# THE DEVELOPMENT OF INDUCTIVE REASONING AS A FUNCTION OF SELECTED FACTORS

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**Abstract:**

In this study, we examine the measurement of inductive reasoning in primary and secondary school students who belong to the Hungarian minority in Slovakia using a Cattel's Culture Fair Test (CFT). The main objective of our research was to determine the dynamics of inductive reasoning

development among primary and secondary school students belonging to the Hungarian minority in Slovakia (in grades 4th, 6th, 8th, 10th and 12th) and to examine the effects of certain background factors. We found that the CFT 20-R differentiates well according to the age groups studied and is suitable for measuring inductive reasoning ability. Based on the results obtained, it appears that inductive reasoning develops continuously until the 10th grade, after which it seems to stagnate. If we consider the type of school attended by the students participating in the study, we can conclude that the most dynamic periods of inductive thinking development occur during periods of transition in the school system: between lower and upper grades, and between elementary school and high school. According to our study, the most effective type of school for the development of inductive reasoning is the eight-year grammar school, while the secondary school system also develops it effectively, but at a lower level. However, in the case of students attending four-year secondary schools, a decline can be observed in this area. Among the background factors, we examined the impact of not only the type of school attended by the students, but also their gender and social-economic status.

**Keywords:** Inductive reasoning, measurement, CFT

## Introduction

Slovakia has recently embarked on a comprehensive education reform, prompted by results below the OECD average in various international competency tests and the failure of previous reform attempts (Ambasz, 2022). The reform policies pay close attention to rethinking the content of the public education curriculum, the role and methodology of classroom teaching, as well as defining priorities and planning the individual goals of each institution (Ambasz, 2023). Analysis of international surveys has also made it clear that the performance of Hungarian minority students in Slovakia is gradually declining compared to that of students attending Slovak educational institutions (Morvai, 2014; Papp, 2014). Given the strategic importance of the quality of minority education for the Hungarian community in Slovakia, it is important to identify the factors that can improve the performance of Hungarian educational institutions in the long term. Complex educational reform efforts partly reflect this aspiration, but the objective measurement tools needed to monitor and evaluate the achievement of specific, relevant, and achievable goals are not yet available.

The importance of systematic evaluation of the quality of the educational process, organizational efficiency, and the value foundations of educational

institutions is also emphasized by empirical findings indicating that perceived institutional responsibility and the quality of internal processes are closely linked to educational outcomes and the trust of educational stakeholders (Porubčanová et al., 2024).

An objective comparison of the quality of education is also complicated by the extremely heterogeneous nature of the Hungarian minority school network in Slovakia (primarily due to its geographical location). This institutional network stretches for approximately 500 km along the Slovak–Hungarian border and includes small schools, fully organized institutions, school centers, as well as rural and urban schools. The socio-economic situation varies markedly from east to west, and the social environment is also extremely diverse from an ethnic point of view (e.g., areas with a Hungarian majority, language borders, and schools in scattered communities).

This complexity of the educational environment must also be viewed in the context of factors of secondary socialization, which significantly influence students' educational trajectories, their adaptive strategies, as well as their school success, particularly in linguistically and culturally differentiated school settings (Zapletal et al., 2022). Since the change of regime, numerous ideas of educational reform have emerged in Slovakia, elements of which have taken root in different ways and have shaped the local school culture.

In order to monitor the effects of the reform in a relevant manner, given the relatively small size of the school network (due to its minority status) and the numerous variables influencing the educational process, it is advisable to select a measurable characteristic that provides information about changes in students' cognitive abilities – and thus about the actual state of this area of the educational process. Therefore, our research focuses on measuring students' general thinking skills, specifically inductive reasoning. We are using a measuring tool that can be applied in educational reform and in the international competency assessments for the age groups involved, as well as for secondary school students, and which can measure inductive reasoning in a valid and reliable manner, regardless of language, educational content, cultural background, and school system.

To accurately evaluate the effectiveness of changes occurring during educational reform in the heterogeneous educational environment outlined above, measuring tools are needed that can assess students' thinking skills and changes therein.

Among the thinking skills to be developed, one of the most important is the ability to acquire new knowledge, which is known as inductive reasoning (Molnár, 2013). We will focus on measuring this skill in the following sections.

The essence of this thinking strategy is how to apply the experiences gained in one situation (recognized rules) to other situations (Popper, 1972). Its importance is indicated by its strong correlation with students' general thinking skills (Mackintosh, 1998), the development of problem-solving thinking (Egan–Greeno, 1974; Molnár, 2013), critical thinking (Ennis, 1987), creativity (Johnson-Laird, 1988), basic learning ability (Pellegrino–Glaser, 1984), i.e., the "soft skills" that are considered so important today (OECD, 2021).

One of the most accepted models of inductive reasoning was developed by Klauer (Klauer–Phye, 2008) who distinguished four types of tasks to be used in assessing and enhancing inductive reasoning processes: classification, series, analogies and matrices. These taxonomies also form the basis for the Cattel's Culture Fair Test (CFT), which we have chosen as the measurement tool for this study (Cattell, 1963; Cattell, 1987).

**Methodology**

In this study, we examine the inductive reasoning of elementary and secondary school students belonging to the Hungarian minority in Slovakia using the Cattel Culture Fair Test (CFT).

Our research questions were as follows: (1) How does the inductive reasoning of primary and secondary school students change in grades 4th, 6th, 8th, 10th, and 12th? (2) Are there any sensitive periods in the development of inductive reasoning? (3) How does inductive reasoning change as a function of certain background factors (e.g., the SES, the students' gender)

We used a standardized assessment test (CFT 20-R), which is also a suitable tool for measuring inductive reasoning. This test is appropriate for the age group we intend to examine. It does not depend on language skills or cultural background and therefore fits our requirements well.

The CFT 20-R tests the ability to identify patterns and relationships through a series of graphic tasks. The 101-item test consists of two similar sections, each containing four subtests: series continuation, classification, matrices, and topological conclusions.

Although the first version of the test dates to 1940, the version we use dates from 2006 and has been standardized in the Czech Republic, among other countries. (Fajmonová, 2015)

The participants in our study were Hungarian minority students 4th, 6th, 8th, 10th, and 12th grade in schools in the Komárno region of Slovakia. We randomly

selected students from rural, urban, small, and large schools using layered sampling. The 4th, 6th, and 8th graders were elementary school students, while the 10th and 12th graders were secondary school students. Among the students in grades 6th, 8th, 10th and 12th, there were also students participating in the 8-year high school form. The composition of each grade was based on the data shown in Table 1.

**Table 1. The gender and age indicators of the sample studied.**

| | 4th grade | 6th grade | 8th grade | 10th grade | 12th grade |
|---|---|---|---|---|---|
| N | 112 | 136 | 143 | 121 | 121 |
| Boy/Girl Ratio (%) | 52,7/47,3 | 43,4/56,6 | 49,7/50,3 | 32,2/67,8 | 33,1/66,9 |
| Mean Age | 10,3 | 12,5 | 14,3 | 16,2 | 18,4 |

The data was collected in the first half of the year 2025, using tablets online, but in presence of the respondents. During the recording of the CFT test, we did not deviate from the requirements specified in the methodology, but we set the time limit required to solve the test to the extent necessary for the students. The background questionnaire was recorded after completing the CFT 20-R test.

**Results**

The general statistical characteristics of the test results can be seen in Table 2. It is clearly visible that the results for each grade (expressed as a percentage) show an increasing value, which stops at grade 12 and even shows a slight decrease.

**Table 2. Summarized descriptive statistical indicators of the CFT test data.**

| | 4th grade | 6th grade | 8th grade | 10th grade | 12th grade |
|---|---|---|---|---|---|
| N | 112 | 136 | 143 | 121 | 121 |
| M | 50,68 | 58,91 | 64,04 | 76,18 | 75,765 |
| SEM | 1,119 | 1,142 | 1,203 | 1,192 | 1,032 |
| CI95L | 48,463 | 56,653 | 61,661 | 73,822 | 73,722 |
| CI95U | 52,899 | 61,172 | 66,419 | 78,543 | 77,809 |

| | | | | | | |
|---|---|---|---|---|---|---|
| SD | | 11,846 | 13,322 | 14,390 | 13,113 | 11,353 |
| Var | | 140,317 | 177,480 | 207,080 | 171,941 | 128,882 |
| Perc. | 5% | 25,04 | 33,51 | 38,41 | 50,70 | 55,45 |
| | 10% | 32,97 | 39,60 | 44,55 | 59,61 | 57,83 |
| | 25% | 44,80 | 50,50 | 55,45 | 66,34 | 68,82 |
| | 50% | 50,00 | 60,40 | 64,36 | 78,22 | 76,24 |
| | 75% | 59,16 | 67,33 | 74,26 | 87,13 | 85,15 |
| | 90% | 64,06 | 75,25 | 81,19 | 92,08 | 89,90 |
| | 95% | 67,68 | 79,21 | 88,91 | 94,06 | 93,07 |
| K-S | | Z = 0,097 | Z = 0,103 | Z = 0,047 | Z = 0,109 | Z = 0,077 |
| | | p = 0,011 | p = 0,001 | p = 0,200 | p = 0,001 | p = 0,075 |
| norm | | - | - | + | - | - |

Based on Kolmogorov-Smirnov normality tests, only the results for 8th grade can be declared normally distributed, so they must be used as a basis for further calculations. The growth rate of inductive reasoning in the grades examined is illustrated by the graphical presentation of the measured data (see Fig. 1.). It is easily recognizable that the growth rate is more intense in the lower grades, but in the high school age group, the development of inductive reasoning skills seems to stagnate. It is not surprising that the Mann-Whitney test proves the significance of differences between grades in all cases, except for grades between 10th and 12th, where the difference between test results is not significant (Z = -0,591, p = 0,555).

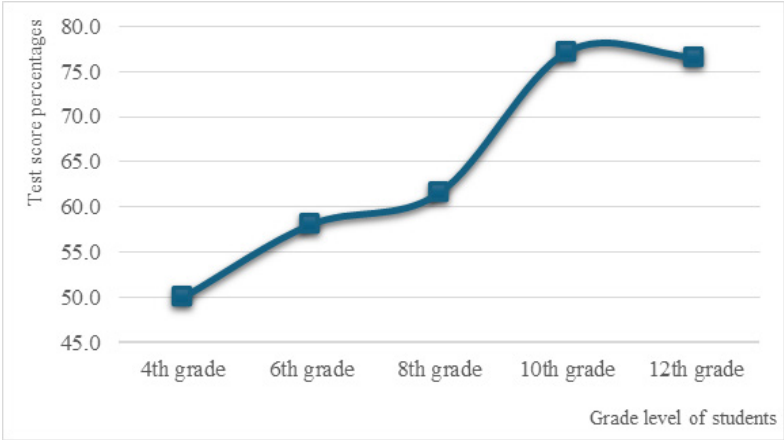

Fig. 1. Students' CFT scores by grade level.

In addition to the slight regression or stagnation between grades 10th and 12th, it is worth examining the slope of the function between grades. From this, we can identify the so-called sensitive periods during which the development of inductive thinking shows the most intense growth. The figure clearly shows that these periods fall between grades 4 and 6 and grades 8 and 10. These are the periods that we consider to be the most problematic in school life: the transition from lower to upper elementary school and the transition from elementary school to secondary school. An interesting research question might be to what extent the changing educational environment and the forced adaptation to new circumstances and expectations can influence such explosive development of (inductive) reasoning ability.

This phenomenon is further illustrated by Fig. 2, which shows the average percentage values of students' inductive reasoning by school type in addition to the average results. Here it is clearly visible that students in 8-year secondary schools are selected from among the best in elementary schools, and their reasoning skills develop steadily over the course of 8 years. (The 10th grade is missing from the graph because no classes of this type were opened in the region that year.) The growth in inductive reasoning among vocational school and technical secondary school students is also interesting, as it is occurring at a visible rate, but at a lower level. The average decline between grades 10 and 12 can be clearly seen in the graph and is linked to students in four-year high schools. The conclusion that can be drawn from this is that this trend does not indicate the early onset of age-related cognitive decline (since in that case, a decline would be seen in all school types), but rather that we are witnessing a phenomenon related to the inadequate development of students in four-year high schools.

As part of our research, we used a background questionnaire to determine the socioeconomic status of the students. We used a nonparametric method, Spearman's rank correlation, to examine whether there was a correlation between their inductive reasoning and their SES.

Spearman’s rank correlation indicated just a moderate positive relationship between the results of the 4th grade and their SES ($\rho = 0{,}209$, $p = 0{,}027$), and similarly in other grades: in 6th grade ($\rho = 0{,}235$, $p = 0{,}006$), in 8th grade ($\rho = 0{,}339$, $p = 0{,}000$), in 10th grade ($\rho = 0{,}205$, $p = 0{,}024$) and in 12th grade ($\rho = 0{,}296$, $p = 0{,}001$).

We also examined whether there was a correspondence between the biological

sex of the students and their test results. The analysis was conducted separately for each grade level using the Mann–Whitney U test. A significant gender difference was found in grades 4th (U = 1092,000; Z = -2,750; p = 0,006), and 8th (U = 1989,000; Z = -2,290; p = 0,022) where girls outperformed boys, but in grades 10th (U = 1078,00; Z = -2,891; p = 0,004), and 12th (U = 1046,000; Z = -3,165; p = 0,002) boys outperformed girls.

No significant differences were observed only in grade 6th (U = 2217,5; Z = -0,237; p = 0,812).

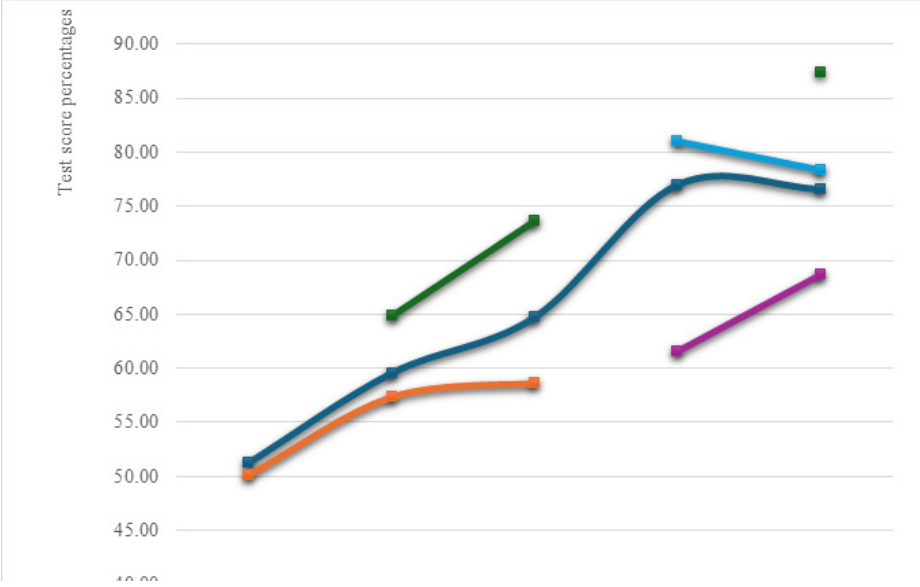


Fig. 2. Students' CFT scores by grade level and school type.

## Conclusion

The initial problem addressed by our research was the fact that, according to various international cross-sectional measurements, certain competencies of Hungarian minority students in Slovakia are not only below the OECD average, but also below the average of their peers attending Slovak schools. We focused our attention on measuring inductive reasoning in order to track the effectiveness of the ongoing school reform. In this study, based on our previous research experience (Madarász & Tóth, 2025), we used the CFT 20-R test battery. The

results showed that the chosen measurement tool differentiates well according to the age groups studied and is suitable for measuring inductive reasoning ability.

Based on our measurements, we not only plotted the age-related development curves of students' inductive reasoning but also determined that the most sensitive periods for the development—and perhaps also the improvement—of inductive reasoning are between grades fourth and sixth, and eighth and tenth. Around grade 12th, inductive thinking begins to stagnate, and its speed begins to decline. We can assume that this phenomenon is not a general age-related characteristic (cognitive decline), but rather a result of the ineffective educational development of students in four-year secondary schools. The 8-year high school selection model (mathematical performance) proved to be a suitable indicator of inductive reasoning.

Based on our research, it can be assumed that the specified SES values show only a moderate correlation with the measured values of students' reasoning abilities. The study of biological sex-related differences yielded exciting results, suggesting that at a younger age, boys' inductive reasoning is less developed, but after reaching high school, it slightly exceeds the level of girl's inductive reasoning.

## Discussion

The results of our research require further refinement in several areas. It would be worthwhile to conduct the research using other suitable tests and then compare the results. The relationship between biological sex and test results may also be the subject of further research, as it is not entirely clear whether the results obtained are due to differences in cognitive maturity between boys and girls, different attitudes, the composition of the samples studied, or factors other than these. However, the extraordinary time and resource requirements of the research must also be taken into account, which may somewhat complicate the practical monitoring of the characteristics discussed in our research on heterogeneous school networks.

Taking all this into account, we still evaluate our research positively, as it seems possible that these experiences could be used to effectively measure the development of inductive reasoning skills among students from different cultural and linguistic backgrounds in other countries and school systems.

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