2 SCHOOL EDUCATION

2.1 THE IMPACT OF READING AND MATHEMATICS TEST RESULTS ON FUTURE EARNINGS AND EMPLOYMENT

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Introduction

Until the recent decades, *educational attainment* was measured by qualifications or completed years of schooling, when researchers tried to explore its impact on labour market prospects, because there were simply no other data comparable across time and space. This substantially distorted findings, since it was not possible to take into account differences in the quality of education, its efficacy and the knowledge gained outside school. Owing to the spreading of the standardised assessment of competences, enabling comparison across regions and over time, in recent decades it has become possible to measure the competence level of school leavers. As a result, later research has increasingly focused on the level of cognitive skills and their impact on labour market outcomes and earnings (cf. *Hanushek,* 2009).[1]

Studies typically find that higher test scores, implying better cognitive skills, are associated with an easily quantifiable wage advantage throughout working life. Research has also demonstrated that test results are strongly associated with future earnings, even after controlling for educational background, work experience and other typical explanatory variables. For example, the literature review by *Hanushek* compared several studies based on American data, and concluded that one standard deviation increase in test results at the end of upper-secondary school translates into 12 percent higher annual earnings in adulthood on average.[2]

One could say that although the association between test results and future earnings is undeniable, there is no causal relationship between them and the assumed positive impact of test results on earnings is in fact due to differences in innate abilities and intelligence. However, the findings of some studies (including *Lazear,* 2003) strongly suggest that general intelligence, that is the level of innate abilities, does not entirely determine subsequent labour market outcomes. Indeed, learning improves specific cognitive skills and in this way the results of intelligence tests, and even if it does not enhance general intelligence (cf. *Ritchie et al,* 2015), the improved specific cognitive skills are reflected in increasing earnings (*Finnie and Meng,* 2001; *Fazekas,* 2018).

Therefore it is crucial to investigate to what extent cognitive skills correlate with labour market success. This subchapter is the first in Hungary to ana-

1 Another major group of studies (inspired by *Bowles–Gintis,* 1976 and *Jencks,* 1979) explored the impacts of non-cognitive skills and abilities (also called personality traits) on labour market outcomes and wages, in addition to (or sometimes instead of) the impacts of cognitive skills. For more details see Subchapter 7.2.

2 Several other studies from developed and developing countries have come to similar conclusions: there is a statistically and economically significant association between skills and wages (and other labour market outcomes, such as employment). However, the size of the wage premium, attributed to a standard deviation increase in skills, varies a lot (from 5 per cent to 48 per cent), since the utilized model form and control variables affect the results considerably.

lyse how standardised test results of upper-secondary school students relate to subsequent wages in young adulthood and unemployment probabilities.

Data and methods

We used a panel of linked administrative data (Admin3) compiled in 2019 by the Databank of the Centre for Economic and Regional Studies (*Sebők,* 2019), which contains individual-level, anonymized data of 50 percent of the Hungarian population between 2003 and 2017, stored in administrative databases. The database contains data indispensable for this study such as the reading and mathematics skills of individuals assessed during their school years, as well as their qualifications, age, wages and labour market status in early adulthood.

The sample includes those who were tested either for mathematics or reading or both in grade 10 during the National Assessment of Basic Competences (NABC) in 2008, provided that there is information available concerning their labour market status in 2017. This is one cohort of upper-secondary school students, aged 25–26 in 2017.

Inactive persons and students (including the ones working and studying simultaneously) were excluded from the sample, in addition to those whose labour market status was unknown at the time of the survey.[3] Therefore labour market chances are analysed from a narrow perspective (employed *versus* registered unemployed or unemployed receiving benefits).

Our earnings estimations refer to those who were employed on 15 October 2017 and whose actual wage data are available from the database. Our unemployment estimations are based on the sample including registered unemployed, recipients of unemployment benefits, participants of labour market programmes or public works and the number of employees, respectively, as of October 2017.

Mincer earnings functions (*Mincer,* 1974) were estimated first, with earnings regressed on mathematics and reading test scores in grade 10, and educational attainment, gender, estimated labour market experience[4] as well as the latter squared in 2017. Certain subsequent regressions were controlled for sectors, occupations and place of residence (district level). The dependent variable for the earnings regressions was the logarithm of monthly wages, thus the results can be interpreted as percentages.[5]

In addition, estimations on unemployment probabilities are also provided, where the dependent variable is a dummy variable taking the value 1 for registered unemployed and public works participants and 0 for employees.

The mathematics and reading scores of grade 10 pupils at the NABC in 2008 were standardised (i.e. converted into variables with means of 0 and variances of 1), therefore the coefficients in the estimations below can be interpreted as changes in standard deviation.

3 The latter group may include the unemployed or inactives not receiving social benefits and may also include those working or studying abroad. Thus it is not possible to identify the inactive population not in education accurately.

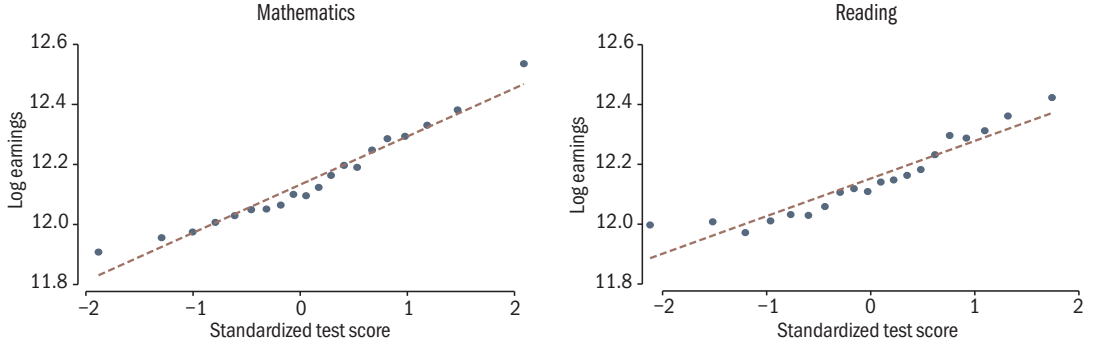
4 The estimated labour market experience is defined as the number of years between the time of obtaining the highest qualification (school attainment) and October 2017.

5 For those who did not work in their job throughout October 2017, a monthly wage was calculated from the wage observed, taking into account the number of days actually worked. Unfortunately, the database cannot at present differentiate between full-time and part-time workers.

Results – total sample

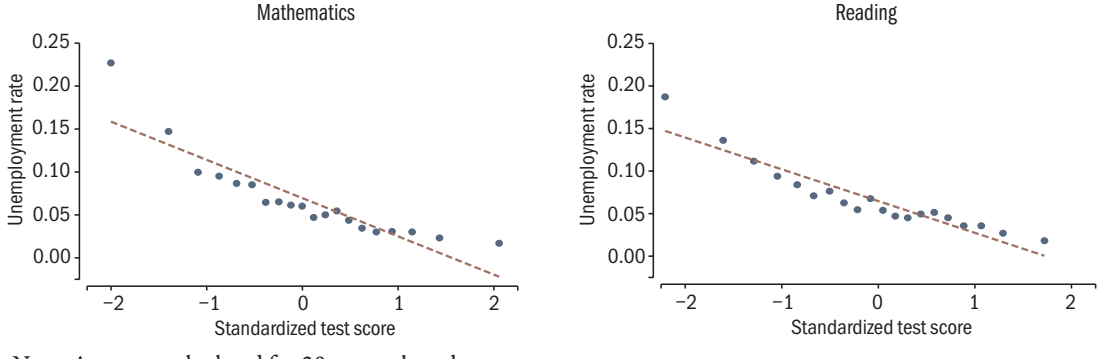
Figures 2.1.1 and *2.1.2* show the raw association between standardised test scores and the logarithm of earnings, or unemployment probability, respectively. The Figures reveal, on the one hand, that both mathematics and reading are strongly associated with labour market outcomes, and, on the other hand, that the connection is almost linear, just slightly diverging from the straight line at the ends of the distribution, thus a linear form is adequate to use in the employment and wage equations.

Figure 2.1.1: Association between test scores in grade 10 and the logarithm of earnings



Note: Averages calculated for 20 groups based on test scores.
Source: Authors' compilation.

Figure 2.1.2: Association between test scores in grade 10 and unemployment



Note: Averages calculated for 20 groups based on test scores.
Source: Authors' compilation.

Tables 2.1.1 and *2.1.2* show the Mincer regressions estimated for the entire sample described above. The impact of test scores in grade 10 on earnings is shown in *Table 2.1.1* and the impact of test scores on unemployment probability is presented in *Table 2.1.2*. The estimated coefficients are expected to be positive in the first case, and negative in the second.

Column (2) of *Table 2.1.1* relies on mathematics scores as the sole indicator of cognitive skills. It reveals that students achieving one standard deviation

higher scores in grade 10 are likely to have 8.5 per cent higher wages in the labour market. Estimates in Column (3) include both mathematics and reading test scores. The results indicate that mathematics scores are more strongly associated with wages than reading scores. For understanding the underlying reasons, a more thorough research is needed than the present descriptive study.[6]

Table 2.1.1: Impact of test scores in grade 10 on the logarithm of earnings in young adulthood

	(1)	(2)	(3)	(4)
Vocational school	0.122**	0.137***	0.138***	0.0966**
	(0.0532)	(0.0529)	(0.0529)	(0.0471)
Secondary school (Matura)	0.203***	0.144***	0.137***	0.0987**
	(0.0512)	(0.0510)	(0.0511)	(0.0454)
Higher education degree	0.591***	0.454***	0.440***	0.280***
	(0.0585)	(0.0588)	(0.0590)	(0.0528)
Mathematics scores		0.0850***	0.0752***	0.0448***
		(0.00499)	(0.00622)	(0.00561)
Reading scores			0.0166***	0.00685
			(0.00636)	(0.00571)
Constant	11.71***	11.81***	11.82***	11.70***
	(0.0628)	(0.0627)	(0.0628)	(0.0940)
Fixed effects				
Sector				Yes
Occupation				Yes
District				Yes
N	28,188	28,188	28,188	28,136
R^2	0.077	0.087	0.087	0.299

Note: OLS-estimations.
Dependent variable: logarithm of monthly wages. Control variables not shown in the table: gender, potential work experience and its square, dummy variables signifying missing values for experience and test scores.
The reference category for qualifications is lower secondary school (8-year general school).
Standard errors are indicated in brackets.
***Significant at a 1 per cent, **5 per cent, *10 per cent level.
Source: Authors' compilation.

The estimation in column (4) of *Table 2.1.1* contains further control variables that may have an impact on wages regardless of test scores, for example the sector and type of occupation and the location of work. The estimation in Column (4), including all control variables, shows a lower value for the coefficient of the mathematics test score achieved in grade 10, as compared to the figure in Column (3), but the connection is still significant and strong. The results of equation (4) indicate that better cognitive skills not only enable people to get jobs in better paid occupations, but persons with higher mathematics scores also tend to have higher earnings within a given occupation. It may be concluded that in Hungary cognitive skills in upper secondary school are strongly associated with subsequent wages in early adulthood.

6 Considering the rather strong association between the two test scores, it is difficult to separate the effect sizes. The correlation between the two test scores ranges between 0.7–0.8 in Grade 10 in the various years.

Table 2.1.2 shows the association between cognitive skills and the probability of unemployment in the total sample. Similarly to wages, mathematics test scores achieved in grade 10 are strongly associated with the probability of becoming unemployed. Column (2) relies on mathematics test scores as the indicator of cognitive skills. Our results indicate that one standard deviation increase in results in grade 10 reduces the probability of unemployment by 2.7 percentage points in young adulthood. Column (3) includes both mathematics and reading scores. Similarly to wages, the explanatory power of mathematics test scores is stronger, but unemployment probabilities of individuals are also significantly explained by their reading skills. After taking local labour market control variables into account, coefficients in Column (4) are lower but still significant.

Table 2.1.2: Impact of test scores in grade 10 on the probability of unemployment in young adulthood, marginal effects

	(1)	(2)	(3)	(4)
Vocational school	-0.0395***	-0.0397***	-0.0395***	-0.0300***
	(0.00842)	(0.00765)	(0.00761)	(0.00682)
Secondary school (Matura)	-0.0928***	-0.0664***	-0.0604***	-0.0507***
	(0.0159)	(0.0147)	(0.0145)	(0.0129)
Higher education degree	-0.0977***	-0.0655***	-0.0585***	-0.0531***
	(0.00992)	(0.0106)	(0.0110)	(0.00918)
Mathematics scores		-0.0270***	-0.0202***	-0.0146***
		(0.00155)	(0.00195)	(0.00172)
Reading scores			-0.0112***	-0.00481***
			(0.00196)	(0.00173)
District fixed effect				Yes
N	31,855	31,855	31,843	31,326
Estimated average probability	0.0674	0.0674	0.0674	0.0683

Note: Probit estimates.
Dependent variable: Registered unemployed or public works participant (1) or employee (0). Control variables not shown in the table: gender, potential work experience and its square, dummy variables signifying missing values for experience and test scores.
The reference category for qualifications is lower secondary school.
Standard errors are indicated in brackets.
***Significant at a 1 per cent, **5 per cent, *10 per cent level.
Source: Authors' compilation.

Results by school attainment

Tables 2.1.3 and *2.1.4* show the last specifications of the tables above, containing all control variables, estimated for subgroups by school attainment. *Table 2.1.3* indicates that the association between cognitive skills and wages is stronger among higher education graduates, compared to those with lower qualifications, but the situation completely different for labour market chanc-

es: *Table 2.1.4* shows that cognitive skills at upper-secondary school are far more strongly associated with subsequent labour market outcomes (employment status, or the chance of becoming unemployed) among the low-qualified than among higher education graduates.

Table 2.1.3: Impact of test scores in grade 10 on the logarithm of earnings in young adulthood by school attainment

	Low-education level (lower-secondary or vocational school)	Secondary level (Matura)	Higher education level (BA or above)
Mathematics scores	0.0192	0.0370***	0.0758***
	(0.0128)	(0.00808)	(0.00996)
Reading scores	0.00673	0.0102	0.00650
	(0.0123)	(0.00801)	(0.0112)
N	4,948	14,644	8,544
R^2	0.300	0.250	0.319

Note: OLS-estimation.
Dependent variable: logarithm of monthly wages. Control variables not shown in the table: gender, potential work experience and its square, dummy variables signifying missing values for experience and test scores as well as sector, occupation and district fixed effects.
Standard errors are indicated in brackets.
***Significant at a 1 per cent, **5 per cent, *10 per cent level.
Source: Authors' compilation.

Table 2.1.4: Impact of test scores in grade 10 on the probability of unemployment in young adulthood by school attainment, marginal effects

	Low-education level (lower-secondary or vocational school)	Secondary level (Matura)	Higher education level (BA or above)
Mathematics scores	–0.0319***	–0.0136***	–0.0160***
	(0.00618)	(0.00274)	(0.00305)
Reading scores	–0.0194***	–0.00201	–0.00301
	(0.00609)	(0.00274)	(0.00337)
N	5,624	15,642	6,615
Estimated average probability	0.141	0.0699	0.0385

Note: Probit estimates.
Dependent variable: Registered unemployed or public works participant (1) or employee (0). Control variables not shown in the table: gender, potential work experience and its square, dummy variables signifying missing values for experience and test scores.
Standard errors are indicated in brackets.
***Significant at a 1 per cent, **5 per cent, *10 per cent level.
Source: Authors' compilation.

The above findings reveal that in the case of the low-qualified better cognitive skills strongly contribute to avoiding unemployment; however, they do not substantially contribute to higher (observed) wages. By contrast, among

higher education graduates, better skills result in a smaller reduction in the probability of unemployment, but contribute more substantially to higher wages. Considering that the standard deviation of wages is smaller at the lower end of the qualification distribution than at the top, while the standard deviation of the probability of unemployment is much smaller at the top, the findings of this study are by no means surprising. Nevertheless, in order to better understand the mechanism behind the associations between cognitive skills assessed at upper-secondary school and labour market outcomes in early adulthood in Hungary, further research is warranted.

Conclusion

The impact of the quality of education on the level of cognitive skills has been well documented. Other factors also influencing their level include – among others – family environment, peer groups and health. The latter are not easily influenced by social policy instruments, while the quality of education, which may significantly improve the cognitive skills, and thus the labour market chances of the population, is much easier to raise.

This study is the first to show in Hungary that the cognitive skills of pupils assessed in grade 10 are strongly associated with labour market success in young adulthood. Our findings indicate that one standard deviation increment in mathematics test results may increase future earnings even by 8–9 per cent on the whole, but within a given occupation or sector, the increase is also about 5 per cent. Furthermore, better cognitive skills are likely to substantially reduce the risk of unemployment: overall, one standard deviation increase in mathematics test results decreases the probability of unemployment by approximately 2.7 percentage points. Accordingly, the likelihood of unemployment for adults with skills considerably (i.e. by about 2 standard deviation units) better than the average are negligible – between 1 and 2 per cent –, while those with substantially worse than average skills face a more than 10 per cent probability of becoming unemployed.

When analysing cognitive skills and labour market success by qualification level, it is seen that cognitive skills are more likely to have an impact on wages among the highly qualified, while they are more strongly associated with unemployment risks among the low-qualified. One of the reasons for this pattern is that better cognitive skills contribute to avoiding unemployment on the one hand (if this is an immediate threat, for example in the case of the low-qualified), and, on the other hand, they result in higher earnings through better occupations, higher positions and higher wages, which is mainly observed among the highly qualified.

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