Improving the Productivity of America's Schools

Syntheses of thousands of research studies show the power of nine factors influencing learning.

HERBERT J. WALBERG

Education may be our largest enterprise in terms of the numbers of people involved, the value of human time required, and the capital and operating expenditures budgeted. The value of education invested in the American labor force, for example, is now \$815 billion compared to \$65 billion in 1900 (Walberg, 1983).

In the last few decades, moreover, spending on schools and colleges accelerated: it rose from \$11 billion to \$200 billion per year; from 3.4 to 6.8 percent of the gross national product. During the past half century, the inflation-adjusted annual cost of public-school education rose about five-fold from \$490 to \$2,500 per student (Walberg, 1984).

Education: A Declining Industry?

Even though costs have risen, the National Commission on Excellence in Education (1983) and other groups report that students appear to be learning less. For example, comparisons made a decade or two ago showed that American students did relatively poorly. Although comparing achievements of U.S. students with those from countries with more homogeneous populations, national ministries of education, and centralized control can be misleading, the differences are striking enough to compel attention to our assumptions and practices.

Recent studies provide a grim picture of U.S. achievement even in the elementary grades. Stevenson (1983) found that in mathematics, U.S. students fell farther behind the Japanese and Taiwanese at each grade level; and, by 5th grade, the worst Asian classes in his large sample exceeded the best American class. My research and observations in elementary science classes in Japan corroborate his findings. Recent achievement comparisons in high school mathematics also showed that American high school students score on average at the first or second percentile of Japanese norms (Walberg, 1983; Walberg, Harnisch, and Tsai, 1984).

Herbert J. Walberg is Research Professor of Education, College of Education, University of Illinois, Chicago.

Author's note: *I thank Benjamin S. Bloom and Ralph W. Tyler for comments on a previous version of this paper; the opinions and remaining shortcomings, however, are attributable to me.*

Thus, by measurable standards, U.S. educational productivity has not kept up even with that of U.S. smokestack industries such as steel, automobiles, and consumer electronics—which themselves are declining as world-class competitors in quality and costs. Of course, neither the costs of educational inputs, including human effort, nor the value of outputs relevant to immediate and long-term goals are well measured. For that reason it is difficult to arrive at definitive conclusions about the causal relations of educational investments, services, and values beyond the narrow areas indicated by objective achievement tests and reports of attitudes and behavior. Nevertheless, since 1975 my colleagues and I have tried to develop a comprehensive framework for the analysis of productivity and test it out in a variety of classroom studies in the U.S. and other countries.

Research Approach

Following the lead of early agricultural experimentation, much educational research focuses on the relation of single causes and effects. Education, however, obviously involves many means and ends, each with an explicit or implicit cost or value. The promotion of efficiency requires the specification and measurement of the chief causes, means, or "factors" of production.

Experiments and statistical studies of productivity data together with cost and value estimates have enabled a wide variety of industries to increase the value of their output while simultaneously reducing costs, thereby raising human welfare. Although such thinking may seem alien to some educators, the public ranks research on educational productivity higher in priority than scientific investigation in most other natural and social sciences (Gallup, 1983; Walberg, 1983); and we educators may do well to think more explicitly and unsentimentally about our business and to try to found it on the emerging consensus of scientific evidence.

It should also be said, however, that we are far from being able to estimate explicit costs and values. The prior problem, now being solved, is estimating the magnitude of effects of educational inputs on outputs, which primarily involves causal rather than value questions.

"Since 1975 my colleagues and I have tried to develop a comprehensive framework for the analysis of productivity and test it out in a variety of classroom studies."

A Theory of Educational Productivity

Nine factors require optimization to increase affective, behavioral, and cognitive learning (see Figure 1). Potent, consistent, and widely generalizable, these nine factors fall into three groups:

Student aptitude includes:

1) Ability or prior achievement, as measured by the usual standardized tests,

2) Development, as indexed by chronological age or stage of maturation, and

3) Motivation, or self-concept, as indicated by personality tests or the student's willingness to persevere intensively on learning tasks.

Instruction includes:

4) The amount of time students engage in learning and

5) The quality of the instructional experience, including psychological and curricular aspects.

Four environmental factors also consistently affect learning: the educationally stimulating, psychological climates of

6) The home,

7) The classroom social group,

8) The peer group outside the school, and

9) Use of out-of-school time (specifically, the amount of leisure-time television viewing).

The first five aspects of student aptitude and instruction are prominent in the educational models of Benjamin Bloom, Jerome Bruner, John Carrol, Robert Glaser, and others (see Walberg, 1984, for a comparative analysis); each appears necessary for learning in school; without at least a small amount of each, the student can learn little. Large amounts of instruction and high degrees of ability, for example, may count for little if students are unmotivated or instruction is unsuitable.

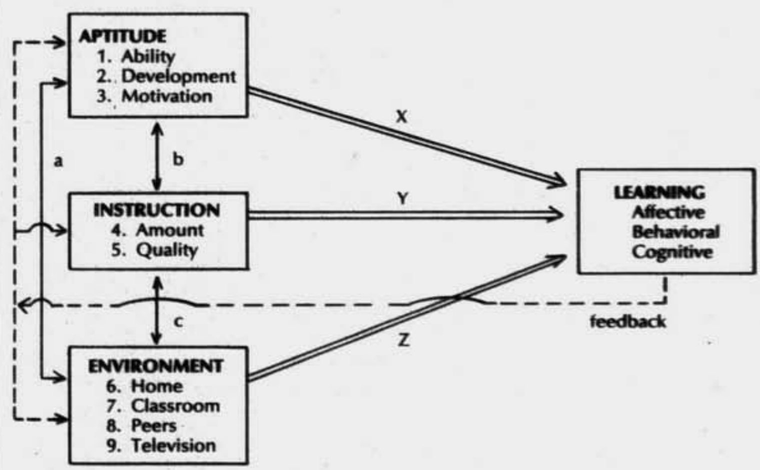
These five essential factors, however, are only partly alterable by educators since, for example, the curriculum in terms of lengths of time devoted to various subjects and activities is partly determined by diverse economic, political, and social forces. Ability and motivation, moreover, are influenced by parents, by prior learning, and by the students themselves. Thus educators are unlikely to raise achievement substantially by their own efforts alone.

Three of the remaining factors—the psychological climate of the classroom group; enduring affection and academic stimulation from adults at home; and an out-of-school peer group with learning interests, goals, and activities—influence learning in two ways: students learn from them directly, and these factors indirectly benefit learning by raising student ability, motivation, and responsiveness to instruction. In addition, about ten (not the more typical 30) weekly hours of television time seems optimal for learning; more hours than this displace homework and other educationally and developmentally constructive activities outside school.

As Figure 1 shows, the major causal influences flow from aptitudes, instruction, and the psychological environment to learning. In addition, however, these factors also influence one another, and are influenced in turn by how much students learn, since those who begin well learn faster (Walberg, 1984a).

Other factors influence learning in school but are less directly linked to academic learning. For example, class size, financial expenditures per student, and private governance (independent or sectarian in contrast to public control of schools) correlate only weakly with learning, especially if the initial abilities of students are considered. Thus, improvements in the more direct and more alterable factors hold the best hope for increasing educational productivity (Walberg and Shanahan, 1983).

Figure 1. Causal Influences on Student Learning



Aptitude, instruction, and the psychological environment are major direct causes of learning (shown as double arrows X, Y, and Z). They also influence one another (shown as arrows a, b, and c), and are in turn influenced by feedback on the amount of learning that takes place (shown as broken arrows).

Applied Research

Unlike other national studies of education that have relied on hearings and testimony, our investigations of educational productivity followed applied research in the natural sciences in several respects (Walberg, 1983a). The theory of educational productivity (discussed above) which guided the inquiry (Walberg, 1981) is sufficiently explicit to test; and, using large bodies of national and international data, a wide variety of empirical studies of it were conducted.

We published about two dozen of these empirical studies in research journals of the American Educational Research Association and the American Psychological Association that require review by referees as in other scientific disciplines. Only after extensive observation and some modifications of the theory (notably the addition of television and peer group to the list of major factors) were the implications drawn in professional and policy journals such as *Educational Leadership* and *Daedalus*. Like other explicit scientific theories, however, the theory of educational productivity should be considered open to disproof in part or whole by empirical contradiction.

In our investigations, we tried to follow three scientific canons—parsimony, replication, and generalizability. Parsimony means that the theory converges on the least number of factors that powerfully and consistently predict or explain cognitive, affective, and behaviorial learning.

In this regard, the theory is reductionist and psychological: it fundamentally assumes that academic learning is an individual affective, behavioral, and cognitive activity that mainly takes place in the social context of the classroom group as well as in the home and peer groups. This is not to deny the influence of Washington, the statehouse, the community, superintendent, and principal but to encourage examination of their effects on the nine factors directly impinging on individual students.

Thus, from our view, school and district economic, political, and sociological characteristics are less relevant to learning because their influences are less alterable, direct, and observable. They are not substitutes for the nine factors, but more distant forces that can support or interfere with them.

More and less productive classes, moreover, may be expected in the same school; and it is somewhat misleading to characterize a whole school or district as effective—just as it is less accurate to speak of the optimal condition for plant growth as being the average annual rainfall in a state rather than the amount of moisture reaching the roots of a single plant.

The educational productivity theory itself is admittedly simplified because learning is clearly affected by school and district characteristics as well as by many economic, sociological, and political forces at the school, community, state, and national levels. Yet these characteristics and forces—such as the sex, ethnicity, and socioeconomic status of the student, the size and expenditure levels of schools and districts, and their political and sociological organization—are less alterable in a democratic, pluralistic society; are less consistently and powerfully linked to learning; and appear to operate mainly through the nine factors in the determination of achievement. Thus, we offer our theory not as a threat to those concerned about these other factors but as a friendly, collegial invitation to demonstrate their effects on the nine factors or directly on the outcomes of schooling.

The canon of *replication*, means that the findings in similarly designed studies should reproduce one another fairly closely. For example, reinforcement or reward of learning has been implemented in various forms such as candy, tokens, symbols, and social recognition; it can be and usually is operationally defined in various studies. The question is whether these forms are the same or different in their effects.

To answer this question, the various implementations or strategies grouped under the same category may be more finely categorized and empirically compared in their effects on learning to see if their magnitudes are the same or different. Simple rather than complicated, detailed classifications usually serve to summarize the findings; and these relatively simple findings suggest educational implications that are convenient and practical to implement.

Generalizability means that studies should yield similar results in national and international samples of students of different characteristics such as sex and age, in different subjects such as civics and science, and using different research methods such as surveys, case studies, and experiments (Walberg, 1983a). For example, the effects of mastery learning on different types of students and in different school subjects and grade levels may be estimated to determine the extent of their generality.

What has been empirically found in thousands of studies is that generally the results are surprisingly robust. Echoing the folk adage, what's good for the goose is good for the gander.

But there are exceptions to the results reported below. The more powerful factors appear to benefit all students in all conditions; but some students appear to benefit somewhat more than others under some conditions. In addition, some studies report larger effects than the averages given below; others, of course, report smaller effects than the average. The cited research should be consulted for details.

Methods of Research

Since our concern was productivity, we hoped that our own research would efficiently capitalize on previous inquiry; and, under the support of the National Institute of Education and the National Science Foundation, our team of investigators started by compiling reviews of the 1970s on the productive factors in learning (Walberg, Schiller, and Haertel, 1979; Waxman and Walberg, 1982). Next, quantitative syntheses of all available studies of productive factors were conducted; syntheses of nearly 3,000 investigations—summarized below—were compiled (see Walberg, 1984c, for a more detailed account). Case studies of Japanese and American classes were carried out to compare educational productivity in the two countries (Schiller and Walberg, 1982; Walberg, 1983).

The productive factors were further probed for their significance in promoting learning in three large sets of statistical data on elementary and high school students—the National Assessment of Educational Progress, High School and Beyond, and the International Study of Educational Achievement (Walberg, 1984c; Walberg and Shanahan, 1983; and Walberg, Harnisch, and Tsai, 1984). Finally, large-scale studies were made of the most effective ways of assisting educators to bring about constructive changes in schools (Walberg and Genova, 1982).

Results

Collectively the various studies suggest that the three groups of previously-defined nine factors are powerful and consistent in influencing learning. Syntheses of about 3,000 studies suggest that these generalizable factors are the chief influences on cognitive, affective, and behavioral learning (see Figures 2 through 4). Many aspects of these factors can be altered or influenced by educators.

The first five essential factors appear to substitute, compensate, or trade-off for one another at diminishing rates of return. Immense quantities of time, for example, may be required for a moderate amount of learning if motivation, ability, or instructional quality is minimal. Thus, no single essential factor overwhelms the others; all appear important.

Although the other factors are consistent correlates of academic learning, they may directly supplement as well as indirectly influence the essential classroom factors. In either case, the powerful influences of out-of-school factors, especially the home environment, must be considered.

For example, the 12 years of 180 six-hour days in elementary and secondary school add up to only about 13 percent of the waking, potentially-educative time during the first 18 years of life. If a large fraction of the student's waking time nominally under the control of parents that is spent outside school were to be spent in academically-stimulating conditions in the home and peer group, then the total amount of the student's total learning time would be dramatically raised beyond the 13 percent of the time in conventional American schools.

For instance, the mere four or five hours per week high school students typically devote to homework might be supplemented by some of the 28 hours per week they spend viewing television (Walberg and Shanahan, 1983). Europeans and Japanese believe homework helps learning; empirical results of American research summarized below support their belief.

Specific Effects

Figures 2 through 4 show the numerical results of syntheses of several thousand studies of academic learning conducted during the past half century. Interested readers and those who wish technical details may examine the findings and methods reported in the compilations of these syntheses (cited in the references), which in turn, contain references to the original studies. (In several instances, separate estimates of correlations and effects are available for science and mathematics because the National Science Foundation awarded grants for special synthesis projects on these two subjects. The tables contain both effects and correlations, and the correlations assume a one-standard deviation rise in the independent variable).

Student Aptitude

Figure 2 shows that IQ is a strong correlate of general academic learning but only a moderately strong correlate of science learning. A student's Piagetian stage of development correlates moderately with both general and science learning. By comparison, motivation and self concept are weaker correlates.

Student aptitudes as a set may be less alterable than instruction. Yet positive home environments and good instruction affect them (Figure 1); and, since they are powerful correlates of learning, they deserve inclusion in theories of educational productivity.

The Largest Instructional Effects

Figure 3 shows the effects of various aspects and methods of instruction. Of all the factors in the table, the psychological components of mastery learning rank first and fourth in their effects on educational outcomes: Skinnerian reinforcement or reward for correct performance has the largest overall average effect—1.17 standard deviations; instructional cues, engagement, and corrective feedback have effects equal to approximately one standard deviation. Separate syntheses of mastery programs in science show an average effect of .8.

Acceleration programs, ranked second in effect, provide advanced activities to elementary and high school students with outstanding test scores. Students in these programs gain much more than comparable control groups.

Reading training, ranked third in instructional impact, refers to programs that coach learners in adjusting reading speed and techniques to purposes such as skimming, comprehension, and finding answers to questions. The usual learning criterion in evaluating these programs is learner adaptability to purpose.

Other Large Effects

Several other instructional programs and methods have strong effects ranging from .3 to .8. These include cooperative-team learning in which some autonomy over the means and pace of learning is delegated to students who help each other in small groups.

Figure 2. Influences of Aptitudes on Learning

Aptitude	Effect	Size
Ability		
IQ	.71	XXXXXXX
IQ (Science)	.48	XXXXX
Development		
Piagetian Stage	.47	XXXXX
Pia. Stage (Science)	.40	XXXX
Motivation		
Motivation	.34	XXX
Self-Concept	.18	XX

Note: The X symbols represent the sizes of the correlation coefficients in numbers of tenths.

Personalized and adaptive instruction, tutoring, and diagnostic-prescriptive methods also have strong effects. Personalized learning, sometimes called "the Keller Plan," is similar to mastery learning in mainly eliminating lectures and recitations but guiding each student by entry tests and written lessons plus individual help. Adaptive instruction uses similar techniques plus work in small groups and differentiated staffing to increase learning.

Tutoring and lesson prescriptions based on diagnosed individual needs are similar ways to adapt instruction to learners rather than batch-processing them. These related methods may attain their success by helping students to concentrate on the specific goals they individually need to achieve, or by freeing them from the pervasive seatwork and recitation in groups that may suit only the middle third of the students.

Moderate and Small Effects of Instruction

Although many schools no longer use the science and mathematics curricula created in the decade after Sputnik in 1957, several syntheses of their evaluations show that they had moderate effects on learning.

High teacher expectations for student performance also have a moderate effect, on average, as do advance organizers, which are "cognitive maps" showing the relationship of material to be learned in a lesson to concepts learned in previous lessons.

Some highly touted programs have had small and even negative effects on average (shown in the lower part of Figure 3). Reduced class size, for example, has small positive effects but is expensive and draws money and effort away from factors with large effects.

(Japanese school classes often run three times the current U.S. average of 17 students per class; yet they consistently rank highest among nations compared in mathematics and science achievement. With fixed or declining budgets for U.S. education, we may face the trade-off of sharply increasing teachers' salaries and incentives—which may help the morale and productivity of a smaller, elite workforce—*versus* keeping class sizes far smaller than the averages of the first seven decades of American education in this century.)

The effect reported for computer-assisted instruction is deceptively small. Most of the research was conducted with drill-and-practice or "page-turning" programs rather than the more psychologically sophisticated ones now being developed. Because future programs will be able to adapt to learner interests and abilities, they are likely to show large effects (Walberg , 1983). (However, educators may have to wait a decade or two before such effects are demonstrated. Accumulating closets full of unused or usable computers today may deter valid and efficient use of much better ones later.)

Quantity and Instruction

Instructional time, as shown in the last line of Figure 3, has an overall correlation of about .4 with learning outcomes. It is neither the chief determinant nor a weak correlate of learning; like the other essential factors, time appears to be a necessary ingredient but insufficient by itself to produce learning.

For at least two reasons, time is a particularly interesting factor: first, several national reports have called attention to the need for lengthening the school day and year to the levels of other countries, particularly Japan and Western Europe (National Commission, 1983; Walberg, 1983).

Second, time is the only factor that can be roughly measured on a ratio scale with equal intervals between scale points and a true zero point. Perhaps because it can be measured on an absolute scale resembling capital and labor inputs to production processes in agriculture and industry, time has shown diminishing returns (Frederick and Walberg, 1980): equal additions of time, with other factors held fixed, yield ever smaller gains in learning, which suggests that neither time alone nor any other factor by itself can solve the productivity problem.

It is also reasonable to think that zero time results in zero learning no matter what the level of the other factors, and, to generalize, that each of the other essential factors, if well measured, would prove necessary but insufficient by itself and would show diminishing returns—thus the possible danger of concentrating on any one factor alone.

Since the other factors are not measured as universally and precisely as time, this remains a matter of speculation. But it can be concluded that learning is produced jointly by several factors rather than any one by itself. A preliminary estimate suggests that optimizing all the factors simultaneously is associated with an effect of about 3.7, which is about three times the 1.2 effect of the most powerful factor, reinforcement, by itself and nearly 15 times the effect of socioeconomic status (Horn and Walberg, 1984).

Environments

Figure 4 shows the major results of syntheses of the supportive or supplementary factors. Ignored in several national reports and in instructional theories, these factors have strong influences on learning. The psychological morale or climate of the classroom group, for example, strongly predicts end-of-course measures of affective, behavioral, and cognitive learning. Morale refers to the cohesiveness, satisfaction, goal direction, and related social-psychological properties or climate of the classroom group perceived by students. By comparison, the influence of the peer-group outside of school is moderate and comparable to the influence of the student's socioeconomic status (SES).

As also shown in Figure 4, homework that is graded or commented upon has three times the effect of SES. By comparison, homework that is merely assigned has an effect comparable to SES. More than about 12 per weekly hours of leisure-time television viewing, perhaps because it displaces more educationally-constructive home activities, has a weak negative or deleterious influence on school learning.

In addition to increasing supervised homework and reducing television viewing, school-parent programs to improve academic conditions in the home

Figure 3. Instructional Quality and Time Effects on Learning

Method	Effect	Size
Reinforcement	1.17	XXXXXXXXXXXX
Acceleration	1.00	XXXXXXXXXX
Reading Training	.97	XXXXXXXXXX
Cues and Feedback	.97	XXXXXXXXXX
Science Mastery Learning	.81	XXXXXXXX
Cooperative Learning	.76	XXXXXXXX
Reading Experiments	.60	XXXXXX
Personalized Instruction	.57	XXXXXX
Adaptive Instruction	.45	XXXXX
Tutoring	.40	XXXX
Individualized Science	.35	XXXX
Higher-Order Questions	.34	XXX
Diagnostic Prescriptive Methods	.33	XXX
Individualized Instruction	.32	XXX
Individualized Mathematics	.32	XXX
New Science Curricula	.31	XXX
Teacher Expectations	.28	XXX
Computer Assisted Instruction	.24	XX
Sequenced Lessons	.24	XX
Advance Organizers	.23	XX
New Mathematics Curricula	.18	XX
Inquiry Biology	.16	XX
Homogeneous Groups	.10	X
Class Size	.09	X
Programmed Instruction	−.03	−.
Mainstreaming	−.12	−X.
Instructional Time	.38	XXXX

Note: The X symbols represent the sizes of effects in tenths of standard deviations.

Figure 4. Home, Peer, Class Morale, and Media Effects

Method	Effect	
Graded Homework	.79	XXXXXXXX
Class Morale	.60	XXXXXX
Home Interventions	.50	XXXXX
Home Environment	.37	XXXX
Assigned Homework	.28	XXX
Socioeconomic Status	.25	XXX
Peer Group	.24	XX
Television	−.05	X.

Note: The X symbols represent the sizes of effects in tenths of standard deviations or correlations.

have an outstanding record of success in promoting achievement. What might be called "the alterable curriculum of the home" is twice as predictive of academic learning as is family SES.

This curriculum refers to informed parent-child conversations about school and everyday events; encouragement and discussion of leisure reading; monitoring and joint critical analysis of television viewing and peer activities; deferral of immediate gratifications to accomplish long-term human-capital goals; expressions of affection and interest in the child's academic and other progress as a person; and perhaps, among such unremitting efforts, smiles, laughter, caprice, and serendipity.

Cooperative efforts by parents and educators to modify these alterable academic conditions in the home have strong, beneficial effects on learning. In 29 controlled studies of the past decade, 91 percent of the comparisons favored children in such programs over nonparticipant control groups. Although the average effect was twice that of SES, some programs had effects ten times as large; and the programs appear to benefit older as well as younger students.

Since few of the programs lasted more than a semester, the potential for those sustained over the years of schooling is great. On the other hand, it should be recognized that educators cannot carry out these programs by themselves; they require the concerted cooperation of parents, students, and other agents in the community.

Autonomous Learning

If education proceeds by fads rather than cumulative research, it will fail to make the great advances in productivity that have characterized agriculture and industry in this century. Syntheses of research on the effects of open education illustrate the dangers of basing conclusions, policies, and practices on single studies no matter how large or widely publicized. They also illustrate the strengths of replication and improved methods of synthesis, and a shortcoming of some of the research discussed above that employs grades and standardized achievement as the only outcome of educaton.

Open education has been dismissed by many educators, but syntheses of research now illuminate its beneficial effects. From the start, open educators tried to encourage educational outcomes that reflect teacher, parent, student, and school board goals such as cooperation, critical thinking, self reliance, constructive attitudes, life-long learning, and other objectives that technially oriented psychometrists seldom measure. Raven's (1981) summary of surveys in Western countries, including England and the United States, shows that, when given a choice, educators, parents, and students rank these goals above standardized test scores and school marks.

Moreover, a synthesis of the relation between grades and adult success shows their slight association (Samson and others, 1984). Thirty-three post-1949 studies of the college and professional-school grades of physicians, engineers, civil servants, teachers, and other groups show an average correlation of .155 of these educational outcomes with life-success indicators such as income; self-rated happiness; work performance and output indexes; and self-, peer-, and supervisor-ratings of occupational effectiveness.

These results should challenge educators and researchers to seek a balance between continuing autonomy, motivation, responsibility, and skills to learn new tasks as an individual or group member on one hand and memorization of teacher-chosen, textbook knowledge that may soon be obsolete or forgotten on the other. Perhaps since Socrates, however, these views have remained so polarized that educators find it difficult to stand firmly on the high middle ground of balanced or cooperative teacher-student determination of the goals, means, and evaluation of learning.

Progressive education, the Dalton and Winnetka plans, team teaching, and the ungraded school, and other innovations in this century—all held forth this or a similar ideal but drifted into authoritarianism, permissiveness, or confusion. They were difficult to sustain as idealized.

"The 'alterable curriculum of the home' is twice as predictive of academic learning as is family socioeconomic status."

Although open education, like its precursors, faded from view, it was more massively researched by dozens of investigators whose work goes little noted. Perhaps the syntheses of this research may be useful to educators who want to base practice on synthesized knowledge rather than on fads, or to those who will evaluate future descendants of open education.

Hedges, Giaconia, and Gage (1981) synthesized 153 studies of open education, including 90 dissertations. The average effect was near zero for achievement, locus of control, self concept, and anxiety (which suggests no difference between open and control classes on these criteria); about .2 for adjustment, attitude toward schools and teachers, curiosity, and general mental ability; and about a moderate .3 for cooperativeness, creativity, and independence. Thus, students in open classes do no worse in standardized achievement and slightly to moderately better on several outcomes that educators, parents, and students hold to be of great value.

Unfortunately, the negative conclusion of Bennett's (1976) single study—introduced by a prominent psychologist, published by Harvard University Press, publicized by *The New York Times* and by experts that take the press as their source—trumpeted the failure of open education, even though the conclusion of the study was later retracted (Aitkin, Bennett, and Hesketh, 1981) because of obvious statistical flaws in the original analysis (Aitkin, Anderson, and Hinde, 1981).

Giaconia and Hedges (1982) took another recent and constructive step in the synthesis of open education research. From their prior synthesis, they identified the studies with the largest positive and negative effects on several outcomes to differentiate more and less effective program features. They found that programs that are more effective in producing the nonachievement outcomes—attitude, creativity, and self concept—sacrificed academic achievement on standardized measures.

These programs were characterized by emphasis on the role of the child in learning, use of diagnostic rather than norm-referenced evaluation, individualized instruction, and manipulative materials but not three other components sometimes thought essential to open programs—multi-age grouping, open space, and team teaching. Giaconia and Hedges speculate that children in the most extreme open programs may do somewhat less well on conventional achievement tests because they have little experience with them. At any rate, it appears from the two most comprehensive syntheses of effects that open classes on average enhance several nonstandard outcomes without detracting from academic achievement unless they are radically extreme.

Caveats and Conclusions

Research workers and educators should retain both openmindedness and skepticism about educational productivity and syntheses of research. Yet the present does seem a period of quiet accomplishment. In a short time, research synthesis and other comprehensive approaches helped sort what is known from what needs to be known about some important means and ends of education.

Agriculture, engineering, and medicine made great strides in improving human welfare as doubts arose about traditional, natural, and mystical practices, as the widened measurement of results intensified, as experimental findings were synthesized, and as their theoretical and practical implications were coordinated and vigorously implemented and evaluated. Education is no less open to humanistic and scientific inquiry and no lower in priority since half the workers in modern nations are in knowledge industries, and the value of investments in people is now more apparent than ever (Walberg, 1983). Although more and better research is required, synthesis points the way toward improvements that seem likely to increase teaching effectiveness and educational productivity.

In addition, we educators can learn more from our past successes and failures in using scarce resources, especially human time, to meet competing goals. Recent national reports may rightly call for more emphasis on academic subject matter, and the National Commission on Excellence (1983) seems right in emphasizing the need for more time in school. But students should also be employing more time in academic pursuits outside the school and using both in-school and out-of-school time more efficiently.

Synthesis of educational and psychological research in ordinary schools shows that improving the amount and quality of instruction can result in vastly more effective and efficient academic learning. Educators can do even more by also enlisting families as partners and engaging them directly and indirectly in their efforts.

The present overview of a vast amount of research cannot substitute for selectively reading some of the several dozen syntheses and thousands of studies conducted in the past half century. Since many details are omitted here, reading the original material might promote a more complete and critical understanding of specific factors and methods. For example, although the factors that have large effects are robustly positive, exceptional conditions can reduce their effectiveness.

Finally, educational costs and goals beyond immediate measurement are worth remembering. But great accomplishments also result from sustained hard work, supportive parents, and world-class standards and instruction. Psychological studies of the lives of eminent painters, writers, musicians, philosophers, scientists, and religious and political leaders of past centuries as well as prize-winning adolescents of today reveal early, intense, and sustained concentration as well as parents and teachers who sacrificed much to help them.

World-class performance may require 70 hours of effective instruction and practice per week for a decade (Walberg, 1983). It may take considerably more—or perhaps less. The fact that we cannot say shows how much more we need to know about investing in students—and how much more seriously educators and their allies might take the idea of improving their productivity.□

References

Aitkin, M.; Anderson, D.; and Hinde, J. "Modeling of Data on Teaching Styles (with Discussion)." *Journal of the Royal Statistical Society, Series* A 144 (1981): 419–461.

Aitkin, M.; Bennett, S.N.; and Hesketh, J. "Teaching Styles and Pupil Progress: A Re-Analysis." *British Journal of Educational Psychology* 51 (1984), in press.

Bennett, S.N. *Teaching Styles and Pupil Progress.* London: Open Books, 1976.

Gallup, G.H. "The 15th Annual Gallup Poll of the Public's Attitudes Toward the Schools." *Phi Delta Kappan* 65, 1 (1983): 33–47.

Giaconia, R.M., and Hedges, L.V. *Identifying Features of Open Education.* Stanford, Calif.: Stanford Center for Educational Research, 1982.

Hedges, L.V.; Giaconia, R.M.; and Gage, N.L. *Meta-Analysis of the Effects of Open and Traditional Instruction.* Stanford, Calif.: Stanford University Program on Teaching Effectiveness, 1981.

Horn, A. and Walberg, H.J. "Achievement and Attitude as Functions of Quantity and Quality of Instruction." *Journal of Educational Research* (1984), in press.

National Commission on Excellence in Education. *A Nation at Risk.* Washington, D.C.: U.S. Government Printing Office, 1983.

Raven, J. "The Most Important Problem in Education is to Come to Terms With Values." *Oxford Review of Education* 7 (1981): 253–272.

Samson, G.; Graue, M.E.; Weinstein, T.; and Walberg, H.J. "Academic and Occupational Performance: A Quantitative Synthesis." *American Educational Research Journal* (1984, in press).

Schiller, D.P., and Walberg, H.J. "Japan: The Learning Society." *Educational Leadership* 39 (March 1982): 411–413.

Stevenson, H. *Comparisons of Japanese, Taiwanese, and American Mathematics Achievement.* Stanford, Calif.: Center for Advanced Study in the Behavioral Sciences, 1983.

Walberg, H.J. "A Psychological Theory of Educational Productivity." In *Psychology and Education.* Edited by F.H. Farley and N. Gordon. Berkeley, Calif.: McCutchan, 1981.

Walberg, H.J. "Scientific Literacy and Economic Productivity in International Perspective." *Daedalus* 112 (1983): 1–28.

Walberg, H.J. "Families as Partners in Educational Productivity." *Phi Delta Kappan* (1984a), in press.

Walberg, H.J. "Quantification Reconsidered." In *Review of Research in Education.* Edited by E. Gordon. Washington, D.C.: American Educational Research Association, 1984b.

Walberg, H.J. "Synthesis of Research on Teaching." In *Handbook of Research on Teaching.* Edited by M.C. Wittrock. Washington, D.C.: American Educational Research Association, 1984c.

Walberg, H.J., and Genova, W.J. "Staff, School, and Workshop Influences on Knowledge Use in Educational Improvement Efforts." *Journal of Educational Research* 72 (1982): 69–80.

Walberg, H.J.; Harnisch, D.; and Tsai, S.-L. "High School Productivity in Twelve Countries." *Journal of Educational Research* (1984), in press.

Walberg, H.J.; Schiller, D.P.; and Haertel, G.D. "The Quiet Revolution in Educational Research." *Phi Delta Kappan* 61, 3 (1979): 179–182.

Walberg, H.J., and Shanahan, T. "High School Effects on Individual Students." *Educational Researcher* 12, 7 (1983): 4–9.

Waxman, H.C., and Walberg, H.J. "The Relation of Teaching and Learning: A Review of Reviews." *Contemporary Education Review* 2 (1982): 103–120.

A Guide to Educational Trouble-Shooting

Walberg's work shows that no single factor by itself determines learning, but that a few key factors in combination do. Educators can use this knowledge to examine their own school programs.

RALPH W. TYLER

Many of us who are concerned with teaching and learning have had difficulty in making constructive use of reports of educational research, particularly those dealing with large aggregates of data. Herbert Walberg has done a superior interpretation of one of the most massive collections of data on school learning. He avoids the common weaknesses of many statistical reports; he recognizes the complexity of much human learning and does not try to reduce it to a simplistic model; he discusses the meaning of the data as well as indicating the quantitative results; he does not confuse statistical significance with substantive or social significance; he seeks to explain interactions among variables in common-sense terms; and he examines and reports both macro studies and micro studies.

A macro study in the social sciences deals with large bodies of data aggregated over a large number and variety of phenomena. It seeks to develop a mathematical equation that will produce from a relatively few factors or variables a numerical approximation to the many particular quantities reported as data. Early macro studies in the fields of agricultural economics illustrate the nature of macro studies in the social sciences. The investigators sought to develop an equation that would produce an approximation to the actual reported agricultural production in the leading Western nations. The original equation that was developed predicted the quantity of a product produced by the nation from the amount of land devoted to producing the product, the number of persons employed in the production,

Ralph W. Tyler is Director Emeritus, Center for Advanced Study of the Behavioral Sciences, Palo Alto, California.