radical potential of Logo at the level of use: the power of the traditional organisational culture of mainstream schools and the influence of the wider social and political context in the 1980s.

4. LOGO AND THE ORGANISATIONAL CULTURE OF SCHOOLS

Logo was not simply received as a finished product from the context of production and implemented at schools; rather it was subject to interpretation within the context of "consumption", it was "re-created" and re-constructed -as is, of course, always the case with educational innovation. "Logo" assumed as many different interpretations as the different individual histories, experiences, values and interests of the various participants to the classroom arena. In 1985, Papert was writing:

There are tremendous differences in the ways that Logo is being used by different people -even in their perceptions of what Logo is or not… when I travel across the country and the world seeing Logo in many different contexts and many different classrooms, I am struck by the variety of forms it takes in these different settings with different teachers and different children (Papert, 1985:3).

Logo was utilised in very different ways in different school and classroom contexts with very different results. Reaction ranged between enthusiasm and commitment to complete rejection and resistance.

Those teachers who saw Logo as another chance for radical educational reform and were familiar with the "Logo philosophy" for education tended to use Logo very much in the ways anticipated by its developers. Logo became their way to restructure what education should be about. They viewed Logo as a way to change existing educational arrangements towards a direction of child-centredness, exploratory learning and open-ended projects. Molly Watt remembers:

We became very excited by Logo and by what children were doing, it was the most interesting intellectual experience in our lives. We were very excited...becoming a community of learners **with** the kids; it changed our relationship, we were no longer the experts. We were all learning together and it was a different kind of educational experience (Molly Watt, interview).

Logo work was used to cut across the division of the day into periods, the division of knowledge into subjects, to break off the ordinary structure of the curriculum and the traditional power relations in the classroom. Brian Harvey, at that time director of the computer centre at Lincoln-Sudbury Regional High School in Massachusetts and subsequently a lecturer in Computer Science at the University of California at Berkeley, remembers:

Kids set up their own working partnerships; more experienced kids taught newcomers. *Most of my effort went into this meta-curriculum rather than into teaching programming.* It didn't always go smoothly; there were fights, violations of privacy, and the like. But we all saw these problems as community problems, not just as something for me, the teacher, to deal with (Harvey, interview).

In some classes the innovative enthusiasm of teachers went beyond the expectations of Logo's producers. Mitchel Resnick, a member of the MIT Logo team in those days who has subsequently become director of the Lifelong Kindergarten research group (part of the Epistemology and Learning group) at the MIT Media Lab, recalls:

In some classrooms there were phenomenal things that happened. Some teachers used it in ways that Steve and Seymour and I had never imagined. They pushed in directions that we hadn't imagined and some of the things that we had dreamed about did come about (Resnick, interview).

Beyond the few committed enthusiasts who already had a vision, the reaction of teachers and the ways in which Logo was taken up were uneven, depending significantly on the views of individual teachers as well as on the culture of the specific school environment in which Logo was being introduced.

Evidence suggests that although elements of progressive educational practice were already in place in a number of US and (more) UK classrooms by the mid-eighties, for the vast majority of mainstream classrooms, the Logo discourse -in both its *revolutionary* and its *reformist* versions- was seen by many as a substantial threat to the stability of educational institutions. The open-ended character of the work that Logo was calling for meant that it was an innovation which clashed with the routine dominant in the majority of mainstream schools. The "Logo philosophy" for education was a discourse of fundamental change, and it contained the promise of disruption of conventional classrooms[4]. Largely neo-progressive in orientation and radical in style, it challenged a number of basic organisational

values upon which school has been developing as an institution in the West since the Enlightenment, like respect for hierarchy, competitive individualisation, a receptivity to being ranked and judged, and the division of knowledge into discrete units susceptible to mastery. In this sense, Logo was in most cases undesirably disruptive as it meant that the culture should change its values and habits in order to implement it. Celia Hoyles, a key-figure in the evolution of Logo in the UK and now professor of Mathematics Education at the Institute of Education, University of London says:

An institution like school likes things as they are and will resist... When a foreign body comes along it wants to keep it out. Because it upsets the way the curriculum is organised, the way the hierarchy is organised... There is not very much difference in terms of the reaction to Logo and the reaction to any innovation (Hoyles, interview).

Especially in secondary schools (where the division of knowledge into separate subjects is much clearer) the introduction of Logo was felt as a threat to traditional school structures:

Essentially what Logo calls for is project-based work, where kids have projects that they work on. But the project-based thing does not necessarily work with the 40-minute class where everybody does this now, etc. So all of that has to do with the social milieu of schools and all these issues that are involved in restructuring and reform and so on (Feurzeig, interview).

The child-centred principles of Logo challenged the self-image of many teachers as professionals, by threatening to take away the primary commodity of superior knowledge, skills and expertise upon which they all, to a greater or lesser extent, relied to maintain control in their classrooms. Dan Watt, a former teacher, Logo teacher-trainer and subsequently a curriculum developer at the Education Development Center in Newton (Mass.), who was involved in the Brookline Logo Project at MIT, says:

[Logo] was a departure in terms of the pedagogical style... we have a term that is now fairly widely used in this country, "constructivism". Logo was exactly that, the notion of people constructing knowledge based on their experience of the world and playing with what they already know and working with other people, and the notion that the teacher should be a helper rather than a dictator or instructor in the old-fashioned sense... (Dan Watt, interview).

To work with Logo in the way its developers had envisaged meant that teachers should make a fundamental shift in their relationship with pupils, to become co-learners, partners engaged in a joint exploration negotiating each difficulty as it arose. Dave Pratt, a former mathematics teacher and curriculum developer, who subsequently became a senior lecturer in Mathematics Education at the University of Warwick, UK says:

But if the teacher is prepared to give children the freedom to actually explore for themselves and guide the children along every now and again, then the child sees the Logo activities as a very creative process (Pratt, interview).

This, however, was a lesson not learnt for many teachers who felt uncomfortable when faced with the challenge. Although "reflective practice" was the dominant orthodoxy in teacher education and professional discourse in the 1980s, in the day-to-day reality of many teachers, the view of themselves as reflective practitioners that Logo implied automatically constituted a disruption of the classroom's traditional social organisation. Some teachers understandably found it difficult to give up their role as authorities which was until then one of the fundamental parts constituting their definition as "teachers". This, for example, was the case with a group of teachers from Boston who spent a summer making a sequential "Logo curriculum" which they implemented in autumn. Dan and Molly Watt, who were their Logo trainers, remember:

After a week at school they were still delighted with it. But by the end of three weeks they threw up their hands in horror because Logo is a language and the kids talked to each other and they could not withhold commands, kids could try English language commands, they could talk to each other and learn commands. And all of a sudden the teachers had lost all control of the curriculum and the kids were doing things that took them very far beyond what the teachers had ever envisioned... The teachers thought that they could control the information and never get in over their heads. But the teachers went immediately in over their heads with all kinds of interesting bugs to work on. They could not teach in the same way, so it really changed their understanding of what the curriculum could be and what learning could be. *It may be one of the reasons Logo was so difficult for some people to teach or to teach with, you should be prepared to give up control*... (Dan & Molly Watt, interview, emphasis added).

Teaching with Logo requires handing over a high degree of autonomy to pupils who work on their own projects at their own pace:

This is another fundamental principle, to have the children more in control of what they do because

they can try things out and debug as opposed to having the only source of evaluation being the teacher (Hoyles, interview).

This shift is likely to mean not only that different students work on different tasks, but that the classroom looks and sounds very different. Children are more likely to move around the classroom and talk with each other about how they do things. Talking to the authors about their work with Logo, children referred clearly to this issue of control and ownership:

What I like about Logo is the fact that you can build what you want (Julie, Year 2).

I like it when you can get to the part where you can just get on with what you want to make... (David, Year 4)

In such a context, the teacher's role changes from that of the expert who presents information to be assimilated by students to that of a coach or tutor who assists students when they encounter difficulties in their relatively independent work. Many teachers, however, valued professional expertise as antithetical to experimentation and risk-taking, accompanied by a belief that the teacher, not the children, is responsible for learning. It was those teachers who found it most difficult to see any value at all in Logo. Janet Ainley, a former teacher and teacher-trainer in Logo in the UK who subsequently became a senior lecturer in Mathematics Education at the University of Warwick, says:

All the teachers who get enthusiastic [about Logo] have one thing in common, they are prepared to let go their control of what is happening in the classroom. They are prepared to let children experiment and explore and be independent... It is teachers who have this philosophy in their classrooms who were able to get enthusiastic by Logo, the Logo philosophy appealed very much to them (Ainley, interview).

Evidence also suggests that in many cases, teachers dreaded the occasions when they were "shown up" by their students, when they should voluntarily cede authority to the student who knows better how to "debug" the program or how to print effectively what he/she has created on the screen. This is the time when

... the brittle consensual veneer of adult expertise is cracked, the order of things briefly disrupted (confirmed by the sudden eruption of murmuring in the classroom), and casual but alert attention

directed by teacher and students alike toward the performance of the evanescent student expert (Hodas, 1993:14).

The fear of cracking the "consensual veneer" was a major - and understandable - deterrent to some teachers. At root, the difficulty is based on the social structure of the classroom, which has traditionally been built around two complementary roles -those of the teacher and student. An important part of the teacher's role is the exercise of authority which has a number of bases, one of these being the teacher's expertise. Any change in the classroom that seriously undermines the teacher's image as a knowledgeable and competent individual has implications not only for the teacher's personal feelings of comfort and self-esteem, but also for important aspects of classroom functioning related to the teacher's authority. Many teachers felt that to display a lack of expertise would give students an opening to ridicule them that the students would be quick to take -especially at a high school. Only a few teachers were prepared to tolerate knowing less than their students without too much discomfort. A teacher remembers:

The children ... got well ahead of me... I had a booklet that Amanda [a colleague] had written explaining the function keys, but I just took *Big Trak* home and played with it a couple of times in order to keep ahead of the children (teacher, unattributable interview).

As well as being fearful of looking incompetent or less knowledgeable in front of their pupils, many teachers also experienced difficulties in the context of Logo training sessions shared with colleagues. The fear of being embarrassed in front of fellow-teachers is reported as a significant demotivating factor. Dan and Molly Watt, teacher Logo trainers in the 1980s, remember:

Our approach was to say: "Well, frustration is part of learning, debugging... learning to get help from other people…". But some people were not so comfortable with that. And in every group of teachers who would come to learn Logo there were some people who were very-very uncomfortable about having difficulty, about being publicly frustrated (Dan & Molly Watt, interview).

In addition to the issue of teachers' authority and control, Logo presented a challenge to the traditional fragmentation of knowledge into separate subjects and to traditional assumptions about "worthwhile knowledge", "good students", "effective teaching", and "excellent results". Logo put at stake these

traditional codes; in fact, it set off a range of culture clashes. All those thousands of teachers who identified strongly with the teaching styles associated with their traditional subject subcultures were reluctant to adopt a technology that seemed incompatible with those subcultures. Rather, as Dave Pratt remembers, they were confused and constrained:

And so I had that sort of tension in my mind about what to do about the fact that we have a defined syllabus… So even if one values the approach that John [a colleague working with Logo] was using, could one actually afford to have that situation not being able to guarantee what it was that the children would actually work on? (Pratt, interview).

In this context, Logo was more easily assimilated where it fitted with existing practice and caused no substantial changes in content or pedagogy. Some teachers felt they had to modify their use of Logo to ensure that it did not disrupt the established subject subculture. The words of another teacher reveal this pattern of co-option and marginalisation of Logo into her existing teacher-centred framework as a separate "activity" outside the mainstream teaching and learning process:

The first year I let the children play with *Big Trak* quite a lot. *It was more of an activity available if they had finished their work*, to play with and see what they could do. Next year I directed the children far more in what they did. I didn't allow it as free play: it's been part of a specific learning situation. They looked on it as part of their work *with problems I set* (teacher unnattributtable interview, emphasis added).

5. IN DEFENCE OF TEACHERS

We are anxious not to be interpreted as suggesting that this anxiety of teachers is a personal handicap or a professional ill for which teachers should be blamed. Faulting teachers for refusing to change assumes that most teachers are free to adopt changes, if they merely choose to. It assumes that when they do not do so, it is because they are stubborn or fearful of classroom consequences. Attributing to teachers the personal power to halt or divert change is a corollary of the common tendency to locate explanations for events in individual action rather than assessing the potent influence of the situational contexts or a blend of many influences. In this sense, the discussion of the use of Logo in terms of the challenge it posed to the professional identity of teachers should not be taken as an attack on teachers or as an attempt to move away from a critical discussion of other (structural) conditions. Because

teachers are only one part, one accessory in the mechanism of schooling and their use of Logo - whether it be excitement, resistance or anything between the two- should be viewed against the social, political and institutional context within which the introduction of Logo in mainstream schools took place:

Proposals for change may ignore the dynamics of the social situation into which an innovation is "inserted"; not just the situation and the relations between situation and innovation but also the innovation itself inevitably change in unpredictable, irrational ways. Even if teachers and administrators were completely rational actors in attempting to implement a change (and of course they are not), they would not have the power to determine how the change worked out in practice. They do not have that much control over the social context in which they work (Kilpatrick & Davis, 1993:211).

We claim that this set of background conditions was characterised (in both the US and the UK) by conservative restorational politics and the educational policies attached to them. It is in this context of transition from an era of possibilities for "progressive" education that allowed schools and teachers a degree of autonomy to an era of control and accountability that the introduction of Logo in real classrooms is most helpfully situated.

Our discussion so far indicates that a radical uptake of Logo would have been hard to sustain even before the conservative restoration. Our evidence supports Papert's early claim that Logo (as envisaged by its initial developers) was not compatible with the organisational culture of mainstream schools, that the structures of conventional schooling could not provide an appropriate context for Logo as its initial developers wanted it to operate. In this sense, the "failure" of Logo to penetrate existing structures was predictable. However, evidence suggests that while it would have been difficult anyway, the changing social and political context exacerbated the difficulties. The rest of this paper will discuss how the conservative restoration of the 1980s reinforced those very elements of conventional schooling that Logo could not operate with, then reducing almost to zero an already low chance of success.

6. USING LOGO IN THE CONSERVATIVE RESTORATION

Logo was introduced in mainstream US and UK schools at a time that Ronald Reagan's demand for educational quality in the US was paralleled in Britain by Margaret Thatcher's call for a return to "Basics" and also by the Education Secretary's paper on "teaching quality". The new order in the educational policy of both the US and the UK demanded a rapid introduction of computers in education by funding national initiatives to place computers in schools[5]. Within this context, official policy-making circles then preoccupied with the "computer literacy" campaign were quick to link Logo up to the popular rhetoric of the time. In the US, the National Council of Teachers of Mathematics (NCTM, which effectively made the policy for Mathematics) was a catalyst in this process:

The NCTM said 'children should use computers'... there were like ten points in a very short little document... It's what made schools feel they needed to have computers for mathematics...When Apples came out in 1980 **and** the NCTM agenda, suddenly people thought they should be doing something but they didn't have the slightest idea what to do. So they got Logo -that took care of Maths- and they got the *Bank Street Writer* which came out in 1983 and then they thought they had everything they needed for their schools (Dan & Molly Watt, joint interview).

As a result of its official association with the "computer literacy" campaign, Logo was hastily introduced into US mainstream education at an introductory level only, without enough preparation of the teachers who were going to use it or an adequate infrastructure to sustain it as an innovation. This quick-and-shallow adoption of Logo became a boomerang which collided with the original intentions of its producers as for the vast majority of teachers (who had not been in contact with the language and its philosophy before) Logo was constructed simply as a playful way to give the children the opportunity to control the computers. Dan Watt and Paul Goldenberg recall:

...Logo was adopted so quickly because of the goal of computer literacy and because of Seymour Papert's own advocacy and forceful promotion of it. This quick success made it impossible that 'Mathland' would ever occur. Because Logo was adopted too shallowly by too many people too quickly (Dan Watt & Paul Goldenberg[6], joint interview).

Some of the local school districts (in the Boston area initially and later throughout the US) decided that Logo should be part of their curriculum, yet without any well-formulated educational rationale. Within the context of the "computer literacy" campaign, "learning Logo" became an end in itself,

lending schools the glamour of the new technology; Logo became an accessory to a technocentric way of thinking about education:

All of a sudden Logo became something to add to the curriculum but nobody really knew why. It was not used primarily for mathematics, it was not used primarily for... it was about "learning Logo"! (Dan Watt & Paul Goldenberg, joint interview).

At the same time, the new political priorities in both the US and the UK demanded standardisation of the educational experience in which tighter regulation of the curriculum and the teaching process was being imposed and legitimated under the call of national security and interest:

The calls for the social reconstruction of the 1960s gave way to the needs of a middle class to hold on to what they already had. Education again had to answer the call of accountability, efficiency, and control for the purpose of a stronger economy and national interest on a global scale. The underlying interest was to maintain the status quo (Muffoletto, 1993:100).

At the time that Logo was being introduced into US and UK mainstream schools, the political climate of rebellion and reform that had marked the 1960s was no longer present: as the nineteen seventies and eighties wore on, the rise of the new conservatism in educational policy reflected a pervasive retreat among progressive forces:

Using the rhetoric of the civil rights movement's anti-elitism, educational conservatism took over in the mid-1970s leaving fervent ideologues of educational reform bewildered and ashamed. Administrators and teachers who had furiously tried to "retool" in the hectic sixties breathed a sigh of relief and set out to invent a new ideology of learning which stressed "standards" (Aronowitz & Giroux, 1993:58).

Within this context, teachers in the US were required to "teach" Logo as a subject at a certain age or grade level and all students were required to learn it going through a series of activities. In 1984 and 1985 such curricula were in place in many schools throughout the country. Logo became *institutionalised* and teachers were expected to teach it as any other curriculum subject, as just another "thing" that students should learn. A special curriculum for Logo was developed and in most cases specialist teachers undertook to teach it. Goldenberg and Watt remember:

So what happened was you would have a curriculum and if you were a grade 4 teacher you would get a package just like you would get for mathematics, or reading or whatever your students were expected to learn, and some activities. And once or twice a week you would take your class to a computer lab and go through the activities with them (Dan Watt & Paul Goldenberg, joint interview).

In the British context, the conservative counter-attack on progressivism was similarly reflected in the effort to centralise and standardise schooling:

The concern with standards, both academic and attitudinal, is paramount. Schools, it is argued, have been lax, whilst child-centred curricula which work from children's interests are considered antithetical to a disciplined and serious engagement with knowledge. Thus there is a call for a return to basics. The attack from the right has keyed in with popular sentiments and paradoxically is supported and reinforced from the "left" (Avis, 1991:116).

In this context, there was little space for open-ended activities like Logo. A primary teacher in the UK recalls:

I must admit that I was very wary at first about introducing Logo because I felt it was going to interrupt the children's basic skills lessons... (teacher, unattributable interview).

Bill Tagg, director of the Microelectronics Education Advisory Unit in Hatfield (UK) between 1982-1991, says:

Things have changed since [the late 1970s-early 1980s], primary schools too, have a much more urgent curriculum to get through. This is one of the reasons why Logo hasn't survived. But at that stage the big difference between primary and secondary schools was the fact that there was time and opportunity, freedom from constraint in primary schools. Primary schools in those times enjoyed a very high degree of freedom that they have not achieved previously or since. Ten years previously they would be working towards the 11+ exams... ten years later they had the National Curriculum. But roundabout that time they enjoyed a tremendous amount of freedom (Tagg, interview).

Along the same lines, Celia Hoyles confirms Tagg's argument:

Logo does not fit with the curriculum as it stands. If you have a curriculum that is very fragmented there is no nice place for it to fit... In the UK at that time it was a much more flexible curriculum particularly at the primary school, and those teachers could do more about what they wanted. US rather similarly I understand, but I suspect in Germany and in France it was much more laid down what you do and much more fragmented, so it is actually quite hard to introduce this. *And then why it is more laid down, probably it is a symptom of something else more fundamental* (Hoyles, interview, emphasis added).

The why is not hard to detect in the following words of a London's secondary teacher who reminds us that sections of UK official policy-makers at this time were not far in their thinking from the spirit of the Black Papers[7] which in the 1970s provided a conservative political critique of progressivism, cloaked in populist rhetoric of contrasting anarchy and realism. As with progressivism earlier, Logo in official circles was now linked to the growth of anarchy, and a "realistic" approach to education was advocated, namely the National Curriculum. Peter Butt, a senior teacher of Mathematics and Computer Science at a Boy's Grammar School in London, says:

Logo, yes, did encourage you to do what you wanted to do... It was the final bastion of those people who wanted to do what they wanted to do. [And the official argument was that] you cannot have a sensible educational system where everybody just does what they want to do.... that Logo breeds anarchy... And no national government, whether you are left-wing, right-wing or whatever, can allow that to happen... they all wanted a National Curriculum! (Butt, interview).

6.1. COMPUTER LABS AND LOGO TESTS

Within a political context that devalued and discouraged open-ended approaches to pedagogy, the administration-controlled interpretation of Logo quickly became dominant, serving more to bolster the status quo than to undermine it. This "reading" of Logo was partly reflected in the isolation of computer equipment in separate rooms, away from the mainstream of learning. Again, this tendency would be stronger in the US:

The initiative and the power in the field of computers were moving from teachers to school administrations -most often at the city or even at the state level. When there were few computers in the school, the administration was content to leave them in the classrooms of teachers who showed greatest enthusiasm, and these were generally teachers who were excited about the computer as an instrument of change. But as the numbers grew and computers became something of a status symbol, the administration moved in. From an administrator's point of view, it made more sense to put the computers together in one room -misleadingly named 'computer lab' - under the control of a specialised computer teacher. Now all the children could come together and study computers for an hour a week. By an inexorable logic the next step was to introduce a curriculum for the computer. Thus, little by little the subversive features of the computer were eroded away: instead of cutting across and so challenging the very idea of subject boundaries, the computer now defined a new subject (Papert, 1993a:39).

Shunting attempts at fundamental reforms like Logo to the periphery of the "regular" school is a classical strategy for neutralising their transformative potential. As Cuban (1993:6) puts it:

Thus, some basic changes get encapsulated, like a grain of sand in an oyster; they exist within the system but are often separated from mainstream programs.

Logo was encapsulated in the "computer lab", to be used for 30 or 40 minutes on Logo activities that in most cases involved writing trivial turtle graphics programs; Logo was used in ways quite different from the intentions of its developers, as normative and pedagogical technology of a conservative type. A former UK primary teacher remembers:

At first we tried sending the third and fourth year children down in groups to use Logo in the computer room, but by the end of the first term we had decided against that. Logo was coming to be seen as something separate instead of forming part of the classroom activities... (teacher, unattributable interview).

This view of Logo as yet another curriculum component was soon to be followed by Logo *examinations*, which was anathema to its producers' vision for Logo as a tool for exploration and thinking. Papert has registered his disappointment:

While the typical teacher in 1980 had this computer work in her classroom and was using it to cut across the division of the day into periods, the division of knowledge into subjects, to break off the ordinary structure, now there was this shift! The computers were put in a special room away from the mainstream of the learning, there was a specialist teacher, there was a special curriculum even, and - most horrifying- across the river in Boston for the last ten years every elementary school child has to take **a test** in Logo! Like taking a riding test before you are allowed to ride a bike. First it is pass the riding test and then you may ride the bike. And then it turns out that there aren't any bicycles or there are too few bicycles. If you pass the riding test you can ride the bike for five minutes a week.... (Papert, interview).

The intruder (Logo) was effectively brought back into line with school's ways. Logo in the classroom was undermining the division of knowledge into subjects; it was turned into a subject of its own. It undermined the idea of curriculum; it was made the topic of a curriculum of its own:

Today, Logo geometry has acquired the character of a canonical curriculum topic. Workshops for teachers introduce them to standard figures that they can have their pupils draw. The Netherlands has a set curriculum in Logo, and in the UK, Logo geometry is a topic in the National Curriculum (Kilpatrick & Davis, 1993:208).

6.2. EXAMINATIONS, RESULTS AND ACCOUNTABILITY

"Improving test scores", "accountability" and "excellence" were the new catchphrases circulating in the early 1980s, reflecting the preoccupation of the educational establishment with test-scores and results rather than open-ended approaches. With the onset of severe budget cuts to education as early as 1975 (in the U.S.), for many teachers survival replaced talk about reform. The swift turn of events discouraged teacher initiatives, risk-taking, extra efforts, and innovation. A teacher confessed in devastation:

I know I will teach my children how to take the test, although I realise this is basically against what I believe in... I do not have the energy nor, at this point, the willingness to fight the system. I know the scores of my class will be compared with those of traditional classes. The comparison is itself fallacious. I know that. But most parents do not. Many administrators do not and the system does not (teacher, unattributable interview).

Peter Butt says:

I do not use Logo in my normal GCSE or A level teaching as such... If we were using a computer we would take twice as long to do whatever we wanted to do, the boys would fail their GCSEs, the school last year was 31st in the National League tables for academic excellence, if we drop below 32 we will not have any customers, I will be out of a job... Well, it comes down to this! (Butt, interview).

And he went on to say:

Yes, Logo has to do with progressive education. You can do what you want to do and the teachers became fascinated by Logo themselves and they tried to pass on that fascination to their pupils. I have always been restricted by the fact that this is an academic school and we have always had very good GCSE results. And after all this is what the parents pay for. We would like to educate them as well, obviously. But the bottom line is 'how many boys do you get to university'. We assume that all our pupils will go to university or some form of higher education. We are a Grammar school... we try to educate them but one has to... that's it... *there are the pressures of the exams!... When it comes down to it, the boys at this school have to pass their GCSE and A level exams* (Butt, interview, emphasis added).

The managerial preoccupation with results reflects the currently dominant belief shared by policy-makers in education that creativity and problem-solving activity are an unnecessary diversion from the learning of skills, and the testing of measurable outcomes. As a result, teachers find it increasingly difficult to allow children to experiment in this kind of way because they are worried about how much

"useful" material they have to go through. From a British perspective, Ronnie Goldstein, a former mathematics teacher and subsequently project officer for the UK National Council for Educational Technology (NCET), argues:

The fact that Logo faded away in the late 1980s goes back to what I was saying about the National Curriculum. And in fact now people expect the outcomes of the learning that is going on to be much more explicit. And people do not think so much about what the activities are that the students are involved in so much, they think more about the learning that the children have to achieve at the end of the day. And I think it is very difficult to work in a creative way with Logo if those are your aims (Goldstein, interview).

From a US perspective, Paul Goldenberg confirms:

Our entire educational system is too worried about being 'useful'. Certainly the current political climate is going to put a great deal of pressure on anything that does not have a quick pay-off and just get rid of it! It is not that we should not be asking whether our educational interventions 'work' with students -being a 'good idea' is not enough if the program does not actually work- but that 'practical utitily' as the sole criterion is too shallow. By that criterion alone, such subjects as music could be scrapped and, in fact, most of education beyond the early grades could be jettisoned altogether" (Goldenberg, interview).

Under pressure from many quarters to improve their "productivity" (to maximise some measurable output and achieve academic "excellence" while containing their costs), educational institutions maintain mechanisms of assessment and accountability which discourage teachers from taking the risks which the use of Logo implies:

There certainly was a time when -in primary schools at least- teachers still felt that they had a lot of freedom to do what they wanted to do in their classrooms. And that sort of pressures we have now about assessment and accountability just didn't exist. And it is hard now to go back to what that was like... (Ainley, interview).

But teaching is really all about taking risks, it is about putting children into the driving seat, and that's a risk-taking business. But you don't get paid and you don't get promoted on the basis of taking risks, you get promoted on the basis of keeping your nose clean and doing what you are told to do. So teachers don't have the same autonomy and as a result... (Tagg, interview).

6.3. LOGO IN THE UK NATIONAL CURRICULUM

The re-construction of Logo as turtle graphics in the first version of the National Curriculum for England and Wales in 1988[8] intensified the process of Logo's marginalisation and assimilation as harmless into existing educational structures:

Logo has suffered the fate of incorporation into a canonical curriculum, a transformation in which what was to have been an instrument for exploration is ossified into an object of teaching (Noss & Hoyles, 1996:164).

Logo was this time officially constructed as something teachers had to do for a short period and then move on to something else:

Suddenly then there was a big sort of 'everybody has got to do Logo, it's in the National Curriculum' and there was a great sort of such a... people wanting courses on Logo and wanting to know about Logo, and in some ways that felt exciting and it felt good that Logo was being recognised in the NC, but actually in other ways the effect this had was that *teachers would do Logo for three weeks because the NC said they'd got to do it and then they probably drop Logo when they didn't have to do it any more*. And actually I heard teachers saying to me that they would do it for three weeks and that would be enough. So it actually in some ways it had the opposite effect from encouraging it to be really integrated into school (Ainley, interview).

The words of Dave Pratt illustrate the devastation of teachers in that new order and partly explain why most of them ended up assimilating Logo in their existing practice in a rather conservative way:

So if you are a teacher with all the standard problems that teachers have and you have got these issues about parents worrying about the progress of their children and you have a Head of Maths or a Head of the school who insists that you work in a systematic and organised way and they want evidence of children's progress at each stage and the assumption is that the kids do tests and exams and all these sort of things... With all of that stuff there you will only go on to take on board Logo to the extent that you can assimilate it into your current system.... What else could we have done? (Pratt, interview).

Within an adverse political climate reinforcing the inherent institutional conservatism of schools, Logo -in most cases- ended up appropriated in ways different from the expectations of its developers and from the "preferred meanings" encoded in *Mindstorms*. This view of Logo as a "school thing" was a perversion of anything that the developers of Logo – both reformers and revolutionaries -- had imagined. The fact that Logo quickly came to be seen as part of the curriculum meant that any

potential of Logo as a radical educational innovation had been neutralised from its early steps in mainstream schools. Sherry Turkle, now professor of sociology at MIT in the programme for Science, Technology, and Society, who studied the Brookline and Lamplighter Logo experiences, remembers:

Once it became part of the curriculum it was 'normalised' and some of the more radical ideas were lost... somehow it became very hard then to say "look what's happening here, people are expressing themselves". Teachers would say "they are not expressing themselves, they are doing the Logo curriculum..." (Turkle, interview).

In most elementary classrooms it was used simply as a way to teach children how to draw squares and triangles; its use was trivialised, its radical potential neutralised. Wallace Feurzeig, the leader of the team that developed the first version of Logo in the 1960s, says:

What happened in elementary schools is that kids used the Logo turtle graphics to make flowers, houses and trees... Just after that point things stopped there for a number of reasons. In many cases its use is trivialised -that's not surprising (Feurzeig, interview).

The vast majority of the teachers tended to use Logo as part of a conservative educational practice assimilating it into their existing schemata of work:

What people do is they try to put it into whatever system they have at the moment. So if there was something there that you had not seen before, you would evaluate it in terms of things that you currently understood (Pratt, interview).

At the level of pedagogy, Logo was a way of working that involved substantial experimental project-based work. In the early 1980s, the environment for such activity was no longer there as the priorities were shifting. Mainstream schools -especially secondary- were no longer providing a felicitous environment for open-ended, experimental activity. A primary teacher using Logo in the 1990s, says:

The boys have [Logo for] one hour a week ...you see the requirements are different nowadays, to teach the "basics" (Williams, interview).

7. CONCLUSIONS

Our case study of Logo confirms that the social shaping of a technology continues beyond its production; to suggest otherwise is to ignore the power of the context of use, whereby a technology is re-constructed and appropriated. The case of Logo demonstrates that there is no such thing as a simple "fit" between the intentions of a technology's producers and the realities of its use; that there is no such stable and easy correspondence between production and "consumption". We demonstrated that Logo was subject to interpretation within the context of use, it was "re-created" and re-constructed in ways unanticipated by its developers –as is always the case with educational innovation.

Its introduction into mainstream US and UK schools in 1980 marked the beginning of a struggle to integrate new forms of teaching and learning into old educational structures. In this problematic process, the majority of classrooms took up Logo as part of an incremental view of educational change and were quick to absorb it into existing modes of work: Logo became a reinforcing agent of the traditional rather than a vehicle of the new. In its "normalisation" within the curriculum, Logo was no longer about building and reflecting upon knowledge, no longer about changing and evolving cultures. Put into increasingly conservative mainstream school settings, something that the Logo community had seen as revolutionary about the computer culture was no longer the main event. Where it survived, Logo was marginalised, remoulded as harmless to the mainstream educational system, redrawn as "a drawing tool" rather than as any kind of catalyst for rethinking the content of what is or what needs to be taught. It was added to the long list of instances of attempted fundamental school change since the turn of this century that were adopted in many classrooms and yet, over time, either were marginalised into incremental ones or slipped away leaving few traces of their presence.

Is this an inevitable pragmatic resolution of its developers' radical vision? Could history have turned out differently? Has this happened simply because of lack of vision? Or a limitation of resources? Or the absence of an adequate theory of educational change on the part of the Logo community? It is not easy to say. In fact, the story is not over. Logo has been re-instantiated in a number of technical innovations, and many of the ideas which inform the best of these are derived -sometimes explicitly-

from the Logo experience. Some are simple technological developments of Logo itself; others are superficially very different, while sharing many of the philosophical, technical and pedagogical aims of the original Logo ideal. Only time will tell which, if any, will spread beyond the laboratories and into educational systems; and how they, too, will be shaped by their insertion into the cultures of those systems.

Our discussion has demonstrated that beyond the question of access to technology, a number of factors determine the success or failure of such an educational innovation, matters well beyond the technical, and even well beyond the classroom. The fact that a particular technology is available in a classroom does not automatically mean that it will be used at all, or that it will be used in a particular way. We have illustrated in this paper how schools and classrooms are social organisations that both influence the ways in which an innovation will be adopted and are influenced by that innovation. We discussed how Logo was variously embraced and resisted, normalised and institutionalised, marginalised and altered by the various players in the life of the school, in their daily struggle for meaning and power within the classroom arena.

We illustrated that, at the time that Logo was introduced into mainstream schools, conventional organisational structures were so powerful that even if the changing context of conservative restoration had not existed, Logo would have had few chances of penetrating traditional classrooms in a radical manner. This means that, even if Logo had been introduced into mainstream schools earlier (before the onset of the conservative restoration), the difference would have probably been small; the more radicalised adoption of Logo would have been resisted even without the conservative restoration. This conclusion confirms Papert's early claim that Logo was not going to succeed in conventional schools, that no school as we know it would be able to deliver his vision[9].

We also demonstrated that alongside the power of the school itself as an institution to resist innovation, the changing social and political context reinforced those very elements of conventional schooling that Logo could not operate with, then removing completely an already low chance of success. The fundamental mismatch between the Logo philosophy for education and the priorities in

the conservative restorationist context[10] meant that the possibilities of activating Logo's radical messages became almost impossible. We illustrated in this paper that understanding why Logo failed to penetrate traditional educational structures goes beyond conventional explanations which view educational innovation simply as a matter of implementation. We demonstrated that for a fuller account of the backlash against Logo we ought to turn our attention to the fact that Logo is a technology which is compatible with a particular set of socio-political conditions as its operating environment: Logo -similarly to other technologies- is by its very nature an "inherently political technology"[11], rather than a "neutral tool".

In this sense, the discussion of Logo provided a case-study which argues against notions of technological determinism, testing the degree to which change comes from technology or has to come from the social milieu. The gap between the initial expectations and the reality of its implementation demonstrates that the technology needs to be surrounded by social and political relationships that will allow it to do transformational work. That the introduction of technology alone cannot possibly bring about radical change; that the medium alone cannot carry the entire message.

Given, however, the existence of a small number of success stories like the *Lamplighter* project, the question arises of how (and to what extent) the context determines the use of Logo: do pre-existing power relations in schools and classrooms shape Logo use so as to reinforce themselves, or is the user community able to appropriate such a technology locally for transformative ends? Our answer has been rather pessimistic. Although it has given us a glimpse of an alternative, the *Lamplighter* experiment took place in a atypical institutional context and did not last enough in the 1980s to be tested under the changing conditions. A small number of more recent "success stories" can be found in the history of Logo, which provide perhaps more realistic examples of "pockets" of continuing resistance after the conservative restoration, showing again that it is only in very unusual school settings that such radical appropriations of Logo can occur. Such isolated success stories show that despite the depressing power of the context over the ways in which Logo is used there is still some space for a radical appropriation at conducive local environments which value alternative approaches to teaching and learning. Yet, in the current context, they seem likely to remain marginalised in the

absence of a wider transformation of the structure and culture of contemporary schooling. In Bromley's words:

Although isolated "success" stories are sure to crop up even under current conditions, like weeds in the cracks of the status quo, enabling these growths to flourish into a thriving patchwork of alternative practices will require some fundamental changes in the technocratic regime that now governs what happens in schools (Bromley,1995, chapter 4:9).

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[1] The *social shaping of technology* perspective arose through a critique of prevalent linear models of technological change and crude forms of technological determinism. It is a heterogeneous field, the house for a variety of analytical frameworks, including those of social constructivism, feminism, the actor-network approach, the marxist labour process approach, and the emerging cultural studies approach to technology. For a review of the field see Williams & Edge (1996), Williams (2000). For a review of European approaches to the social shaping approach to technology see Cronberg & Sørensen (1995) and Sørensen (1999). For the policy relevance of the social shaping of technology perspective, see Sørensen (2000).

[2] Logo was first introduced to British children in 1972 by Cynthia Solomon, Daniel Bobrow and Seymour Papert. A Logo group was established at the Department of AI of Edinburgh University starting the Edinburgh Logo project which lasted for ten years. The project reached conclusions which were in sharp conflict with the revolutionary MIT Logo Group approach, suggesting that children need considerably more help and guidance than the MIT Logo Group considered appropriate. The Edinburgh Logo project and its results largely defined the way in which Logo would be taken up in the UK context in the 1980s.

[3] For example, Clements (1985); Michayluk (1986); Maddux (1992).

[4] For a discussion of the "Logo philosophy" for education see Agalianos (1997), chapter 6.

[5] For a discussion of the social and political context surrounding the introduction of microcomputers in US and UK education, see Agalianos (1997), Appendix One.

[6] Paul Goldenberg is a curriculum developer at Education Development Center (EDC), Newton, Mass. A former member of the MIT Logo group, he initiated and worked on a number of Logo projects involving children with special needs.

[7] For a discussion of the Black Paper years see Darling (1994), chapter 9.

[8] For an extensive discussion see Noss (1993).

[9] Papert's position has changed significantly since. In his more recent books (Papert, 1993b and Papert, 1996) he is increasingly friendlier to existing schools. A 1998 paper (Papert, 1998) reflects this shift even more clearly.

[10] Priorities which discouraged open-ended approaches and favoured hegemonic "technical fixes" rather than social interventions in education. For a discussion see Agalianos, 1997, chapter 8. See also Muffoletto (1993), Shor (1986), Gordon (1985), Aronowitz & Giroux (1993), Ball (1994), Avis (1991).

[11] Concept first introduced by Winner (1985).