A Proposal for the Reengineering of the Educational System

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Abstract: We propose a reengineering of the educational system that focuses on mastery and on more substantial learning activities and eliminates the constraints on learning that arise from current insistence on grouping children by age. Our basic argument is that eliminating the age-based approach to education has striking advantages that outweigh any social disadvantage. The most powerful reason is the extremely large variance found in any index of learning achievement, even in relatively homogeneous populations. We further argue that modern information systems allow richer educational activities, research-based methods, and multiage schooling to proceed efficiently and effectively. This creates a moral imperative to provide real learning opportunities to the whole of the student population.

The age-grouped classroom is quite new to education and is largely a product of the industrial revolution and especially of the scientific management movement [see Taylor 1947/1967], though there were somewhat earlier threads of similar character. Three main forces have driven the age grouping practice. First, the realization that children's cognitive capabilities differ from those of adults, stimulated by Freud and Piaget, led to the belief that children of different ages need different cognitive resources, need different learning methods, and have different cognitive dispositions for acquiring various forms of knowledge. The extreme form of this view is that children need age mates to support the particular kinds of thinking and emotion that their level of maturation involves. So, for example, the very idealistic kibbutz movement in Israel arranged living facilities so that children lived with age mates rather than with their families (of course, community was valued over family in this culture, but still, a major investment in social change was driven by beliefs in the importance of age-peer interaction).

The second major force toward age grouping was the drive for universal education. This, and the third force, efficiency demands, forced a move from a tutorial approach to a didactic approach in age-grouped classes. When a wealthy person had three or four children to educate and no communal resources to provide that education, hiring a single tutor to teach all the children made great sense. However, when a community had all of its children to educate, specialization of labor became appropriate, and the most obvious and socially compatible specialization seemed to be by age. Had society set its sights higher at this time, the specialization could just as well have been first by subject matter, but the initial goals of universal literacy were low enough that it was assumed that any teacher already had mastered the content. Rather, teacher preparation focused on teaching methods, especially adaptation to children of different ages.

Through all of this time, minimal attention was paid to the variability of learning rates among children. We do not have complete data on how disparate educational achievement would be if we did not limit the speed at which children could progress, but there is every reason to believe that it would be dramatic (see [Gettinger 1984], which cites other findings of a 5:1 ratio among students in time to learn). Even within a highly constrained system, in which faster learners are not afforded sufficient learning opportunities, there is ample evidence of major variability. We present here a few modest examples of the evidence that supports this view.

Consider the standardized educational achievement tests we give to college bound students. In the case of the College Board's Scholastic Achievement Test, for example, scores of college bound seniors have a standard deviation of about 100, by design. What is less-often discussed is the average rate of growth in SAT scores over the course of schooling. Now that we have a substantial number of children taking the SAT as early as 11 or 12 years of age, there is plenty of evidence to support the view that SAT scores grow an average of about 35 points per year (Bond, personal communication, ca. 1985). This means that the standard deviation of the test scores at the end of secondary education is about three years worth of normative learning. While the construction of the test limits the absolute precision of the following claim, it still seems worthwhile to infer that only about 2/3 of high school seniors have attained a level of intellectual capability within three years of the average. To include all but perhaps 5% of students, we would need to have a range of perhaps 12 years of normative education, i.e., the mean plus or minus two standard deviations. In general, this reasoning, and examination of a variety of data sources, suggests that in age-grouped education, the range of achievement is roughly equal to the average - if we look at students after n years of schooling, they will range over 0 to 2×n years of normative achievement.

A very different view is available from the entry end of the public schooling world, though the conclusion is roughly the same. [Lesgold et al. 1985] conducted a longitudinal study of learning to read. Over the first three years of schooling, children were tested up to eight times in an effort to understand the differential effects of two different approaches to reading instruction. For our purposes, though, what is important is the variability in outcomes of learning over the three grades. At the end of the third grade, when students are assumed to have learned the basics of reading, oral reading speeds in the top 20-25% of the students averaged about 100 words/min on passages similar in difficulty to those in their readers but not prepracticed, roughly the speed of conversation and clearly fast enough to support higher-level thinking processes. The bottom 20-25% of students, though, averaged only 50 words/min for one curriculum and 80 words/min for the other, slow enough to be a substantial barrier to understanding. Even with multiple reading groups, major differences in achievement remain, with many students reading so slowly after three years that they will have trouble doing much meaning processing of what they read and others clearly done with the basics of learning to read after a year or so.

While primary reading instruction is partly individualized, with each classroom usually having several different "reading groups," this individualization tends to end after the third grade. It is interesting to note that [Lesgold et al. 1985] observed substantial differences in achievement that did not decrease with years of schooling over the primary grades, yet the capability of the instructional system to support continued individualization past Grade 3 is generally quite limited. While dispersion of achievement did not narrow over grades, Lesgold et al. found that dispersion of "reading level" was maximal at second grade. That is, students begin primary education in a system that allows reading to be acquired at differential rates, but between second and third grade, even though achievement continues to vary widely over students, classification variance decreases—our society expects almost all children to reach the top reading level by the end of third grade, so they do (on paper), independent of their real competence, as measured by reading of passages not previously drilled in class.

We see reading instruction as it begins in first grade as a model for individually-paced learning. Much of the learning activity takes place in groupings that reflect achievement, and there is room for considerable variability in rate of learning. However, this flexibility is provided only for reading and only for a couple years. By Grade 3, efforts are under way to find ways of "passing" all the students out of basic reading, usually by subtle movement from capability to engage new texts as a measure of progress to capability to read a fixed text given sufficient drill. What happens is not "cheating" by teachers but rather an evolution of the third grade curriculum to focus more on rote, rehearsable performances and less on broadly useful skill. In this way, most students can make it through all the "covered" content of the first three grades independent of whether they really learn to read in any sense meaningful outside of school. A truly individualized system would preserve the standard of competence in engaging new tasks as the measure of achievement and would provide appropriate resources for students who need longer to achieve that real goal, rather than substituting schoolish goals or unabashed social promotion for measured success in adaptive competences.

The Low Rate of Success in Adapting to Student Differences

The educational system can move from such an unnatural and inhuman structure as the graded system to one the may benefit from all the insights of nongrading, adaptiveness and multiage grouping, but we find that (a) only a very low percentage of schools adopt the change; and (b) the results in those that actually take the reform path are not dramatically better than those found in conventional schools. This is why, in spite of the positive results the reformers present (with a justified sense of accomplishment), we consider that from a systemic point the experience was not successful, because the results were not convincing enough to be applied nation-wide, and this in a situation where everybody is looking for solutions to the pressing problems of the educational system.

A major effort to integrate the results of the many individual evaluations about the reform methods we described (reasonably gathered under the unique label of nongradedness), was published by [Gutierrez & Slavin 1992]. The central finding of the article, quoting from its abstract, is: *"Results indicated consistent positive achievement effects of simple forms of nongrading generally developed early: cross-grade grouping for one subject (median ES = + .46) and cross-grade grouping for many subjects (median ES = + .34). Forms of nongrading making extensive use of individualization were less consistently successful (median ES = + .02)."* ES, the effect size, is obtained by comparing the results of an experimental group (applying the new methods) with those of a control group (applying the conventional methods). The comparison is done over the same subject (reading, arithmetic, or language arts), usually at fixed points in time (after one, two or three years of instruction). In this case, the effect size for a given subject is defined as the difference between the mean achievement levels of the students in the nongraded and graded programs, divided by the achievement level standard deviation of the students in the graded program.

We would have preferred larger-scale studies conducted by established researchers. Nevertheless, this best-evidence synthesis is the most reliable source we can use for our analysis. What do we learn from this review:

1. The results favor the nongraded programs, but not dramatically.
2. When the complexity of the nongraded program increased, the results decreased.
3. The extent of departure from normative grade levels is seldom measured and has been minimal in the one study where this implementation measure was used.

The Reasons for the Low Rate of Success

We claim that the main reason is that the teachers, on whose shoulders (and heads) success is based, were assigned a "mission impossible". The complexity of the task they had to confront in order to fully implement nongraded programs or individualized instruction was above their real possibilities. With the technology of the 60s and 70s it was impossible for a teacher to follow up on students having each one a different curriculum and a different trajectory in the universe of knowledge, to assign to each one a learning task compatible with his or her previous trajectory, to help in the knowledge development process, and to assess individually each student for diagnostic and adaptation purposes. The reform movements, which (justly) criticized graded schools for assigning impossible tasks to students (particularly the low achievers), tried to solve this problem by assigning impossible tasks to teachers.

[Gutierrez & Slavin, 1992] showed that, if the complexity of the change is small (like introducing the new methods in one subject only), the teachers succeed, and the results are better in a statistically significant form. If the complexity increases, although the methodological changes are conceptually the same, teachers cannot cope with it, and there is no progress. We are not attacking the designers of systems fielded to date; their ideas were excellent, and we think that the educational systems should adopt most of them. We are not attacking the teachers either. As we said, they were assigned an impossible task, in the situation and with the materials at their disposal.

What we do claim, is that now the technology is ready to built an infrastructure that will make the teacher's task feasible, and that the progress in educational research has provided us with additional insights required to design environments where the reform movements ideals can come true.

A last point. It is possible to explain the lack of extended popularity of these reforms at the two other levels that count. The educational authorities never saw really convincing results that would justify the budget increases that are always asked in order to implement a reform, and the parents never saw great benefits, because the nongradedness never took their children out of the Procrustean bed.

The Proposal

Mapping the Traditional Linear Curriculum onto a Project Space

Consistent with current thinking in the educational community, we propose that more of students' learning time be spent in work on substantial learning projects. At least three current viewpoints on learning—constructivism, situated learning and cognitive apprenticeship—agree on the importance of learning through substantial student projects, as opposed to classical teacher presentation. While these three positions differ in their explanations of how learning happens, they concur in the need for project-based learning. Still, there is no complete definition of what a project is, so we need to consider carefully what we mean by project-based education. In general, some or all of the following characteristics appear in the specifications of learning projects: (a) a relatively complex task is posed for the student(s); (b) accomplishing the task requires, and hence fosters the development of, proficiency in different knowledge areas from several disciplines; (c) students often work on projects in teams of two or more; (d) a (relatively) long time is allotted for completion - and varies according to task difficulty and student maturity: from several days in the lower grades to several weeks or even months in the upper grades; (e) each student is responsible for clearly defined parts of the task, but all the students discuss the work and progress of each task component; (f) project execution may require interaction with external resources or individuals, outside the class (or even school) environment; (g) the project is evaluated in terms of its results (reports, laboratory notebooks, artwork, instruments, exhibits, services); and (h) the evaluation of each student's activity within the project is incorporated into his/her personal record.

Projects provide natural challenges to students and a feeling of real accomplishment when the tasks are performed. They constitute a reasonable model of the type of activities students encounter outside school, as opposed to the scenario we find in the expository model of a conventional classroom. Projects permit the replacement of *talking* about thinking with opportunities for *doing* hard thinking. In addition, they permit a more direct assessment of a student's readiness to perform real cognitive work, as opposed to school work, thus overcoming the old problem of "inert knowledge."

Although project-based education is gaining support [see BBN 1994], the majority of teachers are not practicing this method in their classes, at least not regularly. Routinely, high school students get perhaps one major project assignment each semester in each class, but the day-to-day work is traditional. This is not because teachers reject the basic idea but rather because there is minimal supporting infrastructure in schools for project work. The day, and the curriculum, is excessively fragmented for each student and teacher, making it difficult for a team project to be supported. In contrast, in conventional education, the "coverage" of material in classroom presentations, is supported by a rich infrastructure of textbooks, complementary materials, and conventions about responsibilities and schedules, and teachers are judged in terms of their presentation of a curriculum defined in terms of scopes and sequences, and not in terms of projects. Furthermore, teachers were trained for and by means of conventional teaching.

Developing an infrastructure for projects that may compete with conventional textbooks is not a task that can be assigned to individual teachers. What is required is the initial development of a large collection of projects that can be mapped, in terms of cognitive achievement, over the existing curricular strands [see Lesgold 1988]. In this way, the performance of a project can be recognized as the satisfaction of the requirements for certain segments in an overall set of schooling standards, whether the conventional scope-and-sequence structure of one or more subjects or a new set of outcome standards. With the mapping of student achievement as well as project learning goals onto a common space, a teacher gains the ability to select which parts of the curriculum to teach using a project-based approach, and which parts using other methods of instruction.

Project development, as we see it, will require: (a) the definition of the task to be accomplished; (b) the characterization of the prerequisites required from the participating students—in a two-tier structure indicating both the minimal cognitive or skill demands *all* of the participants must satisfy and the broader set of cognitive or skill demands at least one member of the group must satisfy; (c) the development, production and distribution of any resources required for the project which are not readily available to individual schools; (d) a list of the resources that the project requires and that may be obtained at or by the school; and (e) a estimate of the time required for project completion (in student-hours).

Teachers and their students would define their own projects, to be included in the school library of projects, but for a curriculum to have an important project-based component, the development of the infrastructure we propose is critical. This point is essential to our proposal and is presented first, because the possibilities for individual student progress - which are one of our main concerns - are very limited within the framework of conventional education. Projects are need to free students to progress at independent rates.

Developing a Software/Courseware Infrastructure

Educational Administration Software

As suggested above, it is impossible for a teacher to remember the present status of the cognitive map of each student, and thus to make reasonable decisions based on it, when each student is following a different trajectory in the universe of knowledge. Fortunately, present computer technology provides us with the tools to track student status and to make this information accessible to teachers. It is within the state-of-the-art to develop a computer program where all the requirements of the common curriculum will be registered as nodes of a complex structure, and where each student will have a personal copy of this curriculum, annotated with his/her performance on each node of the structure.

The mastery accomplishments can be registered in different ways: (a) automatically, when a student is working in supervised mode on library courseware; (b) as a result of the teacher reporting completion of a project (the computer system will automatically translate project mastery into mastery of all the nodes covered by the project or will provide a rubric that permits the teacher to analyze student products with respect to specific learning goals); (c) as a result of a teacher's direct annotation over a curriculum structure; (d) as a result of school testing; and (e) in recognition of externally-accredited knowledge. Based on these data the computer program may answer specific teacher queries, such as: (a) who are the students satisfying the prerequisites for project X? (b) which are the projects that student Y is ready to tackle? (c) Which are the topics more appropriate as a next stage for student Z? and (d) What are the topics I should teach to students V, W, X, Y, Z if I want them to tackle project A? Using this information, and interacting with the students, the teacher will be, for the first time, in a privileged position to assume responsibility for educational decisions. It is a debt long time overdue that we owe our teachers.

Pedagogical/Instructional Courseware Support

It is necessary to provide a variety of instructional resources, trying to optimize the matching with each student's learning style. Within these resources are particularly important those which are computer-based, in that they may allow for downloading part of the instructional teaching load to the computer. For a general coverage of this topic, see [Venezky &

Osin 1991], and for artificial-intelligence based applications see [Lesgold 1988]. We distinguish between two modes of student-computer interaction: supervised and unsupervised.

In supervised mode, the computer program which manages the interaction includes a knowledge model, a student model and a pedagogical model. The student model may be divided into three layers: (a) the relatively fixed psychological parameters relevant to the instructional process; (b) the cognitive map described above; and (c) the short-term information related to the achievements and problems encountered in the interaction within the specific instructional unit being studied. Based on these data, the pedagogical model will adopt instructional decisions whose objective is to optimize (as well as we know how) the learning process.

The experimental data on student progress results when using well-conceived courseware, are very encouraging [Becker 1992] [Becker 1994] [Osin 1984]. For example, [Osin et al. 1994] showed that the groups which benefit more from computer-assisted instruction are the extremes of the class distribution, i.e., the high achievers and the low achievers. These results exemplify how the computer can supplement the teacher activities, in the areas more difficult for him/her to reach.

Learning time, a very valuable resource, may be optimized as shown by [Lesgold 1994] and [Gott et al. in press]. Trainees in an electronics fault diagnosis training program acquired the equivalent of about four years of on-the-job experience from a 20-25 hour interaction with an intelligent learning-by-doing computer environment.

In unsupervised mode there are neither student nor pedagogical models. The computer is a resource in the student's hand. Nevertheless, this mode is equally valuable, because the computer is the tool of the information era, and mastering its utilization is a fundamental component of education for the future. Furthermore, there are many simulations, microworlds and exploratory tools, designed in unsupervised mode, of high educational value. A well designed educational administration package will include the facilities for providing advice to any student on which of these educational computer programs match more closely his/her cognitive profile, within a certain area of knowledge, using the data stored in the student record [Osin 1992].

Allowing for Dynamic Student Grouping

Conventional schools group students of the same age for fixed periods of time. There is no educational reason that can justify this approach. The diversity of individual learning rates makes it absurd to expect all the students in the same-age cohort to learn the same contents in the same amount of time. Trying to solve this problem by what is called "ability grouping", i.e., separating high achievers from low achievers, is pedagogically and socially unsound. These labels are assigned on the basis of data that is sensitive to maturity, transitory motivation, and teacher quality. Ability grouping tends to perpetuate these labels as a self-fulfilling prophesy, by providing the so called low achievers a low level educational environment, that will inhibit their real possibilities of intellectual growth. We propose to group the students dynamically, according to the similarity of coverage of the curriculum, as reflected in their individual cognitive maps, irrespective of age and learning rates.

Flexible Classes

We start with an organization that keeps many of the formal aspects of the present school structure, while avoiding present pitfalls. Possible alternatives will be presented below. *A class consists of a group of students who are ready to pursue most of the learning goals for a particular grade, under the guidance of a teacher.* Classes would not be age constrained. A student would enter a class when he/she is cognitively ready for it, i.e., when allowed to enter a first grade class (more or less determined by age), or when he/she has learned the previous grade curriculum, as shown by the personal record. A student would leave (graduate from) a class upon completion of the curriculum requirements for the corresponding grade. Satisfaction of the curriculum requirements does not necessarily imply mastery of every topic in the curriculum. This is done to take into consideration that a student may have different aptitudes, and different learning rates, in diverse areas of knowledge, so that it would be too rigid to expect a lockstep progress in all the curriculum areas. Criteria will be established to determine the most convenient moment or circumstance to move a student from one grade to the next. Although the teacher, supported by the educational administration software, would try to keep a relative balance, avoiding the concentration of a student in the study of one specific area to the detriment of the others, the system would allow for a student to pass a grade with 'debts' in certain subjects that would need to be learned in the next class. This means that a teacher responsible for a grade must master the curriculum of at least the adjacent grades also. This is important not only because of our expectations in terms of teacher knowledge, but also because changing grades should be done, for administrative and instructional reasons, at the end of a session (e.g., trimester or semester); a student who has satisfied the requirements of a grade before the end of the period should be able to continue progressing in his/her educational process, in the class where he or she is, until the end of the given period.

Another element worth mentioning is that the emphasis is not on complete encyclopedic knowledge, so that the curriculum requirements for a grade may very well allow for some flexibility of learning goals for different students.

The net result of this approach is that every student has the right to remain in a class for as many sessions as it takes him/her to satisfy the curriculum requirements, and also the right to progress to the next grade as soon as he/she has satisfied them. The immediate consequence is that, particularly as we advance in grades, the age range within a class will increase. There is nothing wrong with this, but it may take a while for society to get accustomed to it. We think that multiage grouping is a better model of the real world, where people are not segregated according to age. Having to get used to it is a small price to pay if it solves a major problem of the educational system.

With our proposed organization, testing of seventh graders, for instance, would not show a performance distribution ranging from second to eleventh grade [Tyler 1950], but rather a relatively homogeneous population of precisely seventh graders. It is this cognitive coherence in class which allows for efficient use of time and resources, transforming the learning process into a fruitful experience for every student.

None of the problems of ability grouping are present in this structure. The educational system offers to all students the same enriching environment. The average and below average students will have the activity of the brighter students as a model and, furthermore, by doing cooperative learning where they can also contribute their part, they will not have a feeling of rejection or isolation.

A practical problem that this "conservative" approach to reform helps to address, is that many teachers do not master the curriculum of all the grades in equal form. There is enough change regarding teachers when we ask them to switch to project-based education and to individual monitoring of student learning, so that we feel that keeping them working with the curricular materials in a grade they are familiar with may help in the adaptation process.

We may envision the alternate usage in class of variable groupings, interclass activities, and other approaches to afford individualized learning opportunities.

Variable Groups

A variety of instructional activities will be available within a class, including project-based education; cooperative learning; computer-assisted instruction; audio-visual resources; didactic presentations (expository, demonstrations, discussions); individual tutoring; self-study; laboratory experiments; and assessment activities. Focusing now on the grouping strategy to be used when defining a project team, or a cooperative learning group, we suggest the following heuristics: (a) heterogeneity of intellectual capabilities; (b) varying partners from project to project (at least partially); (c) matching of student aptitudes to task requirements; and (d) striving for a good working relationship within the group.

In a different dimension, we must consider the number of learning tasks to be assigned to a student. This is the parameter that distinguishes between fast and slow learners, and constitutes an important distinction with conventional schooling. In conventional methods all students are assigned the same tasks, and what distinguishes between them is the quality of their learning. Our proposal expects all the students to reach mastery in each and everyone of the learning tasks they are assigned. The way to give expression to different intellectual capabilities is to allow for a difference in the number of topics a student may be learning simultaneously. Thus, a very fast learner may be participating in three projects, two cooperative learning groups and a CAI activity, while a slow learner may be participating in one project, one cooperative learning group, and an individual tutorial activity. This is how a fast learner may finish a grade in much less time than a slow learner even though both students interact and study together in a socially convivial environment.

A critical element that permits this differential progress is the mapping of the linear curriculum into projects, because it is possible to work on different projects simultaneously, while in the present linear structure every student is forced to progress step by step over a rigid sequence. In other words, we can preserve learning as a social activity, and allow for a different learning rate, because the projects are not sequentially ordered. On the other hand, the classical scope-and-sequence structure forces a rigid order that has to be followed step by step, and we cannot expect a group of students reaching mastery of every step, all exactly at the same time. This may be one reason why students in nongraded or adaptive schools still exhibit a rate of progress which is very much in lockstep with their age cohorts.

Inter-Class Activities

Although the class is the center for the student's cognitive development, the school as a whole serves as an environment where social, emotional and physical development takes place. The school should organize activities where different kinds of groupings take place, crossing class boundaries. Social activities will tend to group students by age, sport activities will tend to group students according to physical or skill development, artistic activities will tend to group students by temperament or special abilities.

Additional Possibilities

According to school preferences, it is possible to define multigrade classes and use a team-teaching approach. There may be a disadvantage of additional complexity, and an advantage of less frequent class changes for fast learners.

The Implications

Clear Benefits for High and Low Achievers

The present educational system is built on the assumption that all the students that belong to the same age-cohort have a similar intellectual development, and thus all the curricula, materials and teaching practices are tailored towards the "average" student.

Our proposal, by recognizing the existence of large individual differences within the same age-cohort, provides equally "tailored" education to all the levels of the cognitive spectrum. It is clear that the main beneficiaries will be precisely those that received the poorest service from the conventional system. In a conventional school, the further a student is from the "ideal" average student, the more his/her educational needs are ignored. This is why low and high achievers will be the major beneficiaries of our proposal. Low achievers will be spared failure, while high achievers will have the possibilities for fully developing their intellectual potential. In addition, it is our educated guess that by changing drastically the present school climate, by creating an atmosphere of challenge and intellectual activity, the "average" students will benefit also, and the baseline of educational achievement will be raised at all levels.

An Improved Model of Social Interaction

The scenario where a teacher, in front of a class, "distributes" knowledge to rows of learners is not only false, but is a very bad model for the real-life situations the students will encounter. By creating their own knowledge, and by cooperating to do so, the students will get used to the environments found in productive activities, and will develop, by practicing it, the cognitive style required in a modern society.

Furthermore, by integrating the students in groups of diverse intellectual capabilities, and various ages, we are again providing a better model for their adult life. Last but not least, the fact that this integration is done with students who are all mature and able to tackle the tasks assigned, allows the students with lower intellectual capabilities to feel productive also, and reassert themselves, while providing the high achievers with concrete examples that students at a lower intellectual level than their own may, nevertheless, be partners in fulfilling a task or creating a product.

The Need for a Coordinated National Effort

Although our proposal may be implemented at a regional scale, the real benefits, and the utmost efficiency (in investment terms) would be obtained in a state-wide, or even nation-wide sharing of many implementation chores. For instance, a rich database of instructional resources (including newly-defined projects), carefully indexed in terms of conventional topics, although a relatively large investment, would result in a very low per capita cost if amortized over a very large student population. These savings can be achieved whether or not the entire population is expected to meet the same standards (i.e., different states with different standards might still benefit from common development of the needed information bases for adaptive education).

For example, if 1,200 projects were to be developed for a national database (and this would provide an average of 100 projects to select from for every school year), with an estimated cost of $50,000 per project, this would be an investment of $60 million dollars. For an estimated student population, in the US, of 50 million students, who could use these projects during a minimum of three years, we would have a cost of 40 cents per student-year.

Another dimension where the national implementation would be very important, is that of the transferability of educational credits. A student learning at the fourth grade level, irrespective of age, should be able to move to another school, maybe in another state, and continue to be in the fourth grade. Ideally, if all schools were working according to our proposal, the transition would be very smooth, because the student would continue to learn enjoying the same instructional methods, and the same type of educational environment.

Superior Work-Force for Industry and Services

In the era of information and high-tech, the instructional level required for the work force is much higher than in previous eras. This point has been made in several opportunities and, most forcefully in the report: "A Nation at Risk".

The high standards defined in the common curriculum result in a population able to cope with the requirements of the most sophisticated industries. Otherwise, the uneconomical trend will continue of industries having to educate their work-force according to their requirements, which are not satisfied by the graduates of the present educational system. Another important dimension is time. By accelerating the better learners, we allow for their incorporation into the work force, with or without an university degree, in a much shorter time than in the conventional system.

Zero-Increment over the Present Educational Budget

The most "original" point in this proposal is to allow each student to progress according to his/her learning rate. As learning rates are normally distributed, this will result in the above-average students leaving the system in less time then what presently takes. Of course, this fact frees educational resources, personnel, materials and space. We can use the resources that have been freed to take care of the below-average students, who will require more teacher attention, more materials, and more time to stay in school. The symmetry of the distribution of learning rates allows us to say that, in general terms, the savings generated by the acceleration of the above-average students will compensate for the additional expenses required by the slower learners.

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