or needlework (King 1985, Pfeifer and Wald 1987). Sometimes this choice is influenced by philosophical or educational considerations, other times by expediency. Sex role stereotyping in the allocation of practical work has remained a persistent phenomenon and has further limited the educative value of work (Jennings 1987a). Some burning questions in this regard are: what exposure can be reconciled with local resources and social tolerance? what place is there for commerce and service activities, and in what ways can the advantages of low technology handicrafts be combined with an introduction to more advanced technologies? including computer aided ones? Further interchange between theorists and practitioners should help to clarify these and other concerns in education with production.

See also: Vocationalism: Theoretical Assumptions; Vocational Education and Training: Anglo-German Comparisons; Nongovernmental Organizations (Latin America); Training for Disadvantaged Groups; Primary School Agriculture in Sub-Saharan Africa; Training with Production

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Education and Productivity

The economic case for educational investment hinges on the assumption that education contributes to increased worker productivity (Schultz 1961). Since productivity differences among workers are difficult to measure, economists have argued that in competitive labor/product markets, marginal productivity equals wages. They have relied on earnings differences as a proxy for such productivity increases and have shown that more education does, indeed, appear to be directly related to such earnings differences (Blaug 1972). Earnings-based weights have then been used to measure education's contribution to output and economic growth (Denison 1967). However, using the earnings proxy assumes away the issue of whether earnings accurately measure productivity, or whether more education actually leads to higher productivity.

This entry focuses directly on the education–productivity relationship. It reviews the arguments that have been advanced for the existence of that relationship and empirical studies that purport to measure it.

1. Why Does Schooling Contribute to Economic Output?

There are five major explanations of why schooling contributes to higher productivity, and these are outlined below.

1.1 The Human Capital Explanation

The original human capital discussion of educational investment argued that something happens in school that results in improved economic performance for those who have schooling, and especially for those who complete levels of schooling. In other words, individuals acquire skills in school that enable them to produce more. These skills are directly related to the characteristics that labor needs so as to use other production inputs, namely capital and land, more efficiently.

1.2 The Disequilibrium Explanation

This reasoning had shifted by the mid-1970s to what Theodore Schultz called "adjusting to economic disequilibrium" (Schultz 1975). Schultz built on Welch's (1970) study of resource use in United States agriculture, which found that farmers with more education received higher gains in income from the use of other resources (more efficient allocation of resources), and then went on to argue that farmers with more education also adjust more rapidly to technological changes. They tend to adopt the new technology sooner and are more likely to make the economic changes dictated by the new technology so as to increase their income. According to Welch and Schultz, this ability to adjust to change and to adopt new ways of doing things, is the result of skills acquired in school, although it should be noted that, in these studies, it was farmers with university education who did significantly better during the process of technological change.

This interpretation of schooling's contribution to increased productivity assumes that the person with the additional education is in a position to make better decisions. The decision-making function is usually restricted to those who are self-employed or in a sufficiently high position of employment to have decision-making responsibility. If Schultz and Welch are right, one would expect that productivity increases due to education would be greater when those who get education enter occupations where they can make decisions, for example, small farmers rather than farm laborers, or small-scale entrepreneurs rather than employed semiskilled workers. Yet the economic returns to education should also be higher to employed workers in job situations where they are relied up on to make judgments rather than simply follow orders (Levin 1987).

The notion of adjusting to disequilibrium also has implications for women's education. As women get more education, the economic payoffs to their schooling should be higher in those activities where they get more say about resource allocation and responses to change. One possible reason for the fact that development projects aimed at women have met with only partial success is their failure to give women decision-making power over resource use. On the opposite side of the coin, countries that do not provide equal education to women often fail to increase productivity in rural areas or in the informal sector because women are often the ones who make the decisions in the use of family resources or market the products produced at the farm.

1.3 The Skills Explanation

A third explanation is that higher productivity skills acquired in school are fundamental for a person to function effectively in modern production organizations (Bowman and Anderson 1963, Peaslee 1967). In the main, these skills are the ability to perform basic mathematical operations (numeracy) and the ability to read and write (literacy). These are the communicative arts of modern society. For traditional societies, the initiation of youth into adult roles enabled those societies to reproduce their culture and their economic survival. For modern societies, numeracy and literacy serve much the same purpose. These skills help people to produce material goods more effectively, especially where following directions and making judgments in work are concerned. Such qualities in the work force improve productivity and therefore economic output.

1.4 The Organizational Explanation

A broader version of the explanation is that schools as organizations socialize young people into functioning effectively in modern society (Inkeles and Smith 1974). This explanation argues that, by virtue of their very structure and the kind of behavior they demand from children, schools and classrooms prepare them to function well in employment situations. As "modern" institutions, schools teach children to work in response to modern stimuli and inculcate in them values and norms that are consistent with productive behavior in factories, banks, and even agricultural cooperatives. Schooled youth become more competent to deal with the requirements of an urban, industrialized society and with its institutional organizations.

By teaching young people how to be effective in modern organizations, schools help them to respond more quickly, willingly, and predictably to demands from supervisors. In addition a schooled youth may learn how to work effectively with others in an organizational setting—to be what is known as a "team player"—since that type of behavior is also rewarded in school.

1.5 The Trainability Explanation

Some studies argue that what is learned in school—whether cognitive skills or certain types of behavior—is not nearly as important to future productivity as simply succeeding at what school demands (Arrow 1973, Carnoy and Levin 1985). Success may mean learning the skills that school requires the child to learn, or completing a particular level of schooling. The very fact of "success" in school sym-

bolizes social approval. It suggests that the young person is more likely to do well in the society beyond the school (Carnoy 1990). This conforms to the argument that education is a "filter," but even if it is a filter, success in school may confer a sense of probable success on the job. As long as this message is confirmed by experiences after graduating from school, such as being able to earn a livelihood, it makes individuals easy to convince that they can learn new tasks, make appropriate decisions and choices, and assume responsibility. These are all characteristics of a highly productive person.

Some would define these characteristics as "trainability," or "learnability." People who are successful in school are those who have shown that they can learn new things and carry them through. In effect, basic education is a training ground for further training or learning. Morever, the jobs or self-employment that provide the most training and learning require the most schooling to prepare young people to get them. This is not so much because of the mathematics and language skills they pick up, but rather because of the skills they acquire in learning how to learn. According to this argument, more education is related to higher productivity to the degree that it makes a high fraction of children "successful" in school.

This notion of "trainability" is consistent with the neoclassical human capital model, which assumes that individuals have free choice in deciding on the amount and kind of schooling that they take. In that case, an individual always feels "successful" in having completed the amount of schooling that is consistent with maximizing return on investment. The different amounts of schooling that are invested in define the degree of success in completing schooling tasks, hence the kind of jobs people can be trained for, and, in turn, their productivity (Rosen 1976).

However, there is a contrary view. If the amount of education individuals take is not just a function of individual choice, but also of the educational system's constraints and controls, education may act as a filter for selecting those relatively few children who can succeed at the tasks basic education places before them from the large majority of children who will "fail" at these tasks and will not complete schooling. If the "learnability" explanation is correct, this majority of failers, even if they are literate and numerate as a result of several years' attendance at school, consider themselves "failures" and are regarded as untrainable by the labor market. Because of the symbolism of their failure, they are indeed slower learners and unlikely to get work that requires further learning. As schooling expands, and the definition of "socially adequate" education changes to include more years of schooling, the filter becomes longer and the definition of school success and failure also changes. Even young people who complete secondary education but do not continue to university could eventually be made to feel unsuccessful, untrainable, and unlearning, as is the case in the United States.

2. *Empirical Evidence*

Studies attempting to relate productivity to either quantity of education, school-related skills, or student performance in school fall into three different categories: (a) correlational studies, (b) studies that measure individual educational attainment and individual productivity, and (c) studies that measure individual school-related achievement and individual productivity.

2.1 Correlational Studies

Economists have long argued that literacy and primary education are positively related to economic growth. The United Kingdom, Sweden, and the United States had all achieved relatively high rates of literacy (40–50%) just before their industrial revolutions. According to one study, no country with less than 40 percent adult literacy in 1955 had a per capita income higher than US $300 (equivalent to US $1400 in 1990), but literacy rates above 30–40 percent in and of themselves were not associated with higher per capita incomes. This suggests that unless a country is rich in a highly valued natural resource, such as petroleum or potash, a minimum level of literacy is a necessary although not a sufficient condition for economic development (Bowman and Anderson 1963).

Particularly after the Second World War primary school enrollment rates were more highly correlated with later per capita income than was either literacy or, to an even greater degree, postprimary enrollment rates (Bowman and Anderson 1963, Peaslee 1967). Throughout the developing world, primary school expansion in the 1950s and 1960s was associated with rapid increases in economic development in the 1960s and 1970s. Such correlation data suggest, but do not prove, a causal link between primary schooling of the population and economic growth (higher productivity) in some later period.

Another approach attempts to relate growth rates of developed countries in the post-Second World War era to increases in young adult IQ over a similar period (Bishop 1992). Using a variety of aptitude tests applied to large groups of young adults in the United States, Japan, and Western Europe between 1930 and the 1970s, Bishop correlates average annual gains on these tests to growth rates for nine countries. The results are rough but suggest that there is a positive and statistically significant relation.

2.2 Productivity Studies

Productivity measures are difficult to obtain (Metcalf 1985) and any estimate of the relationship between education and productivity is beset by limitations.

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Individuals who have completed different levels or amounts of education are generally in different types of jobs, producing different outputs.

However, in agriculture, more years of schooling do seem to result in higher output. A survey conducted for the World Bank of 18 studies that measured the relationship in low-income countries between farmers' education and their agricultural efficiency (as measured by crop production) concluded that a farmer with 4 years of elementary education was, on average, 8.7 percent more productive than a farmer with no education (Lockheed et al. 1980). The survey also found the effect of education to be even greater (13% increase in productivity) where complementary inputs, such as fertilizer, new seed, or farm machinery were available.

Further evidence on the effect of education in raising farmers' productivity appears in studies carried out in South Korea, Malaysia, and Thailand (Jamison and Lau 1982), and more recently in Pakistan, Nepal, Thailand, India, Bangladesh, and a number of Latin American countries (Jamison and Moock 1984, Moock and Addou 1992) (see *Agricultural Productivity and Education*). Other studies (Sack et al. 1980), although reporting mixed results, support the general conclusion that education contributes positively to agricultural productivity, especially when other inputs are available to farmers and land reform has created favorable conditions for a range of production choices.

In the United States, Welch's study of farmer response to technological change (new seeds and other new inputs) suggests that those farmers with higher education have higher earnings from farming (when other inputs are controlled for), respond more rapidly to adopting new inputs once they are available, and obtain higher yields from the use of such inputs (Welch 1970).

Several attempts have also been made to analyze the effect of education on productivity in industry (Berry 1980, Fuller 1970, Min 1987). Berry's review suggests that there is little conclusive evidence that education has a positive effect on productivity in urban jobs. Fuller's research in two electrical machinery plants in Bangalore, India shows that there is a positive effect of education and training on output, especially when that training is in-firm. Min's study of academically and vocationally educated workers in a Chinese automobile factory also shows a small, but statistically significant, increase in productivity associated with more education, and a 6–11 percent higher productivity for those with vocational schooling than for those with academic schooling.

Significant results for productivity–education relations in urban jobs are not easy to obtain because such studies necessarily measure these relations within a single occupation. Yet the main source of higher productivity for those who take more schooling is a move into different categories of jobs (where productivity can be higher), rather than an increase in productivity within the same job (Thurow and Lucas 1972). The more productive jobs also generally provide training that contributes to higher productivity, yet entrants to such jobs generally need to have completed certain levels of education to get them (Knight and Sabot 1990).

The difficulty of making productivity comparisons between different jobs also makes it difficult to assess what the education–productivity relation is. Even assuming that education is somehow responsible for higher productivity in more productive jobs, no study has been able to ascertain whether it is the skills associated with more schooling or the socialization into competence that produces higher productivity in those jobs, although there are some data that suggest a much higher correlation in the United States between socioeconomic background and earnings than between IQ and earnings (not productivity) when years of schooling are controlled for (Bowles and Gintis 1976). Economists have also failed to identify the skills learned at school—beyond adult IQ—that contribute to higher productivity (Carnoy and Carter 1976). An analysis of the adult IQ (achievement)–productivity relationship is presented below.

The more years of schooling completed, the higher the probability that individuals will find work in the formal sector or will stay in that sector once they get a job in it (Tueros 1992). Even so, in many countries the formal sector is growing so slowly that the more important issue is whether schooling contributes to worker productivity in the informal sector. Almost every developing country has a large informal labor market, where production takes place in small-scale units, using labor-intensive technology, and where workers are employed, paid, and dismissed without any regulation or control by government. The informal market is the result of urban growth without corresponding industrialization or increased formal employment in commerce and services.

A detailed study of the informal labor market in Peru shows that in both informal and formal sectors, education contributed to higher earnings, and in some cities, such as Lima, completing primary education seemed to be more significantly related to earnings in the informal sector than in the formal (Tueros 1992) (see *Education and Informal Labor Markets*). Within Peru's informal sector, the entrepreneur's education—especially if he or she has completed secondary education or above—is associated with a positive effect on the firm's profits. These results contradict the widely accepted idea that formal schooling is only relevant to economic performance in the formal sector. They also suggest that the technological and business problems faced by an entrepreneur in such small, informal enterprises requires at least some years of secondary education to increase profitability. This "threshold" effect of

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secondary education on productivity corresponds to the threshold effect of primary education on productivity in agriculture (Jamison and Lau 1982). Moreover, as Jamison and Lau noted for Asian farms, it is the education of the entrepreneur that really counts for profitability in the informal sector, not the education of the workers.

2.3 Student School Achievement and Productivity

In the United States, no significant relation has been found between school achievement and earnings for a given amount of schooling completed (Bishop 1992), possibly as a result of the following factors: (a) employers do not collect information on school performance, (b) there is no national examination in the United States that would yield such information at relatively low cost, and (c) only a small proportion (about 3%) of United States workers are subject to employer-administered tests prior to employment.

Similar insignificant results of childhood and adult aptitude (a proxy for school achievement) on earnings obtain from Swedish longitudinal data (Tuijnman 1989). In the Swedish case, earnings at various ages are closely related to youth education and home background, but not to scores on tests administered at age 10 and 20.

Bishop argues, however, that in those United States firms or enterprises where tests are administered, a significant relation does exist between an individual's school-acquired skills and productivity. He argues further that if it can be shown that scores on tests measuring school-subject aptitude are associated with higher productivity, then "better" education would necessarily raise productivity. Bishop cites two kinds of studies conducted in the United States: (a) US Army trainability ratings, and (b) studies that measure the relation between supervisor ratings and individual employer-administered examination scores in mathematics, verbal ability, and vocational skills. He concludes that early aptitude and the skills learned in school (achievement), as measured by adult aptitude, do have an important effect on both job productivity and trainability, even though these same test scores have insignificant effects on earnings.

In the case of test score effect on final grades in United States armed forces' training programs, Bishop's estimates from others' studies shows that mathematical knowledge and arithmetical reasoning subtests had a highly significant impact on grades, with verbal and science subtests showing less impact.

Bishop's estimates using employer test data indicate that even when years of schooling, relevant job experience, and tenure in the present job are accounted for, mathematical achievement, perceptual ability, and psychomotor ability are significantly related to job performance, as measured by supervisors ratings, in a wide range of broadly defined occupations. Verbal ability is only significant in clerical occupations. Years of schooling do not have a significant effect because of the low variance in schooling of those in each occupational set, but age and relevant work experience do produce sufficiently higher supervisor ratings for older, more experienced workers with low test scores to do better than younger, brighter ones. This suggests that, even if supervisor job performance ratings were considered unbiased estimates of productivity, 4 years of tenure in the job, or age or relevant experience, would offset the "productivity" effect of one standard deviation difference on these test scores.

In addition, controlling for test scores, years of schooling, experience, and tenure does not annul the very large and significant negative effect on ratings in all jobs of being Black and, in some types of jobs, of being female or Hispanic. Black operatives and Black high-skill clerical workers suffer a negative job rating impact equal to two standard deviations on the mathematics component of the employer test. Female craft workers and operatives also suffer a "productivity" penalty of two standard deviations of mathematics score. Such results alone should raise serious doubts about the validity of supervisors' ratings as a proxy for productivity and about the meaning of the test score–productivity relation. Why should Black workers have much lower productivity when mathematical ability, for example, is accounted for?

3. Conclusion

For a variety of reasons, most economists agree that there is a positive relationship between the quantity and quality of individuals' education and job productivity, but proving it has been an elusive enterprise. Empirical studies of the self-employed in agriculture and informal labor markets show that there is a significant, albeit not especially large, effect on productivity from more schooling. However, similar effects in industrial jobs have not been measured. Attempts to link what is learned in school (achievement or adult aptitude) to productivity through supervisors' ratings have been fairly successful but are subject to severe problems which cast doubt on their validity. The principal role of school achievement on productivity is probably through its effect on how much schooling individuals take: this finding further highlights the immense complexity of trying to compare the productivity of employed workers with different amounts of schooling working in different kinds of jobs.

See also: Education and Economic Growth

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Education and the Employment Contract