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TALENT: Critical Literature Review

May 2024

MIROSLAVA FEDERIČOVÁ, TOMÁŠ PROTIVÍNSKÝ

IDEA CERGE EI
PROJEKT NÁRODOHOSPODÁŘSKÉHO ÚSTAVU AKADEMIE VĚD ČR

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IDEA CERGE EI

PROJECT OF THE ECONOMICS INSTITUTE OF THE CZECH ACADEMY OF SCIENCES

TALENT: Critical Literature Review[1]

MAY 2024

MIROSLAVA FEDERIČOVÁ, TOMÁŠ PROTIVÍNSKÝ

Scope and Purpose

- This document has been created to familiarize the reader with scientific literature that deals directly or implicitly with the education of gifted students, their specificities, and the challenges they may face in developing their talents. It focuses on the findings of literature from an economic perspective, specifically in the field of the economics of education, and with an emphasis on topics that are important in the Czech context.
- It offers an economic perspective on the importance of supporting gifted children for individuals and for society as a whole, explores factors that contribute to development of talent, and identifies potential obstacles faced by gifted children. It also draws on psychological and educational literature, particularly in defining talent and examining teaching practices aimed at gifted students.
- We wish to emphasize that there is no expert consensus on what talent or giftedness actually is.[2] Therefore, in this document, we describe a variety of existing views, but we do not subscribe to any one.

[1] This study represents the authors' own views and not the official position of the Economics Institute of the Czech Academy of Sciences nor of the Charles University Center for Economic Research and Graduate Education (CERGE). The authors are grateful to Patrick Gaule (University of Bristol, Global Talent Lab), Hynek Cígler (FSS MU), Daniel Münich and Alena Bičáková (IDEA, CERGE-EI) for their valuable comments and advice. This work was produced as part of Talent, a joint project of IDEA Think Tank at CERGE-EI and RSJ Foundation and also supported from the Czech Academy of Sciences within its AV21 Strategy research programme Society in Motion.

[2] Due to a lack of scientific consensus on the definition of talent and giftedness, the terms are typically used as synonyms, as in this report, and generally refer to high level of a certain ability. If a particular author or a theory distinguishes between these concepts, it is always stated in the text. See Hříbková (2009) for an additional discussion of these terms in the Czech context.

- Due to the breadth of the topic, it is not possible to offer the reader an exhaustive review of related literature. This document is intended to serve more as an initial introduction to the topic and an aid to further exploration of it. For readers who are interested in the specifics of gifted education in the Czech Republic, we suggest consulting the detailed reports by the Czech School Inspectorate (ČŠI, 2016 and ČŠI, 2022).
- Readers interested in an international comparison of gifted education practices may find valuable insights in works such as Rutigliano and Quarshie (2021), Tourón and Freeman (2018), and Heuser et al. (2017). While we reference selected findings from these sources, our report primarily concentrates on economic academic literature and does not attempt an exhaustive review of these well-documented areas.

PROJEKT NÁRODOHOSPODÁŘSKÉHO ÚSTAVU AKADEMIE VĚD ČR

TALENT: kritické zhodnocení literatury[3]

KVĚTEN 2024

MIROSLAVA FEDERIČOVÁ, TOMÁŠ PROTIVÍNSKÝ

Účel a rozsah

- Cílem této studie je seznámit čtenáře s odbornou literaturou, která se přímo či nepřímo zabývá vzděláváním nadaných žáků, jejich specifiky a problémy, s nimiž se mohou při rozvoji svého nadání potýkat. Zaměřuje se především na poznatky z ekonomické akademické literatury, konkrétně z oblasti ekonomie vzdělávání, a klade důraz na témata relevantní pro český kontext.
- Studie nabízí ekonomický pohled na význam podpory nadaných dětí pro jednotlivce i pro celou společnost, zkoumá faktory, které přispívají k rozvoji talentu, a identifikuje překážky, kterým nadané děti čelí. Vychází také z psychologické a pedagogické literatury, zejména při definování nadání a při přehledu současné vzdělávací praxe nadaných žáků.
- Je nutné zdůraznit, že neexistuje odborná shoda na tom, jak přesně talent a nadání vymezit a definovat.[4] Ve studii uvádíme přehled současných konceptualizací a definic, aniž bychom se sami k jedné z nich přikláněli.

[3] Tato studie reprezentuje pouze názor autorů, a nikoli oficiální stanovisko Národohospodářského ústavu AV ČR, v. v. i. či Centra pro ekonomický výzkum a doktorské studium UK v Praze (CERGE). Za cenné komentáře a rady autoři děkují Patrick Gaule (University of Bristol, Global Talent Lab), Hynku Cíglerovi (FSS MU), Danielu Münichovi a Aleně Bičákové (IDEA, CERGE-EI). Veškeré případné nepřesnosti a chyby jdou na vrub autorů. Studie vznikla jako součást Talentu, společného projektu think-tanku IDEA při CERGE-EI a Nadace RSJ, a s podporou programu Strategie AV21 „Společnost v pohybu“.

[4] Vzhledem k tomu, že neexistuje vědecký konsenzus ohledně definice nadání a talentu, používají se tyto pojmy obvykle jako synonyma (stejně tak i v této studii) a obecně se vztahují k vysoké úrovni určité schopnosti. Pokud konkrétní autor nebo teorie mezi těmito pojmy rozlišuje, je to v textu vždy uvedeno. Širší diskuzi o používání těchto pojmů v českém kontextu nabízí Hříbková (2009).

- Vzhledem k šíři tématu není možné čtenáři nabídnout vyčerpávající přehled relevantní literatury. Tento dokument má sloužit spíše jako úvodní seznámení s tématem a podklad pro jeho další zkoumání. Čtenářům, které zajímají především informace o vzdělávání nadaných v České republice, doporučujeme nahlédnout do podrobných zpráv České školní inspekce (ČŠI, 2016 a ČŠI, 2022).
- Mezinárodní srovnání praxe vzdělávání nadaných lze nalézt například v dílech Rutigliano a Quarshie (2021), Tourón a Freeman (2018) a Heuser et al. (2017). Ačkoli odkazujeme na vybraná zjištění z těchto zdrojů, naše zpráva se zaměřuje především na ekonomickou akademickou literaturu a neusiluje o vyčerpávající přehled oblastí, které jsou již dostatečně zpracované v jiných zdrojích.

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1 Introduction: Context and current situation

Where does the Czech Republic stand in identifying and supporting gifted pupils? In their most recent survey, conducted in 2021/22, the Czech School Inspectorate (ČŠI, 2022) states that a mere 5% of primary school pupils are classified as gifted, with fewer than 0.1% identified as exceptionally gifted. In secondary schools, the proportion of students who have been identified as gifted is slightly higher, at 7%. The difference is probably driven by the secondary school selection process. We discuss definitions of giftedness and talent in the following chapter, however, it should be clear from the outset that 'giftedness' is just a label. There is no clear distinction between gifted and non-gifted children. Rather, there is a continuous spectrum, and the cutoff used in identification is always arbitrary. ČŠI (2022) suggests that 10–15% students should be identified as gifted and about 2% students as exceptionally gifted within any specific cohort. These percentages are based on the most common measurements of cognitive skills, such as IQ tests, where the resulting scores are normally distributed through the population. Setting a threshold for giftedness one or two standard deviations above the average would lead to 16% and 2.5% of gifted and exceptionally individuals. Actual identification of gifted students mostly relies on pedagogical observations and interviews, and the numbers of gifted students reported by schools seems to be substantially lower than the percentages stated by the Czech School Inspectorate. Utilization of school counseling facilities (called "Školská poradenská zařízení" in Czech) for more objective identification is rather rare. The assessment by educational counseling facilities is required only for children to be qualified as exceptionally gifted.

It is necessary to identify gifted individuals before support can be provided for gifted students. In the Czech Republic, both identification rates and support for gifted students are low, with only 10% of primary schools collaborating with the National Pedagogical Institute, which implements a system of support for the gifted. The findings of the Czech School Inspectorate report (ČŠI, 2022) emphasize that schools lack systematic development and adequate emphasis on support and education of gifted and exceptionally gifted students. Although education of the gifted is formally integrated into the school educational programs of most schools, practical implementation of this support (e.g., through individualized approaches) is rare and is not subsequently evaluated. Moreover, relevant training of teaching staff, both within their formal education and in continuing professional development, is also inadequate.

How would society change if gifted children were given more optimal conditions and support? Support for gifted individuals not only yields individual benefits, such as better realization of their potential, higher earnings, and increased life satisfaction, but also exerts a broader positive impact on society. This critical literature review concentrates on existing research in the economics of education with a special focus on gifted children.

However, the research into talented children extends beyond the realm of economics. To study talented children, it is first important to define and identify talent, a task that falls within the scope of psychology. Further, one should turn to pedagogy, which provides curricula and effective teaching methodologies tailored for gifted individuals. Thus, we commence our exploration within a broader context, drawing upon psychological and pedagogical literature to address questions pertaining to the nature of talent, its developmental processes, and strategies for nurturing it.

In subsequent sections of this critical literature review, our focus shifts to talented children from an economic standpoint. The predominant analyses in the field of the economics of education are grounded in a basic production model. Analogously to a firm's production function, the education production function gauges the impact of inputs on generating outcomes in the educational process, such as student test scores, educational attainment, career choices, and the like. Prior to delving into the existing economic literature and focusing specifically on gifted children, we describe foundational concepts of the economics of education, drawing on human capital theory and the framework of the education production function.

We then narrow our attention to talent, in terms of both its development and its impact. The allocation of talent in a society has been considered crucial to prosperity since the days of ancient Greece. In complex and highly specialized contemporary societies, the importance of developing and allocating talent is even greater. We begin by discussing the benefits societies reap from skills development and talent allocation – first in the whole society, then focusing specifically on the most talented individuals.

We next explore factors that influence the education production function, examining inputs that contribute to an environment conducive to nurturing student talent. Pedagogical literature discusses the impacts of inclusion as opposed to separation of gifted and special needs students within the whole community of students, and we approach these considerations from an economic standpoint, drawing insights from existing

literature on ability tracking. Separating students into different tracks facilitates a homogeneous class structure, that allows teachers to address individual student needs more effectively. High-ability students can benefit from being surrounded by similarly skilled peers, which fosters an environment that promotes intellectual stimulation and collaborative learning. However, low-ability and average students can lose aspirational role models and classroom diversity decreases substantially. Peer effects literature directly addresses interactions among classmates and offers valuable insights regarding the sometimes-conflicting values of inclusion versus separation of gifted students. We also delve into the impacts of school choice policies, emphasizing their potential to enhance the alignment between students and schools, and ways to grant all gifted students access to programs, resources, and educational environments tailored to their specific needs.

Even within a school system that offers diverse programs for talented children or that creates an environment conducive to the development of talent, various obstacles to nurturing talent can remain. The primary impediment to fostering student potential often lies in the challenge of recognizing talent and consequent failures to establish optimal conditions to nurture it. Certain student groups may be more likely to encounter these barriers. Environmental factors, such as access to education, gender, socio-economic status of parents, and race play significant roles in shaping and fostering talent (Bell et al, 2019). In the final section, we look at the barriers talented people from poorer socio-economic backgrounds and women may face. We also suggest two important policies that can reduce these barriers: early childhood interventions and the role of information.

2 Broader context

"Our data show that teachers sometimes fail entirely to recognize exceptional superiority in a pupil, and that the degree of such superiority is rarely estimated with anything like the accuracy which is possible to the psychologist after a one-hour examination. … Teachers should be better trained in detecting the signs of superior ability. Every child who consistently gets high marks in his schoolwork with apparent ease should be given a mental examination, and if his intelligence level warrants it, he should either be given extra promotions, or placed in a special class for superior children where faster progress can be made. The latter is the better plan, because it obviates the necessity of skipping grades; it permits rapid but continuous progress." (Terman, 1916)

Although the primary focus of this review is on economic literature on talent, its allocation, and its impact on society, there are several closely related fields that should be considered. The understanding of talent, its definition, its relationships to other personal traits, and ways to foster its development have been subjects of psychological research for more than a century. In the five decades since publication of the Marland report in 1971 (Marland 1971a, 1971b), the education of gifted students has attracted sustained interest from educators and policy makers alike, and many gifted and talented programs have been implemented worldwide. This chapter provides an overview of the development of our understanding of giftedness within psychological literature and of gifted education in pedagogical practice around the world.

2.1 Conceptions of giftedness

To date, there is no clear consensus on the definition of giftedness. Although most definitions are linked to intelligence, there is substantial variation both between and within countries, and notions of giftedness and talents are frequently culturally determined. These variations present substantial challenges both for educational practice (as it is difficult to transfer programs into different contexts) and for research and evaluation of interventions, as programs are aligned with certain definitions that are not always fully comparable.

In evaluation of conceptions of giftedness, we need to be aware that (Sternberg and Kaufman, 2018):

- **Giftedness is only a label.** The answer to whether a child is gifted or not depends on the criteria chosen for the assessment, and there is not and cannot be a single correct set of criteria. There is a continuum of giftedness and the threshold for identification is always arbitrary to some extent.
- The label can be **applied in more general or more specific ways.**
- Definitions of giftedness can **vary over time and place** and have changed substantially in history.
- Conceptions of giftedness can be **based either on explicit scientific theories, or on implicit theory** (a layperson's conception of the phenomenon, which lacks an explicit scientific basis).

Over the course of the past century, four distinct waves have evolved in psychology; the following sections offer a brief description of each one. Although the initial focus was solely on intelligence, the scope has since been extended, and modern conceptions of giftedness typically include more traits than intelligence.

2.1.1 Domain-general models

One of the earliest pioneers in the field was Galton, who published a book entitled 'Hereditary Genius' in 1869. More rigorous research followed at the beginning of the twentieth century, focusing mostly on general intelligence and terms such as giftedness, talent, genius, or high intelligence were viewed mostly as synonyms. In 1904, Spearman described the ***g factor*** as the common factor across multiple intelligence tests available at that time. *g* stands for general intelligence manifested across multiple domains, as opposed to *s* factors that correspond to more specific abilities. Binet and Simon developed a mental scale for evaluating educational needs; their test was among the first to include an assessment of higher-level cognitive skills (Sternberg and Kaufman, 2018). Their scale was further adapted by Terman, who created the **Stanford-Binet Intelligence Scale** in 1916. Terman also understood giftedness as a single, hereditary entity and used his scale to identify gifted schoolchildren based on their IQ (an IQ above 135 corresponds to "moderately gifted"). Modern revisions of the Stanford-Binet scale are still widely popular, and it is still used to measure IQ and to identify giftedness today. However, the latest revision has not been standardized on the Czech population.

2.1.2 Domain-specific models

Not all researchers agreed on the existence of the general *g factor*. In 1938, Thurstone proposed a model of seven independent mental abilities. As researchers collected more empirical data, more nuanced hierarchical models were proposed. In the 1940s, Cattell divided the *g factor* into two parts, **fluid intelligence** (*g-f*, depends mostly on the efficiency of the central nervous system) and **crystallized intelligence** (*g-c*, depends more on experience and cultural context), and Horn refined the model to include four additional abilities in 1965. In 1993, Carroll proposed the **three-stratum theory** of intelligence, which attracted wider support in the psychometric community. This theory has more recently been synthesized into the **Cattell-Horn-Carrol theory (CHC)** which preserves the three strata: narrow abilities (stratum I), broad abilities (stratum II) and general abilities (stratum III, *g factor*; Flanagan and Dixon, 2014). The CHC theory is

widely popular among psychometricians and psychologists today, and has influenced modern revision of other intelligence tests, including the Stanford-Binet Intelligence Scale (Sternberg and Kaufman, 2018).

Another well-known domain-specific model is **Gardner's Theory of Multiple Intelligences**. Gardner (1983) considered intelligence to be composed of several cognitive systems: linguistic, logical-mathematical, spatial, musical, bodily-kinesthetic, interpersonal, intrapersonal, and naturalist. He assumed that these systems were truly independent, rather than hierarchically nested under a general *g* factor. Although the theory of Multiple Intelligences was influential and popular among educators (it has been recommended as suitable for gifted education by official authorities in the Czech Republic; VÚP, 2009), it remains controversial in the psychometric community because it has never been properly validated in empirical studies. Some of the proposed intelligences seem to be highly correlated to a *g factor*, rather than independent components as stipulated by the theory. Waterhouse (2006) provides a comprehensive overview of the insufficient evidence and other weaknesses of the theory of Multiple Intelligences. Straka, Cígler, and Jabůrek (2014) reiterate the arguments and point out that many of the perceived benefits of the theory of Multiple Intelligences (such as focus on individual differences and multidimensionality instead of a single IQ score) can be provided by other theories that are better grounded in empirical data (such as Renzulli's Three Ring model, described in the next section).

Although the existence of some form of general *g* factor is widely accepted by psychologists and psychometricians, there is no clear and satisfactory explanation of what it represents. It is generally referred to as "a biologically based variable" and its relationships with cognitive components such as working memory or speed of information processing are not fully understood (Van der Maas et al., 2017). A recently proposed mutualistic model of intelligence assumes that different cognitive components and processes positively affect each other during early childhood development, and the g-factor (manifested as a positive correlation across instruments) arises as a consequence of these beneficial interactions, though the cognitive components may have been independent at the beginning of the development (Van der Maas et al., 2006). The emphasis on the development of cognitive processes is especially relevant for understanding giftedness. The mutualistic theory of intelligence aims to close the gap between intelligence theories and developmental models of giftedness described later in this section.

2.1.3 System models

Research into this approach understands giftedness as a system, that is, a collection of psychological processes that function together. The most influential system models are **Renzulli's Three-Ring Definition** and **Sternberg's WICS Model** (Wisdom, Intelligence, Creativity, Synthesized).

Renzulli (2005) viewed giftedness as the interaction of three characteristics: well-above-average ability, creativity, and motivation. "Well-above-average" ability is defined as the 15–20% top performers in various domains, a substantially wider definition than most. Renzulli made a clear distinction between "schoolhouse giftedness," represented by excellent test results and frequently recognized in schools, and "creative-productive giftedness," which is possessed by many individuals who are only recognized as truly gifted later in life. Empirical research confirms the importance of other factors in addition to above-average ability for high-level creative production.

Sternberg's WICS model conceptualizes giftedness as an integration of wisdom, intelligence, and creativity. 'Wisdom' describes the ability to establish goals and harmonize personal interests with broader societal values. Intelligence facilitates the effective pursuit of these goals and compensates for one's own weaknesses. Creativity is essential for generating innovative and persuasive ideas or products (Sternberg and Kaufman, 2018).

2.1.4 Developmental models

Since the publication of 'Hereditary Genius' in 1869, giftedness has been predominantly seen as inherited and genetically determined. Developmental models emphasize the question of how innate "gifts" are developed into their full potential and enable a successful and fulfilled life.

Gagné's (2005) **Differentiated Model of Gifted and Talented** conceptualizes giftedness as innate potential that can be transformed into talent, given appropriate conditions. His aim is to identify the critical factors that influence this developmental process. Similarly, Tannenbaum presents a theory centered on the elements that facilitate high creative productivity, yet he views "giftedness" as the result rather than merely as latent potential (Kaufman and Sternberg, 2018).

Feldhusen (2005) shares a focus on the transformative process from genetically determined abilities to manifestation of specific talents. He also incorporates some of the models from other paradigms, such as domain-specific abilities, into his theory, and studies interactions between giftedness and environment through different stages of the educational process.

One of the most recent theories is Kaufman's **Theory of Personal Intelligence**, which is understood as the interaction between engagement and ability in the process of realization of one's own life goals. In this theory, every person is seen as a dynamic system with different interacting subsystems: motivational, cognitive, emotional, and personal. In this theory, instead of comparing children purely based on IQ, their development is assessed via comparison of the former self to the current self of each person.

To navigate through the plethora of models and theoretical frameworks, Kaufman and Sternberg (2018) describe three characteristics that a model must possess to be useful:

1. **Use of multiple and varied assessments.** All tests and measurements contain errors, and different instruments have different errors. Intelligence tests measuring IQ are typically more reliable; however, some may be too narrowly focused compared to more comprehensive instruments.
2. **Inclusion of non-intellective personal characteristics.** Success in life is always partially determined by task engagement, passion, and focused personal goals.
3. **Consideration of contextual variables, such as enculturation and socialization.** Children brought up in different types of households (non-native speakers of the local language, different parenting styles, etc.) possess different patterns of skills.

Empirical studies have confirmed the usefulness of broader models, including system models and developmental models, in practical applications. Several programs have used the theory of successful intelligence (akin to Sternberg's WICS theory, minus the wisdom component) and have assessed children based on their analytical, creative, and practical abilities. High scores in any of these categories were predictive of educational performance. Teaching practices aligned with a student's strongest component proved to facilitate learning best. Further, inclusion of creative and practical abilities improved equal access to educational opportunities, as it allowed a more diverse group of students to be identified as gifted.

Renzulli's Three-Ring conception of giftedness also facilitated development of successful programs, mostly centered around enrichment. These programs targeted not only the top performers on ability tests, but also above-average-ability students who rated highly on other behavioral characteristics. Notably, there were no significant differences in product quality across the different types of students at the end of the program. This result suggests that a wide range of students can substantially benefit from programs for the gifted and talented.

Although it is not clear what models and theories will become prominent in the future, Mayer (2005) calls for the scientific community to put more emphasis on:

- consensus definitions,
- straightforward objective measures,
- clear testable theories,
- conclusions based directly on evidence,
- valid scientific data,
- controlled evaluations of programs.

2.2 Gifted education in practice

In the past, it was generally assumed that exceptionally talented individuals do not need special support during the educational process, as they will naturally become highly skilled and successful. Hence, extra support was mostly directed at children with different special needs, and gifted students became a marginalized group within educational systems.

Scientific consensus, however, eventually departed from this traditional view. Gifted education came to be viewed as a continuous process of developing innate gifts into their full potential. This distinction was central to developmental models of intelligence, and in his Differentiated Model, Gagné (2005) made an explicit distinction between giftedness and talent: Gagné understands *giftedness* as a prerequisite for *talent*, however *gifts* do not necessarily become *talents*. The transformation can only happen if a child engages in systematic learning in a supportive environment (Rutigliano and Quarshie, 2021). Such a clear distinction between the two terms is not very common, and some educational systems remain inclined to use the term *giftedness* in intellectual or academic contexts, whereas the term *talent* is more often applied to sports or the arts (Eurydice, 2006).

The realization that traditional education might not meet the specific educational needs of gifted students and may not sufficiently foster development of their potential has led to wide adoption of gifted education in schools and to the design of numerous gifted and talented programs. Gifted education can be broadly seen as a combination of several overlapping areas:

- identification of gifted students,
- school-level interventions, provisions, and programs,
- system-level governance and additional support,
- evaluation and dissemination of best practices.

If any of these four areas is neglected, society will lose a substantial amount of talent due to inefficiencies in education for the gifted.

2.2.1 Identification of gifted students

The identification process typically consists of two stages: initial broad screening and follow-up confirmation. For the initial screening, nomination by teachers is considered one of the most reliable methods, because teachers spend a substantial amount of time with students and observe them in different situations. Nomination by parents, peer referrals, or even self-identification are sometimes also used (Rutigliano and Quarshie, 2021; Eurydice, 2006). Most countries rely on academic achievement and performance data rather than measurements of potential (Tourón and Freeman, 2018). However, this may increase inequalities in education, as many talented students from disadvantaged backgrounds perform below their potential due to environmental factors.

Confirmation of giftedness can be based on ability tests or on psychological and pedo-psychological diagnosis. Ability tests focus on different aspects of development in different countries (see Eurydice, 2006, for a detailed comparison):

- intellectual ability,
- interpersonal / emotional ability,
- psychomotor ability,
- artistic ability.

The psychological assessment is conducted by a psychologist or a specially-trained educator and involves complex assessment of cognitive performance that captures a detailed profile of a student's abilities.

There is a substantial difference across countries in the proportions of students who are identified as gifted and talented. Most European countries identify 3–10% of the student population as gifted. However, the very notion of giftedness can have an elitist connotation in some countries, and many gifted students may not be identified there. For instance, in Germany, fewer than 0.1% of students are identified as gifted, and in Spain, only about 0.27% are estimated to be gifted. There is similar variability across the US, where the percentage of the identified gifted population is most often below 2%, but 13 states identify 3–10% as gifted and 8 states have designated more than 11% students. China identifies about 1–3% students as gifted; the proportion is similar in South Korea and Singapore. Australia uses Gagné's definition of giftedness and identifies 10% of students as gifted (Rutigliano and Quarshie, 2021). The observed disparities in the identification rates of gifted students across different countries do not reflect genuine variations in the innate abilities or in the actual cognitive skills of the population. Instead, these differences are shaped by educational policies and the specific methodologies employed for recognizing giftedness within each nation. This suggests that the criteria and processes used to identify gifted students play a crucial role in determining the percentage of students classified as such.

In the Czech Republic, schools consider 5–7% of students gifted, and about 0.07% as exceptionally gifted (ČŠI). The Czech School Inspectorate considers this proportion to be too low and claims that schools are not well qualified to identify gifted students, as they typically rely only on observation and interviews with students or sometimes parents. The documented heterogeneity across countries arises primarily from different approaches to and conceptualizations of giftedness, and potential inefficiencies in the identification process. In the Czech context, the definitions of gifted and talented students are vague and are not explicitly based on psychological theories. The website of the Czech Ministry of Education, Youth, and Sports only loosely defines the terms without clarification or supporting guidelines[5]:

[5] Available at https://www.msmt.cz/mladez/talentovana-mladez.

- A **gifted student** is an individual who has demonstrated greater knowledge and abilities in a certain field than his or her peers.
- A **talented student** also aims to deepen his or her talent through independent activities (such as diligence, focus, and commitment to develop the talent).

Regulation no. 27/2016 on education of students with special needs and of gifted and talented students[6] uses the following definitions of gifted and exceptionally gifted students:

- A **gifted student** is primarily considered to be a student who, with adequate support, shows a high level of abilities in comparison with peers in one or more of the following areas: intellectual abilities, motor, manual, artistic, or social skills.
- An **exceptionally gifted student** is primarily considered to be a highly creative student with abilities at an extraordinary level across a broad range of activities or in individual areas of intellectual abilities, or motor, manual, artistic, or social skills.

These definitions do not apply any explicit psychological conceptualization of giftedness, and the regulation does not specify how gifted students are identified. Better guidance is offered by the Standard for Complex Assessment of Exceptional Giftedness (Durmeková, 2018), which uses Renzulli's Three Ring model and describes specific procedures that can be applied by a teacher during an initial screening, and by school counseling facilities in the form of standardized tests.

2.2.2 Interventions in gifted education

The most common strategies in gifted education include:

- curriculum enrichment,
- acceleration,
- personalization,
- ability grouping or tracking,
- other activities: the use of technology, competitions, projects.

[6] Available at https://www.msmt.cz/dokumenty-3/vyhlaska-c-27-2016-sb-o-vzdelavani-zaku-se-specialnimi-2.

Modern approaches focus on teaching gifted students in regular classrooms, using differentiated pedagogy strategies. These strategies acknowledge differences among learners across various areas, apply diversified and tailored teaching methods, and develop the autonomous learning abilities of students. In line with these approaches, the Czech School Inspectorate states that gifted education should be implemented and supported primarily through inclusive education and teaching of heterogeneous groups, rather than by supporting homogeneous groups of students with certain characteristics in educational tracking. In addition, it states that gifted education is not sufficiently developed in most Czech schools and is frequently realized through student participation in competitions. Whilst such activities allow talented students to use their skills, they are not focused on further development and do not provide support for disadvantaged gifted learners who have not had opportunities to develop their skills. The Czech School Inspectorate also provides detailed statistics of the frequency of different interventions focused on gifted students at schools offering primary and secondary education (ČŠI, 2022).

A European survey suggests that curriculum enrichment is the most common intervention, and acceleration, typically implemented as grade skipping, is also popular in some countries (Tourón and Freeman, 2018). The Czech regulation on gifted education sets conditions for grade skipping. Personalized teaching is less often seen as a part of gifted education among European schools. Whilst partial ability grouping (for some elective courses or projects) is viewed as beneficial, early ability tracking into different schools remains controversial. Chapter 4.2 of this paper on how talent can be nurtured reviews the existing research on the topic. Additional activities for gifted students, such as special and summer programs, online and college courses, and competitions are also quite common across Europe (Tourón and Freeman, 2018). However, very little is known about the impact of such activities. They are typically small-scale, and systematic evidence of their effectiveness is lacking. Rutigliano and Quarshie (2021) recommend engagement with parents and communities as a part of gifted education, because this can substantially improve the overall success and well-being of all students. Enhanced engagement allows gifted students to learn from inspirational role models in their communities (Bell et al., 2019; Hoxby and Avery, 2012; more details on these studies in chapter 4.1) and can also be motivating. This can be especially beneficial for twice-exceptional students (gifted students with learning disabilities) in contexts in which no additional support is provided (King, 2005).

At the country level, gifted education policies can be broadly divided into four partially overlapping categories (Rutigliano and Quarshie, 2021):

- **Policies that explicitly name and identify gifted students.** These policies acknowledge differences among learners, and they are viewed as a decision to prioritize excellence.
- **Policies that promote gifted education through an egalitarian approach.** Some countries aim to provide individualized attention and tailored instructions to all students, to fully respect their specific needs and predispositions. This approach is typical in Scandinavian countries.
- **Policies that integrate gifted education into mainstream policies.** Most commonly, gifted education can be integrated into policies on special education needs, although the term 'special education needs' traditionally refers to students with learning difficulties or behavioral problems. The Czech Republic falls into this category, as regulation no. 27/2016 defines gifted students along with students with other types of special education needs.
- **Policies that approach gifted education policy as separate and specific policy measures.** This category is a subgroup of the first category that provides a more developed set of measures and policies focused on gifted education. This type of approach has been successfully implemented in South Korea.

2.2.3 Monitoring and evaluation

Evaluation is crucial at several levels in educational systems. At the student level, it allows one to monitor the progress of individual learners, and at the institutional level, it enables policies and interventions to operate in the same ways, and ensures their effectiveness. Although evaluation and monitoring are considered to be crucial elements of gifted education, little is known about what types of educational interventions are truly effective. Even when descriptive data and empirical relationships between interventions and outcomes are documented, evidence of causal relations between gifted and talented programs and overall educational outcomes is often lacking.

A significant challenge in evaluation of gifted programs is related to collecting necessary data and disentangling the effects of interventions from selection bias. Different conceptualizations of giftedness further complicate comparison of results across different studies.

Several longitudinal studies that attempt to address these challenges have been conducted in Germany, the United States, and Australia in recent decades. They provide interesting results (Rutigliano and Quarshie, 2021):

1. Gifted education programs have positive impacts on the academic performance and well-being of gifted students.
2. Improvements in training and professional development of teachers is necessary, as there are significant gaps in these areas.
3. The role of parents is crucial.
4. Differentiated pedagogical strategies should be widely adopted to teach heterogeneous classrooms and to promote inclusiveness.

Economic methodology provides additional techniques for evaluation of gifted programs and enables identification of their effects. These techniques are discussed in section 3.4. Nevertheless, several critical questions remain unanswered: Do the benefits of gifted programs last over time? How are non-gifted students affected? What areas should teacher training and professional development focus on? Although some findings from academic literature are presented in subsequent chapters, the body of empirical evidence on these issues remains limited, and studies often report varying outcomes for different programs. The evidence reviewed in following chapters indicates that there is a general shortfall in evaluation of gifted education policies and interventions, both in academic literature and in practical applications.

The situation in the Czech Republic mirrors the broader issues described above. The Czech School Inspectorate states that school-based gifted education programs are only rarely evaluated, and that only a small minority of teachers participate in professional development in gifted education (only 3–4% of teachers participated in any course or workshop focused on gifted education in recent years; ČŠI, 2022).

2.2.4 Summary

Tourón and Freeman (2018) summarize typical obstacles to providing high-quality gifted education and ensuring that students have equal access to it:

- Identification of gifted students is mostly based on school-type achievement rather than on discovering potential.
- Many education systems suffer from frequent changes at the government level and lack long term, consistent policies.

- Lack of dedicated funding explicitly focused on gifted education means that the area competes for resources with other school needs.
- Misunderstanding and insufficient teacher preparation can lead to low motivation for teachers to engage in gifted education.
- Researchers and practitioners should provide clearer requirements for identification and education of gifted students to relevant government ministers, to aid in creation of better-targeted policies.

Despite approval of the Conception on Talent Development and Provision for Gifted Students in 2014–2020 (MŠMT, 2015), the current practices of gifted education in Czech schools are frequently insufficient and focused on formalities, and are often considered of secondary importance (ČŠI, 2022).

3 Economic approach

Compulsory education, while essential for modern societies, entails significant costs. These are not confined to the monetary expenditures of publicly financed educational institutions, but also encompass the considerable time commitments required from all involved parties, including educators and students. It is legitimate and important to ask: what does society gain in return for its investment in education and what benefits do students reap from their substantial investment of time and effort into studies?

The economics of education seeks to provide comprehensive answers. Human capital theory examines these questions using both theoretical frameworks and empirical data. The education production function is another key concept that delves deeper into the process of human capital creation. The educational process is viewed as a transformation of various inputs (money, teachers and other employees, school buildings, and equipment) into an output: educated young people. The education production function is an analytical framework that allows us to estimate the relative importance of different factors in the process of education, and to analyze differences across educational systems.

This chapter briefly outlines the key concepts of economics of education and the following chapter applies them to the specific area of gifted education.

3.1 Human capital

Initial research focused on human capital, frequently measured by educational attainment (typically years of schooling), as a factor of economic production, together with labor and other capital. Human capital theory assumes that individuals invest in development of their skills and consequently apply them in the labor market. A typical model is the Mincer earnings function, which relates individual earnings to years of schooling and to labor market experience. This simple measurement of school attainment does not provide a complete picture of outcomes and disregards the question of school quality. A common extension is the addition of cognitive skills measured by standardized test scores.

However, test scores can also be interpreted as an explicit measure of human capital, and modern research confirms that the earnings function can be accurately estimated using achievement tests instead of measuring years of schooling. Assessments of cognitive skills via achievement tests is sometimes explicitly called knowledge capital, to distinguish it from school attainment in human capital theory. The average knowledge capital of a given country is predictive of its future economic growth (Hanushek, 2020), which confirms that higher cognitive skills support productivity.

3.2 Education production function

While human capital theory treats knowledge and skills as inputs to explain individual earnings, the education production function considers knowledge capital an output of the educational process, linked to various inputs. This output is often assessed through different measures of student achievement. Though not all inputs to the education production function are within the direct control of policymakers, some can be influenced by policies. The following variables are frequently used as inputs in this context.

- **Family background:** parental education, income, family size.
- **Peer effects:** level of achievement of a student's peers or their socio-demographic characteristics.
- **School inputs:** teacher background (education level, experience, sex, race) and school resources (class sizes, facilities, expenditures).
- **District or community factors:** average educational expenditures, characteristics of the locality.

Initial research in this realm focused on the impact of different school inputs on student achievement. The studies vary considerably in terms of the quality of their data and methodology, and empirical results about the impact of most factors (including the effects of class size or expenditures) remain inconclusive. The main takeaway to date is that school resources are frequently used inefficiently, as schools often focus on improving factors that are not clearly related to student achievement.

The modern line of research mostly uses large administrative data and focuses on value-added over time. Research into teacher quality confirms large and consistent differences in growth rates of student achievement across teachers. The magnitude of measured differences can be as much as a full year of knowledge per academic year (Hanushek, 2020). These differences in achievement can be directly translated into large economic impacts (future student income aggregated for a class). However, teacher quality cannot be clearly or directly related to commonly measured teacher characteristics, and therefore early research did not identify conclusive teacher effects.

From a policy perspective, the costs of interventions must also be considered. Some studies have found a small positive effect of class size reduction; however, this is among the costliest of measures, and many other studies do not support the positive findings.

In general, research on the education production function offers at least some clear conclusions (Hanushek, 2020):

- Differences in teacher quality are the most important differences across schools.
- *How resources are used* is generally more important than *how much is used*.
- Large administrative data is necessary to study differences in the quality of schools and teachers.

3.3 Role of information

In any sizable group within society, various actors are equipped with different sets of information. This asymmetry in information among actors can play a pivotal role in many scenarios. For example, in job markets, employers often rely on an applicant's formal education as a proxy to gauge their skills. The information gap here is crucial, as employers must make inferences about the potential of candidates based on limited available information.

Similarly, when it comes to school choice, parents and children face the challenge of selecting the most appropriate educational path. This decision-making process entails considering factors like the quality and rigor of prospective schools in relation to the child's abilities and aspirations. The asymmetry of information is apparent, as parents and children possess limited insights into the quality of educational institutions, the child's capabilities, and the educational requirements of different job tracks.

Clearly, differentials in information held by various parties significantly influences overall outcomes. A lack of information can lead to incorrect, suboptimal, or inefficient decisions. The efficiency of decision making can often be improved substantially simply by providing easily accessible and reliable information: for instance, data about school quality and feedback about a student's skills.

3.3.1 Signaling

Human capital theory assumes that differences in productivity and wages are caused by knowledge acquired in school. However, job market signaling offers an alternative explanation: maybe students differ in terms of intelligence even before they start school, and firms want to hire the smartest candidates. Likely it is easier for smart people to complete more formal education, so some students may decide to study for higher degrees only to send a credible sign to firms that they are smart. Less talented students might not be sure whether they would finish a college or university degree, and the payoff in terms of uncertain better wages in the future might not be worth the risk. If the above is true, the level of education would be a valid signal of intelligence and companies could rely on it (Spence, 1973). Empirical research confirms that the returns to an additional year of education leading to completion of an education level are substantially higher than for other years of education (Ferrer and Riddell, 2002), which also signals that degree or graduation status matters. This is sometimes called the 'sheepskin effect' (sheepskin was historically used to make parchment for diplomas).

The relative importance of skills improvement via more years in school and the signaling role of educational attainment is not well understood. The amount of time students devote to study has decreased substantially over recent decades, which may suggest that they primarily aim solely to finish their education and obtain degree, rather than striving to learn as much as possible. On the other hand, empirical research estimates the proportion of returns to education attributed to signaling to be below 25% (Gunderson and Oreopolous, 2020).

3.3.2 Informational nudges

Although many traditional economic models assume that humans can acquire and instantaneously process any information necessary for decision making, research in behavioral economics over recent decades has clearly confirmed that humans have limited attention and frequently do not have needed information.

Decisions about educational paths and school choice are among the most important of life decisions, and have long-lasting impact. Students should ideally consider their own skills relative to all students of the same age, their preferences, school quality, and many other factors (commuting or relocation costs, for example). However, reliable, and objective feedback about one's own performance and the performance of peers is not readily available to students – grades are often biased, conflated with other factors, and compare an individual only with their closest peers. Information on the relative quality of different schools is frequently not easily accessible either, and students and their parents must rely on various proxies, such as the number of students in classes or anecdotal information from the community.

Provision of reliable and comprehensive information to students and their parents may represent an inexpensive intervention that can substantially improve the efficiency of their decision making. Empirical research confirms that giving parents easy access to detailed standardized information improves student outcomes. Some parents, typically those of lower socioeconomic status, may not be fully aware of the substantial future returns that education offers. Easily accessible information may help to motivate parents to choose more ambitious schools and ultimately lessen inequalities in access to education (Damgaard and Nielsen, 2020).

3.3.3 School accountability systems

In some countries, information about the quality of different schools may not be available due to a lack of data collection and evaluation. As a growing body of empirical research highlights the crucial role of quality in education, many countries aim to enhance their education systems by introducing mechanisms for ensuring school accountability. These mechanisms typically rely on standardized tests administered to students in certain grades. In the past, status measures of performance were used – typically indicators of performance levels such as test scores. More recently, the focus has shifted to growth measures – changes in scores over certain periods of schooling – because the status

measures are affected by student composition and other factors. A well-designed administrative accountability system not only provides reliable information on school quality to parents and students, it is also crucial for ongoing development of the educational system. It allows evaluation and monitoring of school quality, identification of best practices at schools, and provides crucial evidence for policy recommendations. However, accountability systems must be carefully designed to mitigate potential unintended outcomes, like cheating or curriculum narrowing, which often results in an excessive focus on a limited range of knowledge or subjects that will be tested. This is particularly crucial for tests that carry high stakes for schools (Figlio and Ladd, 2020).

3.4 Methodology for evaluation of educational programs

Identification of causal relationships is always a challenge for scientists: the well-known saying "correlation does not imply causation" is true here, and straightforward comparisons of final educational outcomes do not prove anything. In an ideal world, one would compare realized outcomes with counterfactuals, i.e., compare student achievement when a program is implemented with the outcome that would have been achieved in the absence of the program. Because such counterfactual situations do not exist, researchers must rely on several techniques that allow identification of causal relationships:

- **Randomized controlled trials (RCT)**: participants are randomly assigned into an experimental group that receives a treatment (or educational provision), and a control group that does not. Although this is a gold standard in medicine, it is very challenging to apply to educational research and is only rarely used in social sciences. Participants ideally should not be aware of which group they are assigned to, and there can be ethical challenges in conducting RCTs.
- **Random assignments and lotteries**: in some cases, the capacities of schools and special programs are not sufficient to enroll all applicants, and available places are allocated to eligible students at random. Comparisons of equally talented students among lottery winners and losers allows identification of the causal effect (with some caveats, such as that their ability relative to their peers may change under either condition).
- **Regression discontinuity**: if there is a strict cutoff for eligibility into programs, it may be possible to compare students just above and just below the cutoff. This methodology allows identification of the impact on marginal students (again, the challenge is to disentangle program and peer effects).

- **Fixed effects models**: allow for controlling omitted variable bias that might be caused by unobserved heterogeneity if such heterogeneity is constant over time (for instance, students in different schools where it is not possible to include all relevant school characteristics). These models will not identify a causal relationship on their own, however: it may be necessary to use fixed effects in combination with other approaches to avoid bias in results.
- **Difference-in-differences (DID):** a quasi-experimental approach that compares changes in outcomes between non-randomized treatment and control groups. By analyzing the differences in the pre- and post-intervention outcome changes between two groups, DID allows researchers to isolate and estimate the causal effects of an intervention.

3.5 Economics of education and talent

While this chapter does not specifically address talent, the methodologies, techniques, and tools discussed can be effectively utilized to explore the development and distribution of talent. Talented children exhibit differences from their peers in many respects, and the factors that contribute to their development and potential realization can differ as well. Even though specific research into the education production function tailored to gifted education is scarce, the inputs typically considered in the production function are relevant to gifted children. The program evaluation methods presented here can also be applied to assess programs within gifted education. The next chapter adapts the framework and concepts introduced here to the area of talent, and its development and allocation.

4 Talent in society

4.1 Why is talent important?

"[O]ne individual is by nature quite unlike another individual, that they differ in their natural aptitudes, and that different people are equipped to perform different tasks. … [I]n any enterprise, more is produced — and that it is better and more easily produced — when one person does a single task which is suited to his nature." (Plato, 2000, p. 52)

As the quote from Plato highlights, allocation of talent has been considered a cornerstone of functional societies for a very long time. Politicians often call for their country to become a world leader in skills, and emphasize that they need to tap into their own talent pools or attract talent from abroad. Empirical scientific research clearly confirms

that the talent a society possesses is crucial and is beneficial for many areas. For a more structured overview of the impact of talent on society, we need to specify what exactly is meant by the talent a society possesses and what impacts are considered.

Large-scale empirical studies usually measure talent as the actual (as opposed to potential) level of ability and skills present in a society, as it is frequently infeasible to estimate what the realized talent would be if all members of the society possessed the best available conditions to foster and develop it. Empirical research mostly aims to answer one of the following questions:

- What is the impact of the average level of ability in society?
- What is the impact of high-ability individuals specifically?
- How is the impact affected by the allocation of talent?

The following sections describe the answers research offers to these three questions. In terms of the impact or outcomes of talent, it is useful to distinguish between private outcomes (that concern only a given individual, such as higher wages, better health, or life satisfaction) and societal outcomes that concern society as a whole. In economic literature, outcomes are frequently translated into monetary terms and are designated 'returns to education'. This is a convenient representation, especially for policy recommendations and decision making, as it allows comparison of investments into an education system to other types of investments.

4.1.1 Impact of talent on society

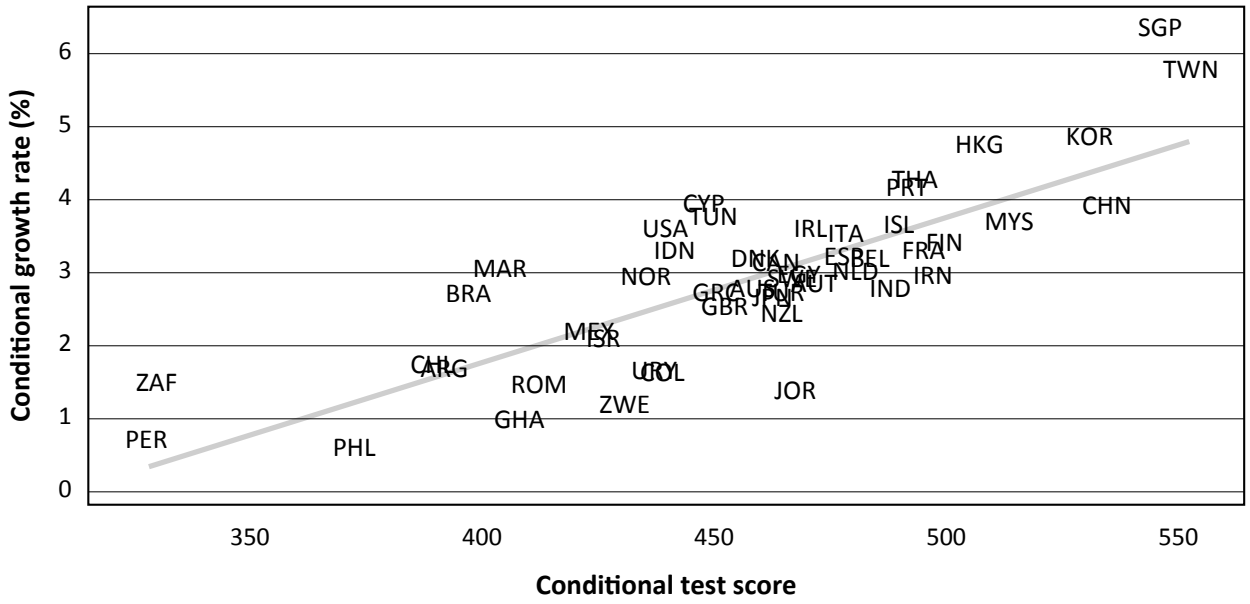
The main purpose of education systems is to provide necessary skills to members of a society. Hence, the most straightforward (and very approximate) metric of the level of talent in society is the amount of education people receive. Research confirms wide and numerous benefits of education in modern societies. The positive impacts affect not only the students receiving the education, but also their neighborhoods and society in general. Education results in better decision-making on health, marriage and parenting, crime reduction, increases volunteering and civic engagement, and reduces social expenditures due to decreases in illness, unemployment, and poverty. Knowledge spillovers and other externalities can affect the productivity of the wider economy due to positive neighborhood and peer effects. In monetary terms, private returns to education in developed

countries are estimated to be 10% on average.[7] Returns to education do not seem to decrease with wider availability of education; the estimates of wider social returns are comparable to those of private returns and add another 10% to the overall returns to education (Gunderson & Oreopolous, 2020). Estimated returns to education in developing countries are even higher (both private and social), as human capital is less abundant in their economies. The returns are typically higher for females than for males, for students on general academic tracks than for vocational tracks, and for completion of primary education than for secondary or higher education (Patrinos & Psacharopoulos, 2020). Even viewing the benefits of education strictly from a financial perspective, investing in education yields higher returns than conventional financial instruments like stocks and bonds, and is very likely more advantageous than the majority of other types of government expenditures.

At the level of the whole economy, the more educated countries are, the greater economic growth they exhibit. Even if we consider solely educational attainment and do not consider possible differences in education quality, every additional year of schooling is associated with 0.58% points higher long-term growth. If we include a better measure of knowledge capital, such as average test scores on international student achievement tests, the association is even stronger, and models can explain 73% of the variation in economic growth across countries. Additional evidence based on a multitude of approaches even suggests a causal direction of the relationship: differences in cognitive skills lead to substantial differences in economic growth, although some uncertainty may remain on this (Hanushek & Woessmann, 2020). Pietschnig and Voracek (2015) show that there is an even deeper connection between cognitive skills and economies: GDP growth seems to be one of the factors contributing to steady IQ gains over the past century (the Flynn effect).

[7] To allow for comparison of different investment opportunities (or budget allocations in the case of government expenditures), returns are expressed as the rate of return of investment into education (conceptually similar to interest rates).

Figure 1: The relationship between knowledge capital and economic growth
(Hanushek and Woessmann, 2020)



Notes: Added-variable plot of a regression of the average annual rate of growth (in percent) of real GDP per capita in 1960–2000 on average test scores on international student achievement tests, average years of schooling in 1960, and initial level of real GDP per capita in 1960 (mean of unconditional variables added to each axis).

Source: Hanushek and Woessmann (2015a).

There is no doubt that there are wide and large benefits of education in general. For this review, the more interesting questions are: what is the impact of the most gifted and talented students, and to what extent they can improve society if they are enabled to develop their full potential? How is their impact affected by allocation of talent and by the occupational choices of individuals?

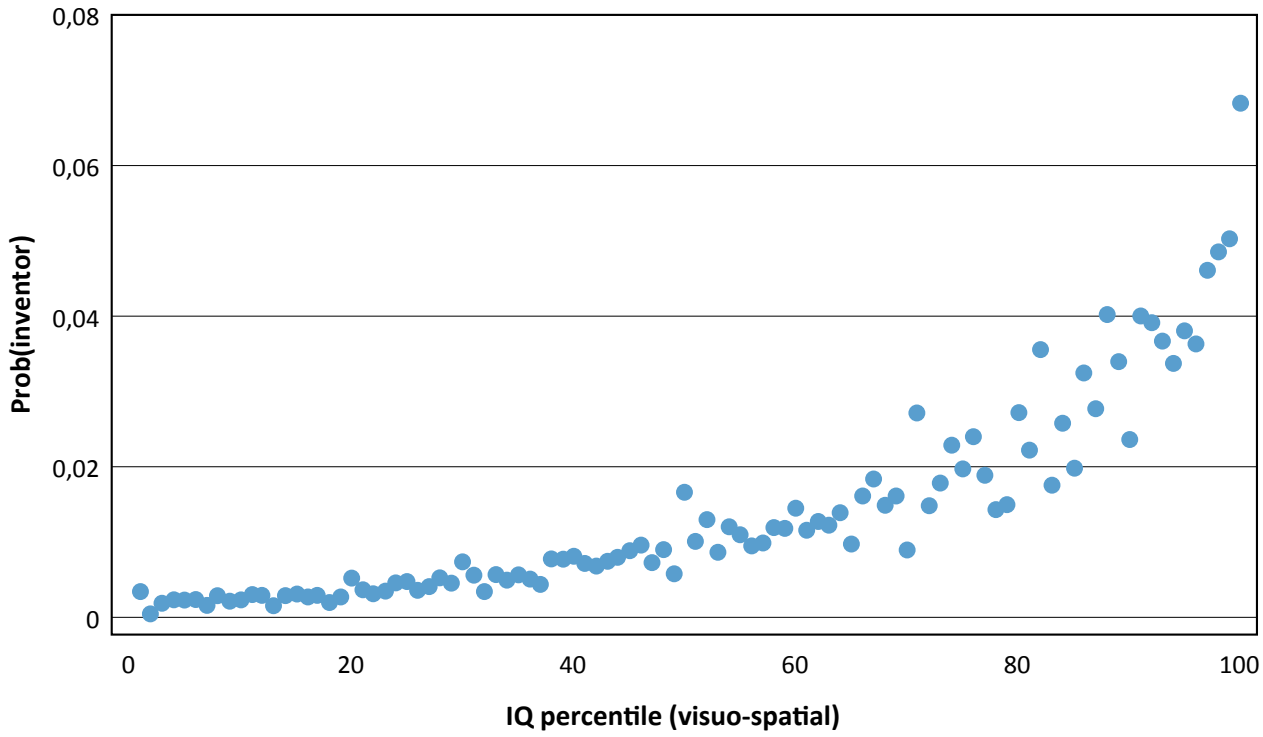
4.1.2 Effects of the exceptionally talented

Innovation is generally seen as a crucial driver of economic growth, and there are many examples of highly talented students who later had significant impacts on society (for instance, famous entrepreneur and philanthropist Bill Gates achieved almost perfect results on the SAT, placing above the 99.9th percentile). To evaluate the contributions of very talented individuals, we can consider the numbers of innovations they are responsible for creating. The rate of innovation is indeed much higher among such individuals – math test scores in 3rd grade predicts the number of future patents granted to a given individual (Bell et al., 2019). The most successful participants in the International Mathematical Olympiad publish substantially more high-quality papers, are referenced more frequently, and more of them achieve exceptional recognition in their fields, such as receiving a Fields Medal in mathematics (Agarwal & Gaule, 2020).

Their contribution to innovation is much larger than their share of the population. IQ also has predictive power: people in the top 5% of a population based on IQ are 5 times more likely to become inventors (Aghion et al., 2023). Supporting evidence of the significant economic value of highly talented and skilled individuals is found in labor market data. Andersson et al. (2009) demonstrate that sectors generating substantial profits from innovative products tend to offer higher compensation and more substantial performance-based bonuses to their most talented employees. They suggest that the rise in income inequality in the US over recent decades is largely attributable to the prevalence of performance-based pay.

The considerable value of innovations in driving economic and societal progress is indisputable. However, some groups of people become inventors more frequently than others – patent record data in the US shows that a child's chances of becoming an inventor depend heavily on race, gender, and parents' socioeconomic class. Children from families in the top 1% of the income distribution are 10 times more likely to become inventors than children from families with below-median income (Bell et al., 2019). Importantly, chances differ in favor of children from better-off families even for the overall population of children with equivalent math test scores in early childhood, which are highly predictive of the propensity to become an inventor. This result suggests that the difference in the propensity to innovate is driven more by environmental factors than by innate abilities. Were we – as a society – able to provide all children the support needed, many more could potentially become inventors or otherwise achieve notable successes. The literature refers to neglected gifted and talented children who could have become successful inventors under different circumstances as ***lost Einsteins***. The research also identifies an important determinant of becoming an inventor: if children are exposed to innovations during childhood, their chance of becoming inventors increases significantly. These exposure effects are class and gender specific (i.e., girls are impacted only by female inventors) and are likely driven by role-model and network effects. If we could leverage the chances that low-income children and girls will become inventors to the same degree as children in high-income families, there would be 4 times more inventors in the US (Bell et al., 2019). These findings do not seem to be specific to the US; dependency on family background has also been confirmed in Finland by Aghion et al. (2023), who also indicate that a large part of the effect is due to parents' education. They found that the influence of family background on the propensity to become an inventor weakened after a comprehensive schooling reform.

Figure 2: The probability of holding a patent conditional on IQ percentile
(Aghion et al., 2023)



Another strand of research sheds light on ways we lose these *Einsteins* and potential mechanisms that could prevent their loss: high-achieving students from low-income backgrounds apply for less selective colleges than their high-income peers. Interestingly, this does not hold for all low-income, high-achieving students: for those who live in better neighborhoods or study at high schools with high-achieving, aspiring peers (typically in cities), the probability of applying to selective colleges is similar to that of their better-off peers (they exhibit achievement-typical behavior in such circumstances). The differences are greatest for high-achieving students from regions or low-income neighborhoods where there are few or no aspirational role models (here, students exhibit income-typical behavior in their decision-making). These findings confirm the crucial role of exposure and network effects, and suggest that typical policies, such as college admissions recruiting or campus visits, are unlikely to be effective, because there is less outreach in more isolated geographical locations. Whether these differences are caused by a lack of information about colleges or by other cultural and motivational factors cannot be fully determined, but the researchers were able to reject other possible explanations, such as lack of resources (Hoxby & Avery, 2012).

There may be even more *lost Einsteins* than research suggests. Ellison and Swanson (2016) compared school differences in producing high-achieving students in mathematics. There is a relatively small group of schools that produce high achievers at much higher rates than others. Based on their estimates, around 11% of schools generate high achievers at twice the expected rate (where the expected rate is based on the demographic composition of the students). 1% of schools generate high achievers at five to ten times the expected rate. These differences cannot be explained by demographic factors. Supplementary analysis suggests that these are true school effects and are not fully caused by parents of talented students selecting into their programs on the student's behalf. One plausible explanation is that there may be long-serving "star" teachers at these schools, who are able to help some students develop further than usual in mathematics. However, the existing evidence for this conjecture is only anecdotal. The key takeaway from Ellison and Swanson's (2016) study is that other schools may also be able to produce high achievers at much higher rates under suitable circumstances. Their results also supplement the literature focused on evaluation of gifted and talented programs; many studies have not found any positive effect for marginal students in such programs. Ellison and Swanson suggest that there may still be substantial benefits for the other end of the ability distribution.

Agarwal and Gaule (2020) add an international dimension to this strand of research. They analyze the career paths of participants in the International Mathematical Olympiad, and confirm that participants in high income countries achieve higher scientific output when compared to equally scoring participants from lower income countries. A participant from a low-income country produces 34% fewer scientific publications in math and receives 56% fewer citations than do equally talented participants from high-income countries. The authors estimate that knowledge production could be 10% higher in terms of scientific publications and 17% higher in terms of citation had the lower income countries been able to attract as many students to scientific careers as did the high-income countries. Agarwal and Gaule recommend several supply-side policies to advance the knowledge frontier faster. They suggest providing fellowships for the most talented students at undergraduate and graduate levels to overcome financial constraints, encouraging applications from developing countries, and supporting the research and training capacity of developing countries. Because the participants in the International Mathematics Olympiad are the most successful high schoolers in their respective countries, they have already been able to develop their innate abilities substantially

and over a long period of time. The true effect is likely underestimated, as there may well be substantial numbers of equally talented children who were not able to develop their skills due to less favorable circumstances, especially in lower income countries.

4.1.3 Allocation of talent

Focus on allocation of talent has a practical advantage: whilst it is difficult to increase the average talent in the society, regardless of whether it is measured by IQ, scores on standardized educational tests such as PISA, or by other metrics, changing the allocation of talent among occupations is easier. Efficient allocation of talent means that each person performs the tasks s/he is best able to perform. However, in practice, this definition of allocation cannot be measured directly. Strenze (2013) offers several metrics for allocation of talent, including the correlation between ability and job complexity, and verifies on empirical data that better allocation of talent is associated with higher rates of economic growth. Most empirical studies on the allocation of talent rely on differences in the share of labor in various occupations or on demographic structure in certain occupations.

In contemporary knowledge societies, innovation is widely regarded as the primary source of economic growth and some occupations are considered more productive than others. Some career paths lead to more entrepreneurs starting new businesses and spur economic growth, while others focus more on safe rent seeking. Murphy, Shleifer, and Vishny (1991) describe characteristics of economies or markets that are more attractive to different career paths.

Market factors that support entrepreneurship as a career choice:

- Good communications and transportation, large markets for goods.
- Easy entry and expansion, access to capital markets.
- Clear property rights and patent protection.

Market factors that support rent seeking as a career choice:

- Large public resources in “official” rent-seeking sectors (e.g. army, government, religion).
- Poorly defined property rights. Substantial authority and discretion of rent seekers (such as government officials).

On a sample of 91 countries, Murphy, Shleifer, and Vishny show that countries with more engineering students exhibit higher long-term growth. If an additional 10% of students chose engineering (roughly doubling the average enrollment), the growth rate would rise by 0.5% per year. On the other hand, an additional 10% of students into law (again roughly doubling) results in a 0.5% lower growth rate.

A more structured approach to the allocation of talent is offered by Hsieh et al. (2019). US society was transformed in many respects between 1960 and 2010, and the structure of workers in different occupations changed significantly. In many well-paid occupations, the vast majority of workers in 1960 were white males, who made up, for instance, 94% of doctors and lawyers. In 2010, the share of white men in these occupations had dropped to 62%. Because it is very unlikely that there has been such a large change in innate abilities, these shifts in occupational distributions can be attributed to more efficient allocation of talents. In 1960, several obstacles were in place that enforced suboptimal career choices in certain groups: discrimination in education affected school choice and educational outcomes, social norms affected preferences and career-related decision making, and discrimination in labor markets limited entry into certain professions. Hsieh et al. attributed 40% of economic growth between 1960 and 2010 to gradual lessening of these obstacles and to better allocation of talent due to the movement of more women and black men into high-skilled occupations. The key factor was improved access to education, which allowed more efficient accumulation of human capital. These results and the findings described in the previous section confirm that improved allocation of talent — both at the very top of the achievement distribution and across a much broader range of abilities — can benefit society tremendously.

Improving access to education for less advantaged groups is also a critical issue in the Czech Republic. The country's education system has long faced significant challenges arising from the impact of socioeconomic background on students' educational outcomes. Recent PISA 2022 results reaffirm this, showing that, despite differences in socioeconomic status that are less pronounced than in some other countries, socioeconomic factors still explain more than 20% of the variations in test scores. This rate of influence is among the highest reported in the OECD's study of 81 countries (OECD, 2023). Only Slovakia, Romania, and Hungary exhibit even stronger dependency of scores on family background. Very few disadvantaged children manage to score among high-achievers in mathematics — fewer than 8% (the OECD average is over 10%, and only

Slovakia and Romania have fewer disadvantaged top performers). Because the PISA results are based on 15-year-old students, it is very likely that the proportion of disadvantaged gifted children is substantially higher, but many of them are unable to develop their skills and realize their potential over the course of primary and lower secondary education.

4.2 How can we nurture talent?

From an economic perspective, nurturing talent requires an environment that allows for the development and optimization of children's skills. Using the education production function theory, in this chapter, we focus on some inputs and factors in the educational process that may have an impact on creating such an environment, with a special focus on talented children. First, we comment on ability tracking, which allows grouping of high-ability students and forms more homogeneous classes that may help to foster talent. This policy relates to peer effects literature that examines the impacts of class composition on individual output and behavior. Nevertheless, certain forms of ability tracking may also introduce notable drawbacks in the form of educational inequality. This concern is particularly pronounced when children are selected at early ages, which we also address in this section. We briefly mention different forms and possible impacts of school choice and conclude the chapter by describing other interventions that are less common in the literature.

4.2.1 School choice

In traditional public school systems, students are assigned to schools according to their attendance zones, i.e., the place where they live. This system ensures equity in education and geographic accessibility aimed to reduce the need for parents to transport their children over long distances. However, the quality of education can vary across school districts in terms of resources and teacher quality, and students in low socio-economic status districts may face limited access to quality education. At the same time, an absence of competition among schools means that schools do not have to compete for students and may result in lower quality education and less innovation.

School choice policies, in contrast to attendance zones, include a range of educational initiatives that grant parents and students the possibility to choose among various public, private, or charter schools. School choice policies directly affect the supply of schooling options and sever the link between where students live and the schools to which they have

access, thereby fostering competition and flexibility within the education system. School choice is not a single policy design, but includes several forms of school choice: established private and/or parochial (church) schools; new systems such as charter or magnet schools in the US; or tuition vouchers, which are common in the US, Chile, and Sweden. The common feature of these forms is that they affect the supply of schooling options outside local public schools. The greatest advantage is that school choice improves matching between students and schools and can thus positively affect student's educational outcomes (Hoxby, 2003; Hastings et al., 2016). Talented students can derive advantages from school choice policies by gaining access to specialized programs, resources, and educational environments that cater to their specific needs, and foster a more conducive setting for their academic and personal development.

However, the negative side of school choice is its potential impact on educational inequalities. Families that face resource, mobility, or information constraints can be at a disadvantage, as they struggle to access and benefit from the educational options available under a school choice system. Existing literature shows that students from families with low socio-economic backgrounds are less able to exercise their choices (Burgess et al, 2014; Calsamiglia and Guell, 2018). As discussed in section 3.3, providing students (or their parents) with information about their most convenient high school (Hastings and Weinstein, 2008) or university options (Hoxby and Turner, 2012) may help disadvantaged students to improve their academic achievement. Further, in some cases, admission processes at schools and colleges may be biased in favor of students from high-income families. Chetty at al. (2023) shows that many prestigious colleges admit children from high-income families at much higher rates than students from low-income families with comparable skills as measured by SAT/ACT scores. This discrepancy is mostly caused by non-academic admission criteria that are more favorable to students from high-income backgrounds, although the criteria are not predictive of future success. Standardized test scores, despite their drawbacks, are important in ensuring equal access to education.

There are several factors that affect effective matches between students and schools, and hence development of the potential of every student: admission criteria, student assignment policies (mechanism design), the role of information, and the role of family background and beliefs. We comment on some of these in the next section.

4.2.2 Ability tracking

Another factor that can play a role in nurturing talent is ability tracking. Similarly to school choice policies, it involves making decisions about how students are educated, but ability tracking addresses different aspects of the educational system. Formally, ability tracking is allocation of students into different classes or schools based on their prior performance, i.e. perceived academic abilities, often determined by standardized tests, grades, or teacher recommendations. In general, there are two types of tracking: within-school tracking and between-school tracking. The first is more common in the US and entails selection of students into different classes within their schools according to student abilities in a particular area or areas, e.g. advanced math classes for students who are more advanced in math, etc. Between-school tracking involves selection of students into different schools or different educational tracks (e.g. a vocational or academic high school track). So, whereas in within-school tracking, students change their classmates but remain in the same school environment, between-school tracking usually results in a transfer to another school, and therefore involves changing both classmates and schoolmates.

From a theoretical viewpoint, the effects of educational tracking are controversial. For both within and between school tracking, there is a trade-off between equity and efficiency. On the one hand, in more homogeneous classes, teachers can better target the curriculum and methods to the specific needs of the students, and it can be easier for all students to learn optimally in homogeneous classes with focused curricula. On the other hand, selecting students by ability to different groups may disadvantage lower performers by confining them to slower learning environments and depriving them of interactions with higher-achieving classmates. Thus, weaker students especially may be disadvantaged if they are separated from the stronger peers early on.

In existing literature, there are no clear findings about the effects of within-school ability tracking. Some studies point to negative effects of ability tracking especially for low-performing students (Fu and Mehta, 2018), and there are studies that find no effects of ability tracking (Figlio and Page, 2002; Betts and Shkolnik, 2000). In an experiment conducted in Kenya, Duflo, Dupas and Kremer (2011) show that all students, high- and low-performers, can gain from ability tracking in developing countries.

4.2.3 Peer effects

As the effects of ability tracking are primarily connected to the composition of classmates and schoolmates, this literature is very closely related to findings on peer effects in education. Peer composition is an important determinant of student outcomes and thus acts as one of the inputs to the education production function. Peer effects are defined as any externality in which peer backgrounds, current behavior, or outcomes affect an individual's outcomes. Having a particular peer as a classmate may have an impact on a student's outcomes through peer responses to teacher questions, disruptive behavior during classes, peer interest in an activity (sport, art, etc.) or high peer ability that may motivate a classmate to work harder. Peer effect literature thus examines the extent to which changes in peer (classmates, schoolmates, or dorm roommates) characteristics affect one´s academic outcomes, such as test scores or abilities, school or career choice, and behavior (e.g. drug use, smoking, or teen pregnancy).

Sacerdote (2011) offers a detailed review of the literature on peer effects. Literature finds very modest linear-in-means effects of peer backgrounds on student outcomes (Ammermueller and Pischke, 2009; Hoxby, 2000; Hanushek, Kain, Markman and Rivkin, 2003). The linear-in-means model assesses peer effects by predicting a student's individual results based on both her own background attributes and the average outcomes and background characteristics of her peers. However, a limitation of this model, as highlighted by Sacerdote (2011), is that the magnitude of peer effects remains constant regardless of a student's own abilities or background. In other words, the model assumes uniform peer effects on both high and low achievers.

Consideration of nonlinear peer effects, however, has not resulted in a clear consensus in literature. In contrast to linear-in-means effects, non-linear models account for a student's position in the ability (or background characteristic) distribution as well as for the type of peer group (e.g. from the top, middle, or bottom of the ability distribution). Using a non-linear model, we can thus examine separately the effect of a high, low, or middle ability peer group on a student who is excelling or underscoring in a particular ability. Examining several possibilities of nonlinear peer effects, Hoxby and Wienghart (2005) created a categorization of different possible peer models. Their findings show that peer effects of the least academically able or least disciplined student in the classroom are not the most relevant effects, in contrast with findings of other studies. The peer model deemed most pertinent in their research is the tracking model,

wherein students are grouped into homogeneous classes based on shared characteristics. Their findings indicate that high-achieving students derive the greatest advantages from the incorporation of like-achieving peers into the classroom.

Other research indicates that having high-ability peers benefits all students, regardless of their performance level, as demonstrated by studies including Hanushek, Kain, Markman, and Rivkin (2003). However, Burke and Sass (2013) present findings suggesting that, for low-achieving students, being in a class with peers of average ability is more advantageous than being with top-performing students. Conversely, Hoxby and Weinghart (2005) align with the perspective of Duflo, Dupas, and Kremer (2011), and assert that students derive greater benefits from classes with homogeneous ability levels.

However, in identifying peer effects, researchers face several identification issues. The first is simultaneity or the reflection problem, which arises when it is difficult to disentangle a cause-and-effect relationship between individuals. In the context of peer effects, this means that individuals both influence their peers and are influenced by them. This mutual influence can create a situation in which it is challenging to establish a clear direction of causality. Another problem arises when peers are self-selected into peer groups or classrooms in a manner that is unobservable by the researcher.[8] Addressing these issues in peer effects analyses requires econometric methods, such as instrumental variables or fixed effects models, to account for potential endogeneity.

Despite no clear linear-in-means effects and diverse findings using nonlinear peer effects in literature, it seems that high-ability students gain more from higher peer quality than low-ability peers. This result leans more towards the value of separating or tracking students, especially talented and/or high ability ones, into different classes according to ability.

4.2.4 Early ability tracking

While literature on ability-based tracking and closely related peer effects suggests a positive impact of grouping high-ability peers into homogeneous classes, ability tracking has been criticized for potentially reinforcing educational inequalities and limiting opportunities for students in lower-tracked groups. This is especially true for between-

[8] For a detailed overview of these three issues see, e.g., Manski (1999).

school ability tracking that begins when students are quite young, so-called early tracking. Countries differ widely in terms of the age at which they first track children into different types of schools. Most OECD countries allocate students into different school tracks after they complete lower secondary education at the earliest, i.e. at the age of 15 or 16. This is termed a comprehensive school system. However, in some central European countries (e.g. in Austria, Germany, the Czech Republic, and Slovakia), the first ability tracking occurs after primary education, at the age of 10 or 11. In the Czech Republic, high-ability students can move to an 8-year gymnasium after the 5th grade, i.e. at the age of 11.

As children at this age typically do not make the decision to transfer to a highly selective school independently, early tracking amplifies the influence of students' socio-economic backgrounds in shaping the decision-making process for school choice and preparing for the admission process (Matthewes, 2021; Hanushek and Woessmann, 2006; Brunello and Checchi, 2007). The earlier the tracking, the greater the impact of family background and the noisier the allocation of students into tracks. Thus, early tracking may lead to an inefficient allocation of talent, and it may also build barriers to further education and reinforce intergenerational persistence in educational attainment.

What matters significantly is the ability to transition between various educational tracks after the initial choice has been made, which can potentially alleviate or even obviate adverse consequences of early tracking (Dustmann, Puhani, and Schonberg, 2017).

Table 1: Empirical findings on the impact of tracking

	Between/ within	Country	Data	Method	Findings
Figlio and Page (2002)	Within school (school specific)	US	National Education Longitudinal Study (NELS)	The effect of tracking separately for students in the top, middle, and bottom thirds of an initial test score distribution, IV (state and county level variables that might affect a school's decision to track)	No evidence that low-ability students are harmed by tracking; it can even increase their test scores (change from 8th to 10th grade in math scores)
Duflo, Dupas and Kremer (2011)	Within school (after the 1st grade)	Kenya	Experiment	RCT	Students of all abilities gain from tracking

	Between/ within	Country	Data	Method	Findings
Betts and Shkolnik (2000)	Within school (school specific)	US	Longitudinal Study of American Youth (LSAY)	Heterogeneous effect (students in the top, middle, and bottom thirds of an initial test score distribution in tracking and non-tracking schools)	No effect of tracking on low-performers, negative effect on middle-performers, and positive on high-performers (change from grade 7 to 12)
Fu and Mehta (2018)	Within school (school specific)	US	Early Childhood Longitudinal Study, Kindergarten Class of 1998–9	Structural model	Negative effect on low-performers and positive on high performers (in the 5th grade)
Matthewes (2021)	Early tracking (after the 4th grade, at age 10)	Germany	German National Educational Panel Study (NEPS), IQB National Assessment Study	Triple differences framework (between state variation in tracking)	Early tracking decreases student achievement (0.17 SD in mathematics and 0.24 SD in reading) Effects are driven by low achievers
Hanushek and Woessmann (2006)	Early tracking (country specific: before age 14 or 15)	18 to 26 countries	PISA, PIRLS, TIMSS	DD approach to the cross-country comparison	-Early tracking increases inequality in achievement -lower performers suffer more -no evidence of efficiency gains of tracking
Brunello and Checchi (2007)	Early tracking (different measures of school tracking)	16 to 25 countries	European Community Household Panel (ECHP), International Social Survey Programme (ISSP), International Adult Literacy Survey (IALS), PISA	Exploits the variation across countries and over time in school tracking (family background interacted with confounding factors)	Early tracking increases the influence of family background on educational outcomes of children (educational attainment, earnings, employment)
Dustmann, Puhani and Schonberg (2017)	Early tracking (after the 4th grade, at age 10)	Germany	Social Security Records, Microcensus, School census, 1987 Census	Natural experiment (individuals at the margin between two tracks randomly assigned to different tracks using quasi-random shifts between tracks induced by date of birth)	Attending a more advanced track has no impact on wages, employment, or occupation choice for marginal students (no effect is due to up and downgrading of students across tracks in later stage, i.e. at the ages of 15 and 18)

4.2.5 Summary

In this section we focus on inputs into the education production function that may help to create an environment that fosters student talent. Existing literature shows that smaller and homogeneous classes help teachers to focus on the specific needs of the class. From

the student perspective, high-ability students gain more from sharing classes with high-ability peers than do low-performers. These are important findings, as they point to specific factors in a school system, i.e., ability tracking or other separation of students by ability, that may help to realize student talent. However, we should be aware of the challenges in identification of high-ability students and of the timing when tracking begins. The earlier the tracking, the greater the possibility of misallocation of students into or out of high-ability tracks. Early tracking may pose a particular disadvantage for potentially highly capable students from low socio-economic backgrounds, as the role of parents in the transitional phase can be critical.

Similar caveats also hold for different school choice policies. Although school choice should result in better matches between students and schools, usually independent of the place where students live, and increase the efficiency of instruction through competition, with inadequate information or resources school choice can be harmful, especially for students from lower socio-economic backgrounds. We discuss potential obstacles that can affect the development of children's skills and talent in the following section.

4.2.6 Acceleration and enrichment

Before we focus on obstacles to talent development, we briefly comment on two types of interventions, acceleration and enrichment, that may help to foster talent, but which are not commonly discussed in economic literature. These types of interventions are more context specific and are often implemented differently at different schools, making comprehensive evaluations only rarely feasible. Empirical evidence from psychological literature suggests that acceleration and enrichment may be relatively inexpensive and efficient interventions.

- **Curriculum enrichment**: students are exposed to more advanced material (in the form of projects, additional assignments, or competitions), but remain with other peers in their class.
- **Acceleration**: students work with educational materials geared to their ability and preparedness; in the most extreme cases, they might skip a grade.

Swiatek (1993) summarizes the evidence on the effectiveness of acceleration in the longitudinal project Study on Mathematically Precocious Youth, and concludes that acceleration is relatively easy to implement, does not lead to academic or psychosocial

harm to participants, and can help gifted students. Olenchak and Renzulli (1989) evaluated a Schoolwide Enrichment model that was applied to eleven schools. The students were positively affected by the program and their attitudes toward school and the learning process improved. Because these interventions can be implemented within a school and avoid tracking students into different educational paths, they are relatively easy to implement and are less likely to arouse societal or political opposition due to alleged elitism.

Sternberg and Kaufman (2018), who provide additional supportive evidence, however, note that the implementation details are often crucial, and not all successful pilot studies can be scaled up to the level of a whole educational system.

5 What obstacles prevent talent development?

Even in a school system with different programs for talented children or with an environment that enables development of talent, obstacles to nurturing talent can remain. One of the largest barriers to realizing student potential is an inability to recognize talent, and a consequent inability to create sufficient conditions for its development. Some groups of students may face these barriers at a higher rate than others because of their gender, race, family background, or other factors. This discrimination in education, i.e., the failure to recognize and develop the potential of each student, regardless of his or her characteristics, is generally referred to as *educational inequality* or *inequality in educational opportunities* in economics literature. It is defined as disparity in access to quality education and resources due to socioeconomic background, race, sex, geographic location, etc. In other words, in a country with high inequality, students with the same academic potential but different background characteristics may reach different outcomes despite their best efforts. In the previous section, we mention school policies and educational practices that may increase educational inequalities, such as school choice or early tracking policies.

Disparities in education can contribute to unequal outcomes among various societal groups, not only in terms of earnings and the probability of employment, but also in terms of better health outcomes, reduced criminal behavior, and more. This is an issue for all students, particularly those who are talented. As we discuss in section 4.1, although the chances of becoming an inventor seem to depend mainly on innate abilities, environmental factors, including access to education, gender, socio-economic status

of parents, and race have all been found to play a significant role in shaping and fostering talent (Bell et al, 2019). We next focus on different types of educational inequality, i.e. inequality due to family background and gender. At the end of this section, we also comment on possible psychological challenges faced by talented students.

5.1 Educational inequality by family socio-economic background

If only the children of wealthy parents have the best educational opportunities and thus better chances to develop their potential and talent, both educational and income inequalities across different societal groups, and across generations (so-called inter-generational transmission) are perpetuated. It is therefore crucial to understand and examine the possible sources of educational inequality in a country.

This concern is particularly salient in the Czech Republic, where educational outcomes are intricately linked to the socio-economic context of a family. The Czech Republic falls into the group of countries with the highest achievement gaps between students from families with low and high socio-economic backgrounds (OECD 2016). This characteristic is demonstrated by Czech schools having one of the most pronounced differentials in test scores in international rankings among schools (Finland exhibits the least disparity; see OECD, PISA 2018). The family a child is born into, and subsequently the school he or she enters (based largely on parental choice), has a significant impact on his or her future outcomes. In a country with high educational inequality, talented children from families with low socio-economic backgrounds have significantly less opportunity to exploit their talents than do talented children from better-off families, or students in a country with less educational inequality.

In an extensive chapter, Blanden, Doepke and Stuhler (2023) discuss several sources of educational inequality based on previous literature and their model of human capital accumulation:

- **Inequality in parental skills** that influences the initial skills of the child (in the literature usually denominated as “nature”).
- **Assortative mating** that may lead to higher correlations between mother’s and father’s skills and consequently to greater inequality in education.

- **Inequality in parental investments or inputs**, e.g., in the form of less-than-optimal educational or school choices made by parents arising from inequality in parental income, differences in parental ability to make an effective choice, or differences in parental preferences and aspirations for their children.
- **Inequality in educational institutions** due to the organization of the school system and its financing, or other features such as teacher quality, school autonomy, and accountability.
- **Inequality in environmental factors** driven by different neighborhoods or classmates, etc.

These inputs into educational inequality defined by Blanden, Doepke and Stuhler (2023) may be divided into those affected directly or indirectly by family background characteristics and by the educational environment, including the impacts of school organizations and systems. Though the first group of inequality sources is difficult to influence at the state level, there are several interventions and policies that may help to alleviate the impact of family background on a child's chances to develop his or her potential and talent. The following focuses on two features documented in literature and considered important to remove or at least mitigate obstacles to nurturing talent: early childhood investments and information frictions.

5.1.1 Early childhood investments

Social and family background factors impact childhood development well before children begin school. A substantial body of literature elucidates the profound impact of early-life influences on the future outcomes of children (see e.g. Heckman and Mosso, 2014). These effects are based on two theoretical findings. First, children possess malleable brains that enable formation and restructuring of neural networks more easily than those of older individuals (Carneiro and Heckman, 2003). Simultaneously, children's neurons exhibit heightened flexibility, and a paucity of older, established neural networks minimizes disruptions during learning processes. Second, learning exhibits a cumulative nature, whereby the capacity to acquire novel knowledge today is contingent upon assimilation of prior learning. According to this theory, differences in outcomes that children achieve very early in life become more pronounced later on, and gaps become more difficult to address. In his comprehensive investigation, Feinstein (2003) demonstrates that cognitive assessments of children as early as at 22 months can serve as predictive

indicators of educational achievements by the age of 26.[9] Nevertheless, this outcome is markedly contingent upon the socio-economic background of the family. Notably, by the age of 26, children who score in the top quartile at 22 months from families with lower socio-economic standing tend to lag behind their peers who fall into a lower quartile at 22 months, but who are from a higher socio-economic background. These findings suggest that interventions in early childhood may be the most efficient and potentially have much greater positive impacts than interventions later in life.

In the US, several large early childhood programs targeting infants from low-income families have been conducted. From 1962 to 1965, the Perry Preschool program in Ypsilanti offered a half-day preschool program five days per week, together with home visits to 3- to 4-year-old low-performing children. The goal was to improve the educational outcomes of these children and to mitigate the existing gap with their peers. This program produced a lasting positive effect on high-school graduation rates, earnings, and employment, and lessened negative social outcomes like arrests and teen pregnancies. The Carolina Abecedarian Program was a more intense program targeting infants born to low-income families between 1972 and 1977. The children were followed until the age of 21 and achieved better educational results than their peers.

In addition to these early childhood programs, the Head Start intervention is a notable US initiative aimed to address educational disparities among children 3 to 5 years old from low-income families. Established in 1965, the program provides comprehensive early childhood education, health, nutrition, and parental involvement services to preschool-aged children. Research, including a study by Bailey, Sun, and Timpe (2021), has examined the long-run impacts of Head Start, and finds positive effects on human capital development, e.g., on school attainment, high-school completion, college enrollment and completion, etc. These interventions collectively underscore the potential of early childhood programs to mitigate educational inequalities and to promote positive long-term outcomes for disadvantaged children.

Existing literature regarding early childhood investments to mitigate achievement gaps between children from low and high-income families also focuses on the effects of early

[9] The size of the effect is small, however. Nevertheless, the stability of general intelligence, starting in infancy (between the ages of 1 and 2 years) has also been confirmed in the psychological literature (Yu et al., 2018; Schneider, Niklas and Schmiedeler, 2014).

childcare. Early childcare has been proven to be advantageous, particularly for children from disadvantaged environments (Felfe and Lalive, 2018; Havnes and Mogstad, 2015). However, in their study of a reform leading to expansion of childcare in Germany, Cornelissen et al (2018) indicate that children from disadvantaged families are less likely to attend childcare than other children, despite the potential for more substantial benefits accruing to them.

5.1.2 The role of information

Parents affect a child's skills through direct transmission of their own skills, but also indirectly through educational choices based on their own aspirations and beliefs about returns to education, available educational opportunities, and more. Existing literature shows that students from low socio-economic backgrounds are less able to exercise choices (Burgess et al, 2014; Calsamiglia and Guell, 2018). Families with lower socioeconomic status sometimes encounter elevated expenses in collecting and interpreting academic achievement statistics, and hence they may opt for schools based solely on proximity, rather than basing their choice on characteristics that are more difficult to assess (Hastings and Weinstein, 2008).

One policy that can help parents choose an appropriate school for their child is to provide sufficiently clear information about their child's options. Hastings and Weinstein (2008) provided parents in the Charlotte Mecklenburg Public School District in the US accessible information about the overall academic performance of each available school, with the estimated probability of admission. Supplying this information to parents led to a notable increase in the number of families opting to apply for schools that produce higher test scores.

The importance of information is well-documented in the choice of college or major, showing that information can produce better matches between students' abilities and school requirements. High achievers from low-income families or families with non-academic backgrounds seem to benefit the most from information, which has been shown to spur higher enrollment rates into colleges (Peter and Zambre, 2017). Information also helps students to apply to more selective colleges (Hoxby and Turner, 2012; Hoxby and Avery, 2013). The more personalized the information, the greater the effect on enrollment. Herber (2018) finds that the presence of a role model increases applications for highly selective scholarships for students from non-academic families.

Recognizing the role of information in educational inequalities, policymakers can focus on initiatives that improve access to information for disadvantaged students. This could include improving career counselling services, expanding outreach programs, and using technology to disseminate information on educational and career opportunities. Existing literature suggests that more personalized information supports better matches between student ability and school quality overall.

Table 2: The role of information in school or major choice

	School level	Country	Data	Method	Findings
Pistolesi (2017)	University	France (Active orientation policy)	Administrative dataset of university applicants to a single institution	RDD	Information about matching student skills and major choice: Receiving a positive signal has little impact on the probability of registration, while receiving a negative signal decreases the proportion of enrolling students by 14 pp.
Bandiera, Larcinese and Rasul (2015)	University	UK	Administrative records (leading UK university)	DID, student FE	Feedback on exam performance improves students' future performance by 13% of a standard deviation. The effect is stronger in higher quartiles.
Mulhern (2021)	University	US	High school graduates in a Mid-Atlantic school district	RDD, FE	Information increases applications and attendance at that college. Negative signal deters students from attending highly selective colleges
Hoxby and Turner (2012)	High-achieving, low-income high school students	US	Experiment, data from the College Board and ACT, NCS	RCT	High-achieving, low-income students benefit from information on application process and colleges net costs by enrolling into selective colleges more often.
Hastings and Weinstein (2008)	From elementary to high school	US	Administrative data	Field experiment, RCT	Providing parents with information about school quality leads them to enroll a child in higher-performing school.
Peter and Zambre (2017)	Application to colleges	Germany	Data from RCT conducted in Berlin	RCT	information increases intended college enrollment for students from non-academic family backgrounds, with no effects on other students
Hoxby and Avery (2013)	Application to colleges	US	Individual data (college assessments – SAT and ACT)	Descriptive	Undermatching for high-achieving, low-income students, especially in small districts with no selective public high school. Personalized information could help.
Herber (2018)	Application for scholarship	Germany	Survey	Field experiment	Personalized information (based on role models) increases the application rate for selective scholarships for students from non-academic backgrounds.

5.2 Educational inequality by gender

As mentioned in section 4.1, analyzing a cohort of 1.2 million inventors in the US, Bell et al. (2019) propose the existence of numerous "Lost Einsteins" – exceptionally capable individuals with the potential to become inventors, who did not succeed due to environmental factors, commonly referred to as "nurture", including exposure to innovation by others during the childhood. One of the groups that is well represented among these "Lost Einsteins" are women.

Women are underrepresented among inventors and generally in science, technology, engineering, and mathematics (STEM fields). These sectors are key to technological progress and the development of new knowledge in science. In STEM fields, new technologies are created and implemented, novel research methodologies are discovered, and inventive problem-solving approaches are developed. Underrepresentation of women in STEM fields and professions can result in tangible consequences for both women and for society at large. It contributes to perpetuation of the gender pay gap (see, e.g., Beede et al., 2011), limits the diversity of perspectives in scientific and technological innovations (see, e.g., Clayton and Collins, 2014), and results in underutilization of potentially valuable talent.

Why are women underrepresented among inventors and in the STEM fields? The rationales for this phenomenon can be delineated into two categories. Firstly, disparities may stem from biological dissimilarities, encompassing variations in cognitive abilities, often denoted "nature" in the literature. This suggests that men exhibit greater proficiency in STEM fields or possess a greater aptitude for innovation. However, some facts from recent decades indicate that factors beyond biology can contribute to the scarcity of women in these domains. First, there has been an observable mitigation of gender disparities in mathematical skills, with certain countries eradicating or reversing these distinctions in favor of girls (OECD, 2020). Simultaneously, we observe a discernible rise in women's participation in higher education, with numbers of female university graduates surpassing their male counterparts in numerous countries. This increase in female university enrollment tends to be in fields that are either female-dominated or that exhibit a gender balance. The numbers of women in STEM fields, both as students and as professionals, remains notably low.

A second potential rationale for the gender disparity in STEM fields pertains to environmental factors that may influence individuals' choices, preferences, and interests. Kahn and Ginter (2017) provide a comprehensive literature review that elucidates the impact of these factors, encompassing differences in preferences, stereotypes, role models, cultural roles, and differences in risk aversion and competitiveness.

Women tend to choose fields that emphasize interpersonal relationships rather than those centered on objects, in contrast to men (Eccles and Wang, 2016). These divergent preferences could contribute to underrepresentation of women in STEM fields. Simultaneously, women can encounter numerous stereotypes within familial or educational contexts, sometimes propagated by teachers and peers. These stereotypes may influence women's self-perceptions, and potentially dissuade them from pursuing STEM careers even when they possess an affinity for the field. Additionally, women may be particularly sensitive to the presence of role models and the presence (or lack thereof) of women within traditionally male-dominated environments. Bell et al. (2019) demonstrate that girls raised in neighborhoods with a higher prevalence of women inventors are more likely to engage in inventive activities. Similarly, the proportion of women among STEM undergraduates positively correlates with the persistence of female students in STEM fields (Griffith, 2010). Positive role models in the form of female faculty members have also been identified as influential for female students in STEM fields (Bettinger and Long, 2005).

Societal perceptions of women can also influence gender disparities in educational outcomes. Countries characterized by high gender equity tend to have smaller gender gaps in math test scores, and in certain instances, a reversal of the gender gap occurs (Guiso et al., 2008). Examining the results of international testing (TIMSS for 8th graders in 34 countries), Nosek et al. (2009) similarly show that socio-cultural factors are behind sex differences in math and science tests. Pope and Syndor (2010) further indicate that the gender gap in mathematics is intricately tied to environmental factors rather than intrinsic predispositions. Through an examination of geographical variations in math and reading score gender gaps across the US, they suggest that these disparities emanate from perpetuation of stereotypes than from differences in innate abilities.

Furthermore, existing literature points to comparatively higher risk aversion among women, particularly when engaging in competition with male counterparts. In a laboratory experiment, Gneezy, Niederle, and Rustichini (2003) demonstrate that

intensifying a competitive environment significantly amplifies performance among men, but exerts no discernible impact on women. Consequently, women tend to underperform in competitive settings, a phenomenon apparent in college entrance exams. Jurajda and Munich (2011) provide evidence that women, despite possessing comparable abilities to men, exhibit significantly poorer performance in admission exams for highly competitive programs in the Czech Republic. This pattern extends to other high-stakes or high-risk examinations, as indicated by Niederle and Vesterlund (2010). Such outcomes may also be attributed to lower self-confidence among women, as girls frequently tend to underestimate their abilities (Weinhardt, 2017). Even highly math-able women demonstrate lower math self-efficacy than their male counterparts. Given that mathematical ability and self-efficacy significantly influence the likelihood of STEM enrollment, a lack of math self-efficacy contributes to the drop-out rates of women from STEM majors (Saltiel, 2022).

An additional environmental factor that contributes to less participation of women in STEM fields is the work environment, including variables such as working hours, job flexibility, and the prevalence of male-dominated occupations. If women have stronger pro-family preferences and engage more in family and household duties, they may prefer to choose fields that lead to jobs that enable better work-life balance. Male-dominated STEM occupations are typically not especially family-friendly.

Clearly, environmental factors can discourage high-ability women from seeking opportunities in STEM fields, impede their persistence in such fields, and influence their decisions regarding highly competitive or male-dominated occupations. Speer (2023) investigated the pivotal phases, from high school to the job market, that contribute to less female representation in STEM fields. The most important stages were found to be the transition from high school to STEM fields (i.e., the selection of a major) and the transition from college to initial employment. Even when they are equally prepared for engagement in STEM fields, women exhibit a markedly diminished inclination to pursue careers in these domains compared to their male counterparts.

Numerous empirical studies examine the choice of majors, persistence of study in STEM disciplines during college, drop-out rates, and graduation rates among women, relative to their male counterparts with comparable aptitude. The literature points to several barriers specific to women, predominantly contingent upon environmental factors rather than innate abilities, that can impede realization of their potential and discourage them

from careers in STEM disciplines or as innovators. However, it is important to acknowledge that the influence of stereotypes is not unidirectional. In similar discussions, we often overlook the opposite effect: boys who may excel in social sciences or humanities might opt for STEM fields instead due to societal expectations or perceived career prospects. This dual impact of stereotypes highlights the complexity of the issue, and underscores the need for comprehensive efforts to address and dismantle such barriers. Because the impacts are not only at the individual level, it is in the interest of society to remove these barriers in the interests of optimizing talent allocation.

5.3 Financial constraints

Financial constraints can also play a significant role in hindering development of talent. For many talented individuals, access to quality education and to extracurricular enrichment activities are crucial for nurturing their abilities and achieving their full potential. However, the cost of education, including tuition fees, textbooks, and other academic expenses, can be prohibitively high for students from low-income backgrounds. Without adequate financial support, talented students can find themselves unable to afford enrollment in prestigious institutions or specialized programs that offer advanced training in their field of interest. Research by Agarwal et al. (2023) underscores that talented individuals, particularly top performers in Olympiad competitions, often aspire to pursue higher education in prestigious institutions abroad, such as those in the US or UK, but can face significant financial barriers that prevent them from doing so.

5.4 Psychological challenges faced by talented students

In addition to various types of obstacles induced by educational inequalities, talented children may encounter other challenges: they may have individual needs that are not fulfilled in school, they are sometimes forced to conform to the average, they can struggle to deal with a too-rigid educational system, or they can experience a higher prevalence of issues in interpersonal relations and mental health, etc. While there is a lack of economic literature dedicated to these challenges, several studies in the psychological realm have delved into the emotional and psychological well-being of gifted students.

Examining the crucial developmental phase of adolescence, a pivotal period for realizing one's potential, Vialle, Heaven, and Ciarocchi (2007) conducted a study on the psychological well-being of gifted students and their non-gifted counterparts in Australia. Identifying gifted students as those scoring in the top 10% in both literacy and numeracy

standardized tests administered in the first year of high school, the study yielded intriguing insights. Despite teachers reporting that gifted students are generally less prone to behavioral and emotional problems, the study found that, on average, gifted students were more likely than their non-gifted peers to express feelings of sadness, loneliness, or dissatisfaction with social support. These findings suggest that, though they are usually perceived as individuals who do not cause problems, some gifted pupils may indeed be at risk in a psychological sense.

While existing literature shows no distinct differences in socio-emotional and personality characteristics between gifted and non-gifted students (Zeidner and Shani-Zinovich, 2011), a study focusing on gifted students in STEM fields suggests that, despite having no average differences in individual traits (aside from performance), gifted students may exhibit specific combinations of personality and behavioral traits (Likhanov et al., 2021).

The prevalence of mental disorders among gifted children compared to their non-gifted counterparts remains unclear due to a lack of consensus on the definition of giftedness and the absence of an appropriate comparison group (Martin, Burns, and Schonlau, 2010). Nevertheless, perception and processing of experiences by gifted children may differ from that of non-gifted peers. Even though gifted children may exhibit mental health issues at similar rates to their peers, there can be unique circumstances in their lives that increase their vulnerability (Cross and Cross, 2015).

In addressing psychological challenges faced by gifted students, interventions such as cognitive-behavioral therapy and socialization with like-minded peers through competitions or enrichment activities can be invaluable. While the literature may not explicitly outline these interventions, it has presented promising avenues for supporting the emotional well-being of gifted individuals. Cognitive-behavioral therapy can help gifted students develop coping strategies to manage stress, tendencies towards perfectionism, and existential concerns often associated with their high abilities. Additionally, fostering socialization among gifted peers through competitions, clubs, or specialized programs can provide a sense of belonging and understanding that may be lacking in traditional educational settings. By creating environments in which gifted students can interact with others who share their interests and challenges, these interventions have the potential to mitigate feelings of isolation and promote positive mental health outcomes. Thus, while further research may be needed to fully explore the effectiveness of these interventions, they offer promising approaches for supporting the psychological well-being of gifted students.

6 Conclusion and recommendations

Gifted and talented students have long been recognized by researchers and educators as a valuable asset that should be identified and developed. The psychological community has been interested in understanding giftedness since the early days of scientific inquiry in the beginning of the 20th century, and the topic of gifted education gained widespread recognition among educators following the release of the first US national report on the subject, the Marland Report (Marland, 1971a, 1971b). Over more recent decades, there has been a significant deepening in the understanding of giftedness and talent, the societal implications of talent development, and the processes and challenges involved in fostering these attributes. This has been particularly evident in international literature and among academic scholars. Any national approach to education for the gifted should consider this international experience and empirical evidence, and build upon it for further development. Nevertheless, several important questions remain insufficiently answered by the literature, and gaps in our understanding of where talent comes from, how it grows, and how we can better enhance this growth through educational programs persist.

6.1 Persistent gaps in research on gifted and talented children

- All available evidence suggests that talented individuals make large contributions to society. However, research samples are always selected by their educational achievements, not by psychological instruments for identification of the gifted. Typically, older students are recruited using large-scale educational assessments, though many truly gifted individuals are unable to fully develop their gifts from early childhood. Although some studies suggest that most gifted children become high-achieving students later, the long-term life outcomes for gifted individuals are not fully known (compare Bell et al., 2019, Agarwal and Gaule, 2020, Kell, Lubinski and Benbow, 2013).
- Psychological literature highlights the importance of non-cognitive factors such as motivation and creativity (Kaufman and Sternberg, 2018). However, these factors are missing in studies focusing on the impact of gifted individuals, so it is not clear to what extent the outcomes of talented individuals are facilitated by these factors.
- Educational programs for gifted children vary widely, not only between countries but also within them, making it difficult to generalize the effectiveness of different interventions. Very little is known about possible interventions focused on obstacles to nurturing talent, such as early childhood interventions targeted for gifted students; clubs, competitions, and enrichment activities for gifted girls; financial support, etc.

- Economic research on the psychological challenges faced by talented children is also scarce. Although there is some evidence that many talented students are well integrated and psychologically stable (Ziegler et al., 2013), this is not the case for all, and suitable interventions might help to ensure that all gifted students are able to fully develop their potential and contribute to society. Little is known about such interventions and their effectiveness.

6.2 System-level and governance recommendations

- The definition of giftedness should draw on psychological literature and should be based on an explicit, well-tested, and validated scientific theory. The definition should also respect the specific national context and cultural traditions.
- Schools need better support to identify gifted students. Any differences in the prevalence of gifted students are likely driven primarily by inefficiencies and the lack of a systematic approach to identification. Identification needs to happen as early as possible, should be applied universally to all students, and should be based on potential rather than already-manifested academic achievement.
- Teachers are not sufficiently prepared to support gifted education (both identification of talent and optimal strategies to educate gifted students). The topic needs to be better included in formal teacher education and as a topic for ongoing professional development. The differences in terms of the impact of good and bad teachers can be immense.
- Overall system quality is crucial. Inefficiencies in the educational system will undermine any activities that strive to improve a particular area of education, including gifted education. Quality must be optimized at all levels of education. Careful design and implementation details are pivotal: existing research confirms that the ways resources are spent is more important than how many resources are available.
- Demands for accountability and results-based incentives in education systems are increasing, and some countries have already developed administrative accountability systems designed to navigate the system toward better results and higher student achievement.
- Administrative accountability systems can also provide crucial data for decision makers and researchers, and can help identify and share best practices in gifted education and other educational areas. However, such systems must be carefully designed not to impose an excessive administrative burden on schools, which is already very high in the Czech Republic. Absence of high-quality, longitudinal, administrative data forms a large barrier to understanding the situation of gifted children and educational processes in general.

6.3 Recommendations on school interventions

- Acceleration and curriculum enrichment are easy-to-implement, uncontroversial interventions that help develop talent among gifted students.
- Empirical evidence on ability tracking is inconclusive. Because gifted students seem to gain more from studying with high-achieving peers, some form of tracking is likely beneficial for them. Tracking can be implemented as partial or full within-school tracking (ability grouping) or as a separate school track.
- A more careful approach is necessary with early ability tracking. Empirical research confirms that it increases inequality in education and can lead to inefficient talent allocation, because early-age decisions are typically driven more by parents' aspirations and decisions than by children's abilities. Potential negative effects may be alleviated by allowing transitions between tracks.
- Most common current practices, such as competitions in which gifted students can manifest their talents, cannot be considered an adequate replacement for systematic gifted education. Not all gifted students are able to manifest their talents on an occasional basis, or under stress.
- Better provision of reliable information on student performance, school quality, and potential benefits of education can be a cheap and very efficient intervention. Information supports better education and reduces inequalities in access to education. Data should be collected at the administrative level and evaluated as part of an accountability system.
- Gifted education should not be fully left to a single specialized teacher. Most teachers should participate, and school leadership should provide supervision and systematically work towards quality improvement in all areas of teaching.
- Evaluation should be considered an important part of every intervention, including those in gifted education, as it allows for assessment of efficiency and impact and for continuous improvement. Best practices must be shared. The existing empirical evidence on different forms of interventions is still scarce and not fully conclusive.

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