

THE EVOLUTION OF INTELLIGENCE MODELS: FROM PSYCHOMETRIC THEORIES TO SYSTEMIC-FUNCTIONAL APPROACHES AND THEIR IMPLICATIONS FOR SPECIAL PEDAGOGY

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Abstract

This paper presents a comprehensive theoretical analysis of the evolution of scientific models of intelligence, tracing the paradigmatic shift from classical psychometric theories to modern systemic-functional concepts. It examines the foundational models of Spearman (g-factor), Cattell (Gf-Gc theory), and Guilford (SOI model), contrasting them with the contemporary approaches of Sternberg (Triarchic Theory) and Gardner (Theory of Multiple Intelligences). The central argument is that this evolution from a static, deficit-focused view to a dynamic, resource-oriented perspective has profound implications for special pedagogy. The paper highlights how modern models provide a framework for qualitative assessment and individualized intervention, shifting the focus from measuring deficits to identifying and leveraging the unique cognitive strengths of children with special educational needs. The analysis underscores the necessity of developing new diagnostic tools that align with these contemporary, multidimensional views of intelligence to improve psycho-pedagogical support.

Keywords: Intelligence models, special pedagogy, psychometric theory, g-factor, fluid and crystallized intelligence, triarchic theory of intelligence, multiple intelligences, cognitive assessment, special educational needs (SEN).

Introduction

The problem of defining, structuring, and diagnosing intelligence holds a central position within the system of psychological and pedagogical sciences. Its relevance is dictated not only by a fundamental scientific interest in the nature of cognitive processes but also by its high applied value for educational practice. This issue becomes particularly acute in the field of special pedagogy, where an adequate assessment of the structure of intellectual activity serves as the starting point for diagnosis, determination of educational potential, and the development of effective programs for correctional-developmental intervention for individuals with special educational needs (SEN).

The scientific discourse on the problem of intelligence spans more than a century and is characterized by a multiplicity of competing, and at times mutually exclusive, theoretical approaches. From the works of F. Galton and A. Binet, who laid the foundations of the



psychometric tradition, to modern systemic-functional concepts, science has progressed from understanding intelligence as a single innate ability to viewing it as a complex, multicomponent, and developing system. Significant contributions to the elaboration of this problem were made by both foreign researchers (C. Spearman, L. Thurstone, J.P. Guilford, R. Cattell, H. Gardner, R. Sternberg) and domestic scientists (L.S. Vygotsky, S.L. Rubinstein, A.N. Leontiev, A.R. Luria, B.G. Ananiev), whose works established the foundations of the cultural-historical and activity-based approaches to understanding higher mental functions. Despite the abundance of research, a universally accepted theory of intelligence has not yet been created, which maintains the relevance of further systematization and analytical work.

The existence of numerous theoretical models generates a practical problem in selecting a methodological foundation for diagnostic and correctional work in special pedagogy. The choice of a particular concept determines the very "lens" through which a child is viewed: a specialist may focus either on measuring the general level of intelligence and stating its deficit, or on a qualitative analysis of the unique structure of their abilities, identifying intact and impaired links. Thus, the research problem lies in the need for a critical examination and comparison of leading models of intelligence to determine their diagnostic and prognostic potential. The aim of this article is to conduct a comprehensive theoretical analysis and comparative characterization of key psychometric and modern systemic-functional models of intelligence, identifying their applied significance for the diagnosis and psycho-pedagogical support of children with SEN.

Analysis of Psychometric Models of Intelligence

The founder of the psychometric investigation of intelligence is rightfully considered to be the British psychologist Charles Spearman. In 1904, he published a work in which, based on an analysis of correlations between sensory discrimination test results and academic achievement, he proposed a hypothesis that was revolutionary for its time. Spearman discovered that all cognitive tests, regardless of their content, demonstrate a positive intercorrelation. To explain this phenomenon, he postulated the existence of two types of factors that determine success in intellectual activity. The General factor (g-factor) represents a general "mental energy" or a universal psychic ability that is engaged to varying degrees in solving any intellectual task. Spearman viewed the g-factor as a kind of "power" of the mind, underlying the ability to reduce relations and correlates. The developmental level of this factor is a key predictor of an individual's overall intellectual success. In contrast, Specific factors (s-factors) are narrowly specialized abilities necessary for performing specific tasks (e.g., verbal, mathematical, spatial, etc.). Each test, in addition to general mental energy (g), requires the engagement of its own unique set of s-factors. Thus, in Spearman's model, performance on any test is determined by a combination of the g-factor, common to all tasks, and the s-factor, specific to that task. It was this theory that laid the methodological foundation for all subsequent factor analysis in psychology and introduced the concept of general intelligence into scientific discourse, which remains a subject of active discussion to this day.

Developing and extending the ideas of Spearman, Raymond Cattell proposed a hierarchical model in which the general g-factor was divided into two more specific second-order factors.



This model was an attempt to reconcile the concept of a unitary intelligence with the observed diversity of cognitive abilities. Fluid intelligence (Gf, from Eng. fluid) is defined as the ability to think and reason, to perceive relationships between elements, and to solve novel, non-typical problems that do not require reliance on past experience. It is believed that fluid intelligence is largely determined by biological and neurophysiological factors and is relatively free from the influence of culture and education. Its age-related dynamics are characterized by reaching a peak in young adulthood (approximately 18-25 years) with a subsequent gradual decline. Crystallized intelligence (Gc, from Eng. crystallized) represents the aggregate of accumulated knowledge, skills, and abilities acquired through the process of learning and life experience. This is the aspect of intelligence manifested in solving problems that require erudition, vocabulary, and mastery of culturally specific knowledge. Crystallized intelligence is formed through the "investment" of fluid intelligence into the learning process and, unlike Gf, can remain at a stable level or even grow throughout adulthood. Cattell's model possesses high explanatory power, as it allows for a description of the complex dynamics of intellectual development in ontogenesis and explains why, with age, some cognitive abilities decline while others continue to develop.

A radically different, non-hierarchical approach was offered by Joy Paul Guilford with his Structure of Intellect (SOI) model. His model represents an attempt to create an exhaustive morphological classification of all possible intellectual abilities, completely denying the existence of a general g-factor. Guilford presented intelligence as a three-dimensional cube, with each dimension corresponding to one aspect of an intellectual act: Operations (5 categories): The type of mental process applied to information (Cognition, Memory, Divergent production, Convergent production, Evaluation). Contents (4 categories): The type of information or stimulus material with which operations are performed (Figural, Symbolic, Semantic, Behavioral). Products (6 categories): The form in which information is processed and stored (Units, Classes, Relations, Systems, Transformations, Implications). The intersection of these three dimensions (5x4x6) theoretically generates 120 unique and independent intellectual abilities. Guilford's model has undeniable heuristic value, as it drew the attention of researchers to previously ignored aspects of intelligence, particularly divergent production (creativity) and social intelligence (operations with behavioral content). However, this model was subjected to serious criticism. Firstly, its extraordinary complexity and cumbersomeness make it practically inapplicable for holistic diagnosis. Secondly, empirical studies failed to confirm the independence of all 120 postulated factors; many were found to be highly correlated, which indirectly indicates the existence of higher-order factors that Guilford denied. Despite this, his work became an important step toward understanding the multidimensionality and complexity of human intelligence.

Analysis of Modern Systemic-Functional Models

In contrast to classical factor models, which, in Robert Sternberg's view, focused excessively on static structures and academic abilities, he proposed a Triarchic Theory. This approach views intelligence not as a property, but as a complex system of processes aimed at purposeful adaptation to, selection of, and shaping of the real-world environment. Sternberg's model



includes three interrelated yet functionally distinct sub-theories, describing three aspects of "successful intelligence." The Componential (Analytical) Intelligence sub-theory describes the internal mental mechanisms underlying intellectual behavior. Sternberg identifies three types of information-processing components: Metacomponents (higher-order processes for planning and monitoring), Performance components (processes that execute instructions), and Knowledge-acquisition components (processes for learning new information). This type of intelligence is most closely aligned with what is measured by traditional IQ tests. The Experiential (Creative) Intelligence sub-theory relates to an individual's ability to function effectively along a continuum from entirely novel to fully automated tasks. It includes two key abilities: the ability to deal with novelty and the ability to automatize information processing. The Contextual (Practical) Intelligence sub-theory determines how effectively an individual can apply their cognitive abilities in a real-world sociocultural context. It is manifested in the ability to "manage the environment" through adaptation, shaping, and selection. This aspect is often described as "practical intelligence" or "street smarts." The triarchic theory offers a more holistic and functional understanding of intelligence, moving beyond the solution of abstract problems to include creative and practical components that are crucial for life success.

An even more radical departure from the psychometric tradition is Howard Gardner's Theory of Multiple Intelligences. It postulates that a single, monolithic intelligence does not exist. Instead, Gardner suggests viewing intelligence as a set of several relatively autonomous "intelligences" or computational capacities. Each of these intelligences represents a separate psychobiological system for processing a specific type of information. To distinguish each type of intelligence, Gardner used strict criteria, including: potential isolation by brain damage, an evolutionary history, a distinct developmental trajectory, and the existence of prodigies and savants. Initially, Gardner identified seven types of intelligence, later adding to the list: Linguistic, Logical-Mathematical, Spatial, Musical, Bodily-Kinesthetic, Interpersonal, Intrapersonal, and Naturalistic intelligence. The key message of Gardner's theory is that different people possess different profiles of intelligence. The traditional system of education and testing, in his view, disproportionately values only linguistic and logical-mathematical intelligences, ignoring and failing to develop the others, which impoverishes the potential of many learners.

Comparative Analysis and Implications for Special Pedagogy

The analysis conducted demonstrates a fundamental evolution in scientific conceptions of the nature of intelligence. This evolution represents a paradigm shift from a static, structurally-oriented psychometric approach to a dynamic, process-oriented systemic-functional approach. The key differences between them can be systematized along several parameters. The subject of analysis for psychometric models (Spearman, Cattell, Guilford) is focused on identifying and measuring the structure of abilities—what intelligence is composed of. Modern models (Sternberg, Gardner), in turn, emphasize processes and functions—how intelligence works and what it is for. In terms of methodology, the psychometric approach relies almost exclusively on factor analysis, while the systemic-functional approach uses a broader arsenal of methods, including cognitive modeling, cross-cultural research, and neuropsychological data. The



concept of intelligence also differs: psychometrics treats it as a relatively stable, genetically influenced trait, whereas modern models view it as a dynamic system that can be modified through experience. Thus, if psychometric theories provide an "anatomical slice" of intelligence, systemic-functional models offer its "physiological" description. This transition from structure to function is of decisive importance for applied fields, primarily for special pedagogy.

The theoretical model of intelligence adopted by a specialist directly determines their diagnostic and correctional strategy. Traditional psychometric diagnosis, based on IQ measurement, is primarily oriented toward assessing the general g-factor. The main outcome is a quantitative score that positions a child on a normative scale and often serves as the basis for stating "deficiency" (e.g., intellectual disability). The main limitation is that it answers "how smart is the child?" but provides virtually no answer to "in what way is the child smart?". It does not reveal the qualitative uniqueness of the disorder's structure nor does it identify intact links. In contrast, modern models offer tools for a qualitative, profile-based analysis. A diagnosis based on Sternberg's theory would allow for the assessment not only of analytical abilities but also of a child's capacity to deal with novelty and their practical sense. Diagnosis within Gardner's paradigm is aimed at creating a "profile of intelligences," which makes it possible to identify their strong cognitive modalities. Such an approach fundamentally shifts the focus of diagnosis from a search for deficits to a search for resources.

Consequently, correctional strategies also change. Those stemming from the psychometric approach are often global and poorly differentiated, aimed at the "development of thinking" in general. Systemic-functional models open the way to constructing highly individualized educational and correctional trajectories. Sternberg's theory allows for targeted work with specific components, such as developing metacognitive skills or practical intelligence. Gardner's theory has become the basis for the concept of differentiated instruction, which posits the necessity of building the learning process by relying on a child's intellectual strengths. For example, for a child with strong bodily-kinesthetic but weak linguistic intelligence, mastering the alphabet can be achieved through sculpting letters or "experiencing" them with the body. The goal becomes not to "pull up" a weak function to the norm, but to ensure the mastery of educational material through alternative channels of information processing available to the child.

Conclusion

The theoretical analysis conducted allows us to state the existence of a fundamental paradigmatic shift in the scientific understanding of intelligence. A transformation has occurred from psychometric models, which sought to identify and quantitatively measure static, predominantly unitary or hierarchical structures (the general g-factor, fluid and crystallized intelligence), to modern systemic-functional concepts. The latter view intelligence as a dynamic, multicomponent, and context-dependent system aimed at solving a wide range of life problems. The key conclusion is that this evolution has not only theoretical but also paramount applied significance for special pedagogy. It marks a transition from a deficit-oriented model, where the focus is on measuring deviation from the norm, to a resource-oriented model. Modern approaches by Sternberg and Gardner shift the focus from the question "How reduced is the



child's intelligence?" to the questions "What is the unique structure of their intelligence?", "Which cognitive aspects are their resources?", and "How can these strengths be used to compensate for difficulties and achieve successful learning?". Thus, intelligence ceases to be a "verdict" and becomes a "profile of capabilities."

Based on the conclusions drawn, several promising directions for further research and practical development can be outlined. Firstly, it appears productive not so much to contrast as to attempt to integrate different models. For example, the information-processing components from Sternberg's theory could be investigated within the various intellectual modalities proposed by Gardner. This would allow for the creation of a more complete and voluminous picture of intellectual functioning. Secondly, the most pressing task for practical special psychology and pedagogy is the development and validation of new diagnostic tools. There is an acute need for methods that go beyond measuring general IQ and allow for the construction of a detailed qualitative profile of a child's cognitive sphere. Such tools should be aimed at assessing metacognitive skills, creativity, practical intelligence, and the various modalities according to Gardner. Finally, further research should be directed at studying the relationship between the cognitive components of intelligence and the emotional-volitional sphere and personality development, as well as searching for neurophysiological correlates of different intellectual functions. Only an interdisciplinary synthesis will allow us to approach a holistic understanding of the phenomenon of intelligence and, consequently, to enhance the effectiveness of psycho-pedagogical assistance for children with special educational needs.

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