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- why is education important to development?
 1. so far, labor has been considered a homogeneous good in the production function; however, effective labor input depends on the skills labor has (human capital), which depends partly on education (note, however, that it is difficult to establish a causation between education and higher income/development)
 2. from a policy standpoint, there is under-investment in some education sectors that have a high rate of return and over-investment in some sectors that have a low rate of return; there is pressure to invest in certain levels of education although sometimes the rates of return at these levels of education are lower than are available elsewhere in the economy
 3. even if education were not important for productivity, it is still an important part of the economy because much investment, labor, etc. goes into it; education is demanded for greater productivity/income and also as a good for consumption
 4. education plays an important social function; through education students acquire the idea of citizenship, modern outlooks, etc.; education could change behavior favorably for development (for example, female education is negatively correlated with fertility, which could be due to an attitudinal relationship)
- page 324, table 9-1 - statistics about education:
 - levels of schooling vary as expected with income level (PPP) in 1995:

| GDP per capita (PPP) | adult illiteracy | enrollment ratio in higher education (beyond secondary schooling) |
|----------------------|------------------|---|
| <\$1,000 | 49% | 1% |
| \$1,000-\$4,000 | 31% | 8% |
| \$4,000-\$7,000 | 12% | 25% |
| \$7,000-\$12,000 | 12% | 23% |
| \$12,000+ | 5% | 59% |

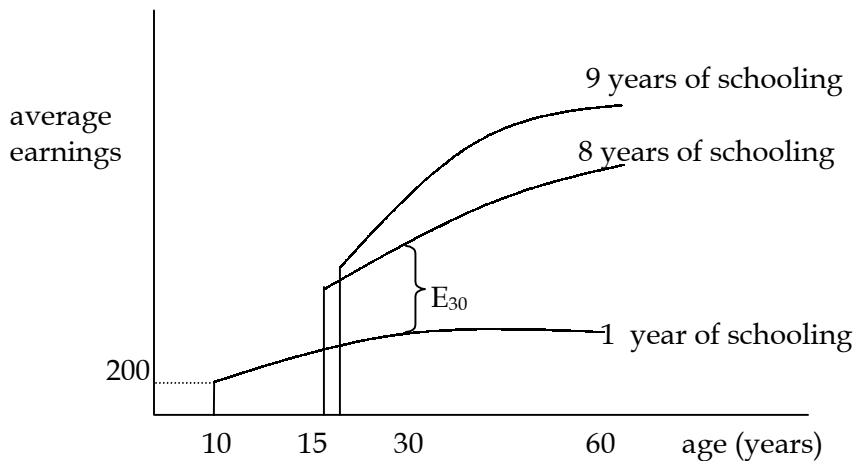
- enrollment in primary education is not as responsive to income above \$1,000 per capita (PPP); all income groups have net primary education enrollment ratios greater than 90% except the <\$1,000 per capita income group, which has a 42% net enrollment rate; the gross enrollment rate refers to the proportion of students enrolled in the level of education in question relative to the proportion of the population in that age range (a gross enrollment rate of 108% for primary schooling indicates that students above and below the usual age range for primary school are enrolled in primary school); net enrollment rate refers to the proportion of students of the normal age range that are enrolled in the level of education in question
- the amount of secondary schooling depends more on the level of development/income than does primary education:

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| GDP per capita (PPP) | gross secondary school enrollment |
|----------------------|-----------------------------------|
| <\$1,000 | 20% |
| \$1,000-\$4,000 | 55% |
| \$4,000-\$7,000 | 67% |
| \$7,000-\$12,000 | 72% |
| \$12,000+ | 106% |

thus, by 1995 primary schooling was nearly universal except in the poorest countries, but the level of secondary schooling varies

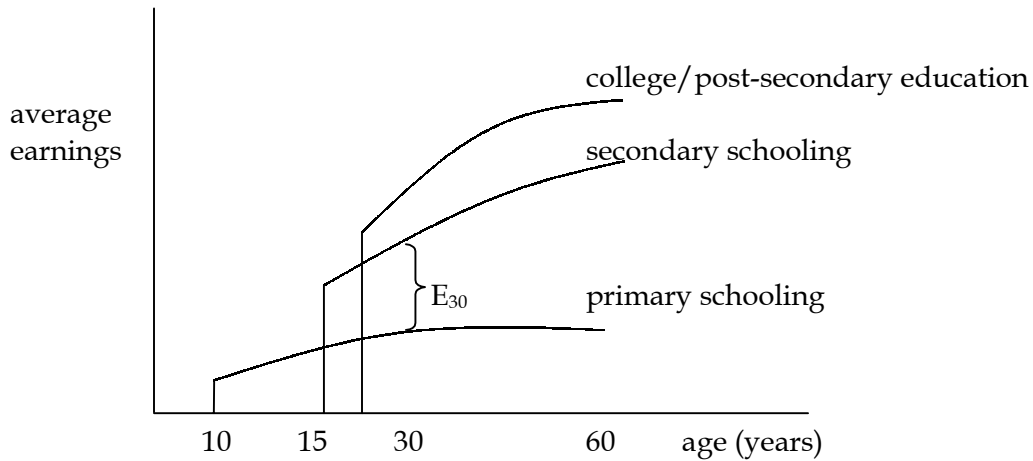
- the level of schooling varies across countries based on other factors; for example, there are sharp differences in public expenditure on education across countries (such as from \$25 to \$4,500 on education per pupil for primary education); these differences in expenditure are partly due to differences in cost among countries but also the quality of educational resources – thus, when assessing education, not only is the enrollment rate important but also the quality of education
- the age-earnings profile:
 - the age-earnings profile shows the average income at different ages of workers with different levels of education;
 - the age-earnings profile for Mexico in 1963:



the worker with one year of education (or a primary education, depending on how the graph illustrates schooling) earns 200 pesos per month at age 10, which increases with age (as maturity, experience, strength increase) until it tops out, after which it decreases slightly (as working ability decreases)

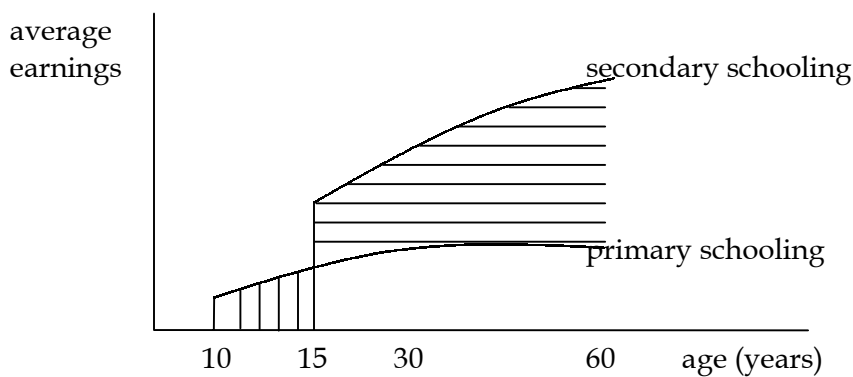
- this graph can also be illustrated using primary schooling, secondary schooling, and post-secondary education:

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- the different curves illustrate different wages at the same ages due to different education levels; for example, E_{30} , marked on the graph above is the difference in wage between a worker with 8 years of schooling and a worker with 1 year of schooling at age 30; the graph can be used to determine the absolute amount of the expected difference in wage at all ages – this is useful when measuring the returns to education
- estimating the returns to schooling and cost-benefit analysis:
 - the returns to schooling can be estimated by 1) discounting to the present earnings over time and 2) considering the foregone income by individuals who enroll in school instead of working

for example, if one individual enters the workforce at age 10 with primary education and another enters the workforce at age 15 with secondary education, then the vertically shaded area is the foregone income (the cost) of the individual who attends secondary school; for the same individual, the additional income (the net benefit) of attending secondary school is the horizontally shaded area:



an individual will determine whether to attend secondary school by comparing the present discounted value of costs with the present discounted stream of benefits

- calculating the present value of the benefits of additional education:

the present value of the benefits of additional education in year t is given by page 333, equation 9-1:

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$$V_o^t = \frac{E_t}{(1+i)^t}$$

V_o^t = the present value of the benefits of additional education in year t

E_t = earnings increment in year t due to the additional education

i = the interest rate

t = the number of years the earnings must be discounted to the present

for instance, the present value of the difference in earnings with a secondary education versus a primary education 30 years from the present is given by:

$$V_o^{30} = \frac{I_{30}^{secondary} - I_{30}^{primary}}{(1+i)^{30}}$$

V_o^{30} = the present value of the benefits of additional education in year 30

$I_{30}^{secondary}$ = the income earned with a secondary education in year 30

$I_{30}^{primary}$ = the income earned with a primary education in year 30 (note that

$I_{30}^{secondary} - I_{30}^{primary} = E_{30}$)

i = the interest rate

30 = the number of years the earnings must be discounted to the present

the overall additional earnings stream of getting additional education must be added up over all years, which is given by page 334, equation 9-2:

$$V = \sum_{t=1}^n \frac{E_t}{(1+i)^t}$$

V = the present value of the total incremental benefits of additional education

E_t = earnings increment in year t due to the additional education

i = the interest rate

t = the number of years the earnings in year t must be discounted to the present

- similarly, the present value of the costs of getting a secondary education is given by:

$$C = \sum_{t=1}^n \frac{C_t}{(1+i)^t}$$

C = the present value of the costs of additional education

C_t = the costs of additional education in year t ; this includes foregone income (the vertically shaded area above) and also explicit costs (such as school fees, etc.)

i = the interest rate

t = the number of years the costs in year t must be discounted to the present

the analysis of cost can be done on both a private and social basis (a social analysis would include costs not borne directly by the family, such as government expenditure, that are not considered in a private analysis)

- to determine whether to invest in more education, the family will compare the present values of the benefits and costs:

if the present value of the costs is greater than the present value of the benefits, then the family will not invest in additional education:

$$\sum_{t=1}^n \frac{C_t}{(1+i)^t} > \sum_{t=1}^n \frac{E_t}{(1+i)^t}$$

if the present value of the benefits is greater than the present value of the costs, then the family could invest in additional education (although there could be other investments with higher returns - they should use the IRR method to determine if additional education is the best investment):

$$\sum_{t=1}^n \frac{C_t}{(1+i)^t} < \sum_{t=1}^n \frac{E_t}{(1+i)^t}$$

- the internal rate of return:

- suppose at an interest rate, $i = 12\%$, the net present value of the benefits is less than the net present value of the costs, but at $i = 7\%$ the net present value of the benefits is greater than the net present value of the costs - why is the NPV of the benefits less than the NPV of the costs at higher interest rates?

- this occurs because costs are usually incurred during the early years and are discounted very little, but the benefits are spread out over many years and are heavily discounted

- at high interest rates, present costs are not justified by benefits in the future; however, there is an interest rate low enough so that the NPV of the costs is less than the NPV of the benefits

- the cut-off interest rate at which the NPV of the costs and the NPV of the benefits are equal is called the internal rate of return (IRR); if the IRR is greater than the interest rate, then the NPV of the benefits is greater than the NPV of the costs, but if the IRR is less than the interest rate, then the NPV of the benefits is less than the NPV of the costs

- the internal rate of return is found by setting the present value of the costs and the present value of the benefits of additional education equal to each other and replacing the interest rate, i , with the internal rate of return, r (page 334, equation 9-3):

$$\sum_{t=1}^n \frac{C_t}{(1+r)^t} = \sum_{t=1}^n \frac{E_t}{(1+r)^t}$$

C_t = the costs of additional education in year t

E_t = additional earnings in year t due to the additional education

r = the internal rate of return

t = the number of years the benefits/costs in year t must be discounted to the present

thus, the IRR is defined by:

$$\sum_{t=1}^n \frac{E_t - C_t}{(1+r)^t} \equiv 0$$

C_t = the costs of additional education in year t

E_t = earnings increment in year t due to the additional education

r = the internal rate of return

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t = the number of years the benefits/costs in year t must be discounted to the present

- the IRR is the tool for comparing different investments; when choosing among investments, those with the highest rates of return should be selected
- page 336, table 9-4 – estimates of the private and social rates of return on education by income group and region:
 - private rates of return:

| | low-income countries | world |
|---------------------|----------------------|-------|
| primary education | 35.2% | 30.7% |
| Secondary education | 19.3% | 17.7% |
| higher education | 23.5% | 19.0% |

the private rates of return are very high for primary education (and are higher than other levels of education), especially in low-income countries; the 35.2% private rate of return is equivalent to depositing \$1 in the bank and receiving \$1.352 the next year

the private rates of return tend to decrease as the level of education increases

- in some countries a primary education is insufficient to earn a job outside of agriculture; as a result, those with only primary education will remain in agriculture, but they might still benefit from a primary education because small-scale farmers make better decisions if they are literate; additionally, the figures in the table are compiled over entire populations and suggest a high economic pay-off to primary education
- in contrast, the rates of return for higher education are lower, especially if considering the social rates of return; however, developing country governments are pressured to support higher education even though some LDCs do not have enough jobs for all of their college graduates
- net present value (NPV):
 - besides calculating the discounted streams of benefits and costs of a project and determining the IRR of a project, a third method to determine whether an investment is worthwhile is calculating its net present value (NPV)
 - the NPV of an investment is the difference between the discounted stream of benefits and costs of the investment:

$$NPV = \sum_{t=1}^n \frac{E_t}{(1+i)^t} - \sum_{t=1}^n \frac{C_t}{(1+i)^t}$$

NPV = net present value

C_t = the costs of additional education in year t

E_t = additional earnings in year t due to the additional education

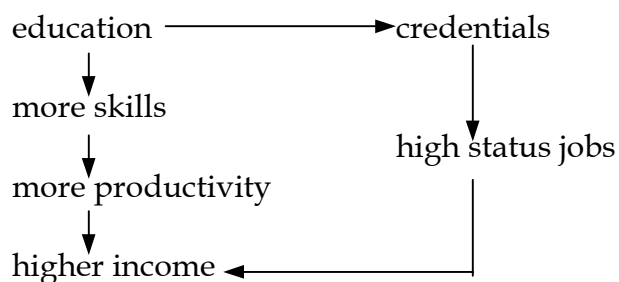
i = the interest rate

t = the number of years the benefits/costs in year t must be discounted to the present

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- the interest rate in cost-benefit analysis:
 - the interest rate represents the cost of capital to society (it is the opportunity cost of money); in cost-benefit analyses often a commercial interest rate is used, under the simplifying assumption that there is one interest rate for the entire economy; arguments can be made for using an interest rate in the cost-benefit analysis that is lower or higher than the economy's interest rate
 - argument for using a lower than commercial rate: if the commercial interest rate is used as the discount rate, the benefits to 2-3 generations later will be heavily discounted and contribute little to the total stream of discounted benefits; however, the present generation might want to save more so that future generations will have an even higher standard of living; in this case, the discount rate should be lower than the commercial interest rate in order that the benefits to future generations count more
 - argument for using a higher than commercial rate: if the commercial discount rate is distorted (controlled) by government intervention, formal credit might be available to a small number of people/firms; small farmers, etc. will not have access to formal credit and will borrow from other sources that have higher interest rates than the commercial interest rate; thus, the real interest rate of the economy is higher than the interest rate in the formal market
- the private and social internal rates of return for different levels of education:
 - the private rate of return considers only the direct costs to the family and the benefits that accrue to the family, but does not consider costs paid by the government
 - the social rate of return considers both the costs paid by the family and the government; the social rate of return should also consider the positive externalities of education (which would not be considered in a private analysis) and would increase the IRR
 - page 336, table 9-4 – private and social rates of return for primary, secondary, and higher education:
 - the rates of return on primary education, especially the private rate, are consistently higher than the rates of return on secondary and higher education
 - the social rates of return on higher education can be modest, such as 11.2% for higher education in sub-Saharan Africa and 8.7% in the OECD countries
 - if the rates of return on higher education are significantly lower than the rates of return on primary and secondary education, then in which kinds of education should developing country governments invest? India and Egypt have subsidized higher education and many people graduate, but there are not enough jobs for all of them; despite the high unemployment among graduates of higher education, people still demand higher education to have a chance in the lottery for a well-paying job
- the empirical relationship between education and income:
 - education could lead to a higher income for a worker because 1) it raises his productivity or 2) it gives him the credentials to compete for a high wage job:

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on the left: education increase the amount of skills a worker has, which increases his productivity and leads to a higher income

on the right: education gives a worker credentials to secure a high status job, which pays a high income

- empirical studies have not been able to determine the causation between more education and higher income (although some have suggested that education for small farmers leads to higher wages because the farmers make better decisions); in aggregate, cross-country analyses, the correlation between education and growth is weak
- although it is difficult to show empirically, economists generally believe that education helps economic growth