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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

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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,

and the value of the farm machinery used.

Later, the production practices in many Western nations changed as scientific knowledge of genetics and other biological phenomena guided the development of new agricultural technologies. Macro studies then produced new equations, in which the number of persons employed in agricultural production had little influence on the quantity produced while a new factor, *the level of technology used in production*, had relatively large influence. These macro studies summarized data obtained from many countries and for many crops, and were used by some national policymakers seeking to increase agricultural productivity. The equation indicated that where land was scarce and high priced it would be more efficient to raise the level of technology employed in agriculture than to obtain more land for agricultural use.

Walberg's macro study is quite analogous to other macro studies in the social sciences. From his analysis of masses of data about academic learning for many subject areas, he developed an equation, employing only nine factors or variables, which approximately predicts the reported numerical measures of learning. These nine factors appear to be sensible; that is, each is often recognized as a probable influence on student learning.

To develop the measuring scales that made it possible to aggregate many studies using different measures, and to synthesize the nine factors from the masses of data examined must have been an enormous task. The value of this work for the research community seems clear. Walberg and his associates have shown a way by which the apparently heterogeneous studies, producing masses of data, can be arranged in an orderly fashion and the results interpreted in terms of relatively few factors. Work of this sort is central to the development of systematic knowledge.

The Significance of Walberg's Research

But what value has this study for the educational practitioner? How can teachers and administrators use Walberg's report?

In the first place, it furnishes us with broader and more objective support for the commonly held view of teachers that school learning can largely be understood as a complex of a relatively small number of underlying factors, some of which can be greatly influenced by teachers. Notions in conflict with this finding are sometimes expressed in the educational literature. For example, attention is sometimes given to a single factor—such as open classrooms, time-on-task, self-concept, or learning style—as though the development of it alone would result in great educational improvement. Walberg's study makes clear that no single factor alone can produce marked increases in academic learning.

A contrary notion that also conflicts with Walberg's findings is that school learning is too complex to be understood in terms of only a few factors, because each situation is unique and can be understood only as impressions obtained by deep immersion as an active participant in that situation. It is, of course, true that every situation and every individual is in some respects unique, but some helpful degree of understanding can be obtained by approximate predictions. This is what Walberg has obtained in his macro study.

A third notion that is dispelled by Walberg's findings is that the important factors in academic learning are those that cannot be altered by teachers or the school. Some claim, for instance, that the child's inherent abilities and the family's social class and culture affect academic learning to such an extent that the school can have little influence on it. Walberg's findings reinforce teachers' observations that there are many exceptions to that claim. Teachers often find high-achieving students who come from homes of poverty or from minority ethnic groups. They have noted diversity among parents within each social group in such matters as: concern that their children do well in school, establishment of a regimen of study and work at home, firm control of their children's television viewing. Many teachers have found that parents often strongly support their children's schooling even when their own education has been limited

and their financial resources scarce. They have also observed among parents who are college graduates of upper social status some diversity in matters relating to their children's schooling. Some of those more fortunate parents show little interest and support for their children's school tasks; some make no effort to develop at home a regimen of work and study for their children. Thus it is reassuring to find that these personal observations are in harmony with generalizations developed from data from a wide range of sources.

Macro Studies: The Big Picture

Macro studies in education seek to identify factors that have wide generalizability; that is, they are found to be influential in a wide range of places, situations, teachers, students, and subjects. Inevitably, such generalizations are approximations and do not indicate the variations that may be found in particular situations. These approximations in education are found both in so-called input factors and in outputs. For example, there is not presently available a measure of aptitude that is equally appropriate for children from different family backgrounds using different vocabularies in the home. The indicators of development and motivation are many and varied among the Western nations. Attempts to assess the quality of instruction take many forms and give somewhat diverse results.

Much the same can be said about outcomes. Within the range of performance of a single school there is little correlation between gains in recalling information, gains in skills in problem solving, gains in reading interests, and gains in responding emotionally to works of art. Hence, the effort to treat such diverse outcomes in a common measure of learning results in a rough approximation. These approximations in Walberg's computations are close enough to identify the nine factors that correlate with the variations in student learning, but they are not precise enough to characterize the interactions taking place in particular situations. This requires micro studies.

Micro Studies: More Specific Effects

Walberg turns to micro studies under the heading of *specific effects*. However,

he summarizes these in large combinations of particular investigations. Although this procedure defines more fully the correlated factors, it necessarily loses the more particular relationships that represent some of the usefulness of a micro study. For example, as I reviewed some of the studies thus summarized, I was most conscious of the differences in effects of Skinnerian reinforcement when used with simple conditioned learning, such as decoding in primary reading, in contrast to its use with self-directed learning in physics. These differences were not visible in the summary.

The field of education differs from that of natural sciences. In the natural sciences, the effort is to understand natural phenomena that take place without regard to human effort. Education, on the other hand, is a social enterprise seeking to help persons acquire understanding, skills, attitudes, interests, and appreciations. It makes use of understanding acquired from other disciplines as teachers seek to produce forces and influences to affect student learning. Whereas in physics, the development of a precise definition for a force like radiation focuses on something that happens regardless of the intent or skill of the observer, the forces and influences in education are largely produced by people and are not exactly the same when produced by different people. Hence, when we try to define "instructional cues, engagement, and corrective feedback," we are seeking to define teaching procedures that are not well standardized. Furthermore their influence is mediated by students whose perceptions of what is happening may be different from the intent of the teacher. Nevertheless, Walberg's summary of micro studies gives us a more particularized understanding than is provided by macro studies, and he is thus able to define somewhat more clearly what the nine macro factors include.

If summaries of micro studies lose some of the important descriptions and findings of the individual studies, what value do they have to the practitioner? As with macro studies they provide a broad basis of support for major findings. Walberg and his associates have made numerical syntheses of the results

reported in several thousand studies of academic learning conducted during the past half-century. These syntheses furnish data from micro studies that identify some of the more specific factors classified under the nine large factors in the macro study. For example, the large factor *quality of the instructional experience* is defined in the summary of micro studies by such instructional practices as mastery learning, reward for correct performance, instructional cues, engagement, corrective feedback, acceleration, reading training, personalized and adaptive instruction, tutoring, and diagnostic/prescriptive methods.

Using Research for Our Own Purposes

Some educators expect research to provide a what-to-do manual for the improvement of teaching and learning. This is a misconception of research. Research can only report the results of practices actually tried out. It cannot report what would result from a new practice that you or I might invent, although the similarity of our invention to a practice that has been researched should help us to estimate the probable results of our invention. We must also remember that research findings are generalizations about groups, and do not predict an individual's behavior. This fact is not limited to educational research. For example, physical science research reports the distributions of molecules, atoms, or electrons; it does not report or predict the velocity or other characteristics of an individual molecule, atom, or electron. But this does not mean that we cannot obtain guidance from research in our work with individuals. As we learn about the behavior of groups of students, teachers, parents, and others, and obtain estimates of the means of these groups and their distribution, we have a guide for studying the particular school, classroom, student, teacher, or parent in order to understand our own situation more fully.

A near analogy is that of a trouble-shooting chart for a car that won't run. Essential to the functioning of an automobile are the fuel system, the electrical system, and the mechanical system of the piston and flywheel. Hence, to un-

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derstand why the car failed to function, we check the fuel system, the electrical system, and the mechanical system. Each of these systems in turn has its parts to check. In the fuel system, for example, we check the tank, the fuel in the tank, the tubing from tank to carburetor, and the carburetor. What we need to do to get our car to function is determined by what we discover from this *trouble-shooting*.

In a similar way, the more we understand about the factors influencing academic learning, the more complete learning system we have in mind to identify factors that may not be functioning and factors that can be strengthened in order to improve our instructional efforts. Reports from macro studies may in themselves furnish a useful picture for those responsible for policies at the district, state, or national level. These policies usually focus on large general factors like the number of days of instruction. But effective action by teachers for improved learning requires greater definition of factors to examine and the collection of data about these factors in the particular

school or classroom and with the particular students there. That is, the findings of research furnish a guide for the inquiries that school personnel need to make about the situation in that school. We as teachers can use general knowledge helpfully only as we obtain particular knowledge about our progress in promoting and guiding learning and the problems we encounter. We should not be surprised about this. The best physicians not only keep in touch with relevant medical research but they are also skillful diagnosticians. They collect data about the patient through observation, interview, and the like and also about the patient's environment. The effective use of medical research requires the physician to carry on his or her own investigations as well.

How do we verify our interpretations of our own inquiries and the steps we have taken to improve learning? By systematic evaluation of the conse-

quences of the steps we have taken. Has learning improved? The proof of a diagnosis and prescription is in the recovery of the patient. Correspondingly, the proof of our diagnosis of the learning situation and the steps we take to improve it is in the increased learning of the students. Research gives us guidance—but we are responsible for finding and analyzing our problems, deciding on tentative solutions, testing them, and verifying or refuting our interpretations.

The Future of Macro Studies of Academic Learning

As Walberg points out, his equation with its nine factors is not to be viewed as a final answer to the question of which factors most strongly influence student learning. With the passage of time, there will be other formulations, because new studies of learning will have been made that may give a new perspective on the total learning system.

Researchers also need to develop more valid and discriminating measures of the varied outcomes of schooling. These developments may shed light on two critical problems of school learning that have been identified in a number of studies in the past 30 years: *transfer* and *retention*.

The purpose of schooling is not to learn things that are used only in the classroom. The knowledge, skills, attitudes, interests, and appreciations that teachers seek to help students learn are those that could be a continuing resource on which to draw throughout life. They have been selected for the curriculum because they are helpful resources in various arenas, at home, in the social life of the community, at work, and in personal activities. Yet many students do not transfer what they are learning in the classroom to those situations outside where the learning could be helpful.

Furthermore, many students forget within a short time much of what they have been learning. The follow-up study of Project Talent found that these high school graduates, now in their 30s, could remember things learned in high school only if they recognized them as helpful in their occupations. They could seldom recall any use made of high school subject matter in their activities in the home, in civic affairs, in other community activities, or in their personal search for happiness and meaning in their lives. There were, of course, some exceptions but they represented less than a quarter of the group. Universal, democratic education seeks to help all students learn what only the favored few learned in the past. Hence, research on transfer and retention is of critical importance. I hope that studies of these problems will produce results that can soon be incorporated into macro studies that will synthesize the important influences on learning that result in transfer and retention.

Walberg has pioneered in studies that furnish guidance to us in seeking to improve academic learning. However, his report will be of minimum practical value unless we use it to guide our own inquiries and actions to improve the learning of our students. □

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