

*Original Research Article*

# Diagnosis of Intellectual Potential for First Grade Entrance Test Candidates in Vietnam with 'Sternberg's Triarchic Theory of Intelligence

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## Abstract

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The article introduces the organization of measuring the intellectual potential of entrance test candidates of grade 1 of Experimental Schools, Vietnam National Institute of Educational Sciences, which is: (i) To apply the models of Eysenck's three meanings of intelligence and Sternberg's triarchic theory to design test to evaluate and measure Analytical, Creative and Practical Intelligences; each intelligence consisted of three areas Language, Quantitative and Space. The test was divided into 12 blocks to measure of competencies of Language (I, II and IX blocks), Logic – Mathematics (III, IV, V and XII blocks), Problem-Solving (X and XI blocks), and Creativity (VI and VIII blocks); (ii) To determine the intellectual potential of candidates by applying Item Response Theory and Rasch model. This would help diagnose children's potential and readiness for these 4 competencies (Language, Logic – Mathematics, Problem-Solving, and Creativity).

**Keywords:** Intellectual potential, Intelligence and competency

## INTRODUCTION

In Vietnam, the Party Central Committee has issued Resolution No. 29-NQ/TW of November 4, 2013 on fundamental, comprehensive innovation of education and training, with the overall goal of "*Educating Vietnamese people to develop comprehensively and best promote the potential and creativity of each individual; etc.*" (Central Executive Committee 2013, p.3). The resolution also stated that "*The examination, testing and evaluation of education and training results should be step by step carried out according to advanced criteria trusted and recognized by the world and professional community.*" (Central Executive Committee 2013, p.6). It can be seen that the Party, State and society are demanding that the Education sector must fulfill the learners' potential and that the educational results must be evaluated based on advanced criteria across the world.

Vietnam's new general education curriculum (commencing from the 2020-2021 school year) requires the development of three General competencies (Self-regulation and self-learning, Communication and team working, Problem solving and creativity) and seven Professional competencies (Literacy, Numeracy, Natural and Social studies, Technology, Computing, Aesthetic competence and Physical competence). These competencies are closely related to the student's potential (Ministry of Education and Training of Vietnam 2018).

Learners' intellectual development is a practical pathway to realize the potential of each individual, in which the diagnosis of the intellectual potential for candidates entering grade 1 is the first step. Therefore, the article mentions:(i) The theory of multiple intelligences

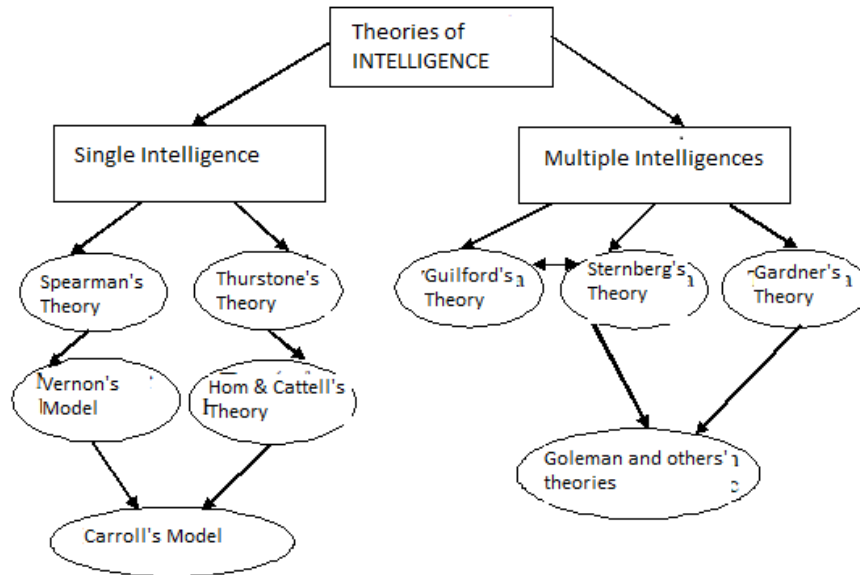


Figure 1. Generalized diagram of theories and models of intelligence

intelligences and the types of intelligence; (ii) Designing tools to diagnose the intellectual potential of grade 1 candidates; and (iii) Results of measuring the intellectual potential of grade 1 candidates.

This is the research finding of the topic. *"Developing a set of instruments to assess the intellectual development of general education students to meet the requirements of potential personal growth in the spirit of Resolution 29-NQ/TW"*, code KHGD/16-20.ĐT.045, under the National Science and Technology Program for 2016-2020 *"Research and Development of Educational Sciences to meet the requirements of fundamental and comprehensive renovation of Vietnamese education"*, code KHGD/16-20.

### Research Rationale

1) Before the middle of the 20th century, *"Intelligence"* referred to the intelligence of humans when exploring phenomena. Since the later half of the 20th century, *"Intelligence"* has been synonymous with (a) academic ability, (b) abstract thinking capacity, or (c) adaptive capacity, in which the third sense is the most common (Aiken 1987). Subsequently, the socio-economic development in the context of globalization has changed the conception of *'Intelligence'* among psychologists in the world: Human psychology (including intellect) is social in nature and not a genetically closed, innate structure; and intellect is both a result of interaction and a premise for human interaction with the environment (Khanh 2010).

There are two branches of intellectual development theory, Single intelligence and Multiple intelligence, with

the illustration depicted in Figure 1.

The *"Single Intelligence"* is the concept that intellect is a general ability "g" (general), which can be divided into two separate factors "s" (specific) according to Charles Spearman (Spearman 2005); or into 7 separate factors (spatial ability, numerical ability, word fluency, memory, perceptual speed, verbal comprehension, and inductive reasoning) according to Thurstone (Spearman 1904); or hierarchical order according to Vernon Philip (Philip 1969).

The *Multiple Intelligences* affirmed that there was not only one common factor, but many intellectual factors. According to Guilford, there are 120 factors of intelligence due to three-dimensional effects: Operations (cognition, memory, divergent production, convergent production, and evaluation), Contents (images, symbols, semantics, behaviors), and Products (units, classes, relations, systems, transformations and implications) (Guilford 1967). According to Howard Gardner, there are 10 types of intelligence: musical-rhythmic, visual-spatial, verbal-linguistic, logical-mathematical, bodily-kinesthetic, interpersonal, intrapersonal, naturalistic, existential, and moral. He acknowledged the cultural context of intellect and analyzes the intelligence at school environment as well as other habitats (Howard. 1983).

2) At the end of the 20th century, a trend of practical intelligence research (Practical Intelligence, PI) and social intelligence (Social Intelligence, SI) emerged. Since then, Eysenck proposed a three-conception model: biological intelligence, psychometric intelligence or academic intelligence, and social intelligence. Figure 2 depicts the three-conception model and their factors (Eysenck (Ed) 1985).

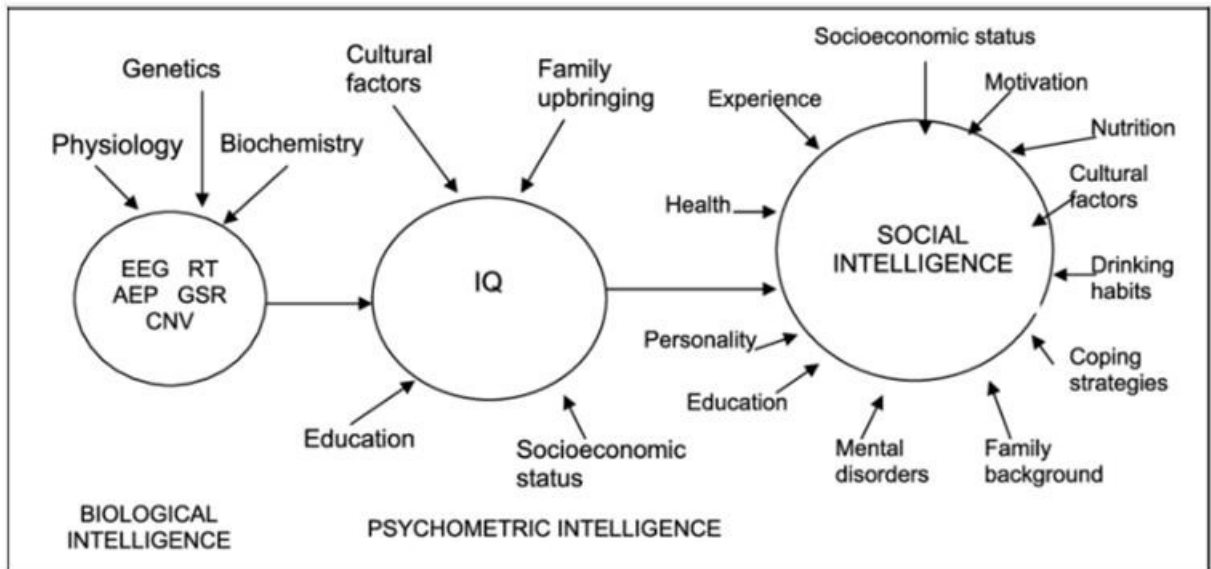


Figure 2. Three conceptions of intelligence (Eysenck, 1985)

3) Robert Sternberg stated the concept of "successful intelligence" on the basis of developing three components: (a) analytical intelligence (the capacity of thinking, reasoning, language, problem solving, evaluate, etc.); (b) practical intelligence (the ability to operate in real situations); and (c) creative capacity (ability to combine experiences, events, discoveries, imagination, predictions, etc. in new ways) (Sternberg 1999).

The Sternberg Triarchic Abilities Test (STAT) assessed the elements of Analytical, Creative and Practical. Each of these elements had 3 sub-tests in the fields of Language, Quantification and Spatial Image, which were denoted as: I. Analytical-Verbal; II. Analytical-Quantitative; III. Analytical-Figural; IV. Creative-Verbal; V. Creative-Quantitative; VI. Creative-Figural; VII. Practical-Verbal; VIII. Practical-Quantitative; and IX. Practical-Figural (Scott, and Jerome 2004; Weng-Tink Chooi, Holly and Lee 2014).

## RESULTS

### 1) Types of intelligence studied and evaluated

Based on Eysenck's three-conception model and Sternberg's triarchic theory, and considering the requirements of the new general education curriculum, the following 7 specific intellectual abilities have been selected to be examined (figure 3).

- Fingerprint biometrics: belongs to genetic factor, or biological intelligence conception of Eysenck model.
- Language, Logic - Math and Problem Solving competencies: belong to educational and cultural factors,

academic intelligence conception in Eysenck model; of the analytical and creative intelligence of Sternberg theory

- Creative/Experiential, Communication and Cooperation competencies: the experience, education and cultural factors, which belong to the social intelligence conception in the Eysenck model; the practical intelligence of Sternberg theory

### 2) Design of diagnostic test of intellectual potential of grade 1 candidates

Applying the idea of STAT, the diagnostic test of intellectual potential of grade 1 candidates consisted of the following 9 sub-tests:

- I. Analytical-Verbal: define a new word definition in a paragraph that simulates the natural context, in accordance with the assumption considered true,
- II. Analytical-Quantitative: rely on data, numerical conditions to find missing numbers, sequence rules, etc.
- III. Analytical-Figural: choose the suitable object for the missing piece.
- IV. Creative-Verbal: orally present and address new/similar issues on the basis of reviewing what was previously considered true.
- V. Creative-Quantitative: present rules and solve math problems based on these rules.
- VI. Creative-Figural: complete/create a new image by applying the suitable rules along with transforming/modifying a range of spatial imagery
- VII. Practical-Verbal: find the best solution to a variety of everyday problems by choosing the options provided.
- VIII. Practical-Quantitative: solve everyday situations through practical math problems.

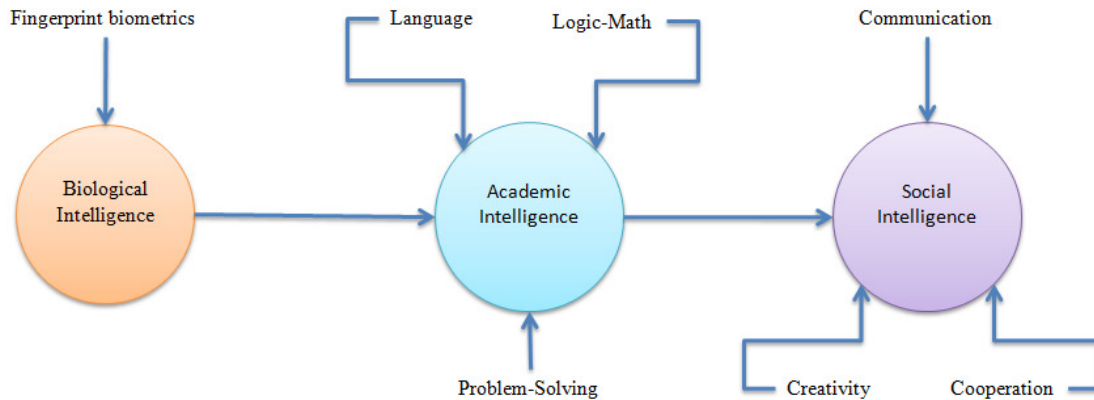


Figure 3. Types of intelligence studied and evaluated

Table 1. Grade 1 Entrance Test matrix

	Analytical	Creative	Practical	
	<i>I. Homophones</i>	<i>VI. Imagination</i>	<i>IX. Title</i>	
	Explain the meaning of phrases and idioms	Imagine a follow-up based on the story provided Imagine, speculate based on assumptions	Introduce the name at school; Know name's letters Retell the story when watching the video	
Language	1	2	2	5
	Listen - Speak	Watch video - Answer	Listen - speak; multiple-choice	
	<i>II. Metaphors</i>	<i>II. Pictorial language</i>		
	Set title for the picture	Explain pictures containing pictorial language		
	1	1		2
	Listen - Speak	Open		
	<i>III. Counting numbers</i>		<i>X. Feasible solutions</i>	
	Count numbers within 20		Solving add/subtract situations in life	
	1		1	2
	Count - Speak		Listen - Speak	
Quantitative	<i>IV. Sorting</i>		<i>XI. Making decision</i>	
	Grouping, distinguishing characteristics of objects		Explain, draw conclusions for practice Explain the rules of sorting things, objects Cover things	
	1		2	3
	Open		Open	
	<i>V. 3D shapes</i>	<i>VIII. Multiple-use</i>	<i>XII. Logistics</i>	
3D space/shape	Complete the missing pieces	Create new uses for household appliances	Find a way through areas in the map	
	1	1	2	4
	Multiple-choice	Mở	Multiple-choice	
<b>Total</b>	<b>5</b>	<b>4</b>	<b>7</b>	<b>16</b>

IX. Practical-Figural: effectively find a way through the area described in the map.

The first-grader entrance test consists of 12 blocks to measure Analytical, Creative and Practical intelligence, each of which includes three areas of Language,

Quantitative and Spatial. Each block has the following question types in Table 1

- Analytical Intelligence is composed of Block I, II, III, IV and V, in order to evaluate the ability to use and interpret meanings of words and idioms; distinguish the group

characteristics of phenomena; identify the missing parts of the whole (shapes, objects);

- Creative intelligence includes Block VI, VII and VIII, in order to evaluate the ability to imagine and speculate stories based on certain assumptions; explain the categories of linguistic symbols, symbols, figurative meanings, etc.; forming a new way to utilize or apply something.

- Practical intelligence: including Block IX, X, XI and XII, to evaluate the ability to solve everyday problems; explain the sorting rules of things and phenomena; optimal path selection in the real world's map.

The above twelve question blocks are designed to measure the following four competencies: Language: includes blocks I, II and IX; Logic - Math: including blocks III, IV, V and XII; Problem Solving: includes X and XI blocks; and Creativity: includes blocks VI and VIII. On this basis, two tests measuring the four competencies mentioned above were compiled, with 35 items, each candidate answered (face to face) in about 10 minutes.

For example, **Item 6** below is designed to measure the practical intelligence – Space/Shape and measure the competency of Logic - Math of candidates:

The image below is a maze

6.1. You are at M position, find your way to Hoa's in B position.

6.2. When you meet her, how do you find your way to the gate to go home?



### 3) Method of estimating the intellectual potential of grade 1 candidates

A total of 630 candidates from many districts in Hanoi such as Ba Dinh, Hoan Kiem, Dong Da, Cau Giay, Hai Ba Trung, Tay Ho, etc, participated in the first grade entrance exam on June 22-23, 2019, of the Experimental Schools of Vietnam National Institute of Educational Sciences.

The diagnosis of the candidate's intellectual potential was made on the basis of the 'Item Response Theory (IRT) and 1-parameter Rasch model, with two main

assumptions: (i) *With one question, people with high capacity are more likely to answer correctly than people with low capacity;* (ii) *For a person, an easy question is more likely to be answered correctly than a difficult question.* The formula for probability of answering a

question is:  $P(\theta) = \frac{1}{1 + e^{-c(\theta - b)}}$ , where  $e$  is the Nepe

constant,  $b$  is the difficulty of the question and  $c$  is the candidate's ability to answer that question (Rasch, G. 1980).

Candidate's test responses were processed by Conquest software. Accordingly, Conquest assigned each candidate a common competency value 'g' on the logit scale (the logarithm base 10 formulas above), and assigned each question a difficulty. If a candidate and a question had the same position on the logit scale, then the probability for the candidate to correctly answer that question would be 0.5; If the candidate had a higher/lower position than the question, then the probability for the candidate to correctly answer that question would be higher / lower than 0.5. Figure 4 shows the 'g' capacity of 630 contestants and the difficulty of 35 items. The first panel is a scale of -2.5 to 2.5, where 0 is the average; the next panel is the competency allocation of contestants; The last panel is the position of difficulty 35 questions. We find that: Competitive competency distribution and question difficulty are quite similar, proving that the test is suitable for them; there are 5 questions that are too easy (10, 16, 29, 5, 6), that is, all candidates have a higher position than their position; 2 questions are too difficult (30, 9), that is, all candidates have lower positions than their position.

Each of the four specific 's' competencies (Language, Logic - Math, Problem Solving, Creativity) of the candidate is estimated when considering the suitability of the average difficulty level between the components, as well as the difficult between questions in each component capacity. Figure 5 shows the candidate's competency distribution in specific 's' competencies: the three competencies for which the candidate has similar divergences are Language, Problem Solving and Creativity (from -2 to 2), and Logic - Math has a narrower range of competencies (from -1 to 1); All 4 distribution lines are in the standard form of Gauss.

Table 2 shows the logit scores of the 10 candidates (randomly selected out of the total 630 candidates) at the common competency and the four above mentioned competences, of which the value '0' is average. are above average, the highest of which is Creative Intelligence (2.67358). For T128 candidates, with the exception of the average Language Intelligence (0.1137878), the remaining fields are all lower than the average.

In order to foster the intellectual potential of students,

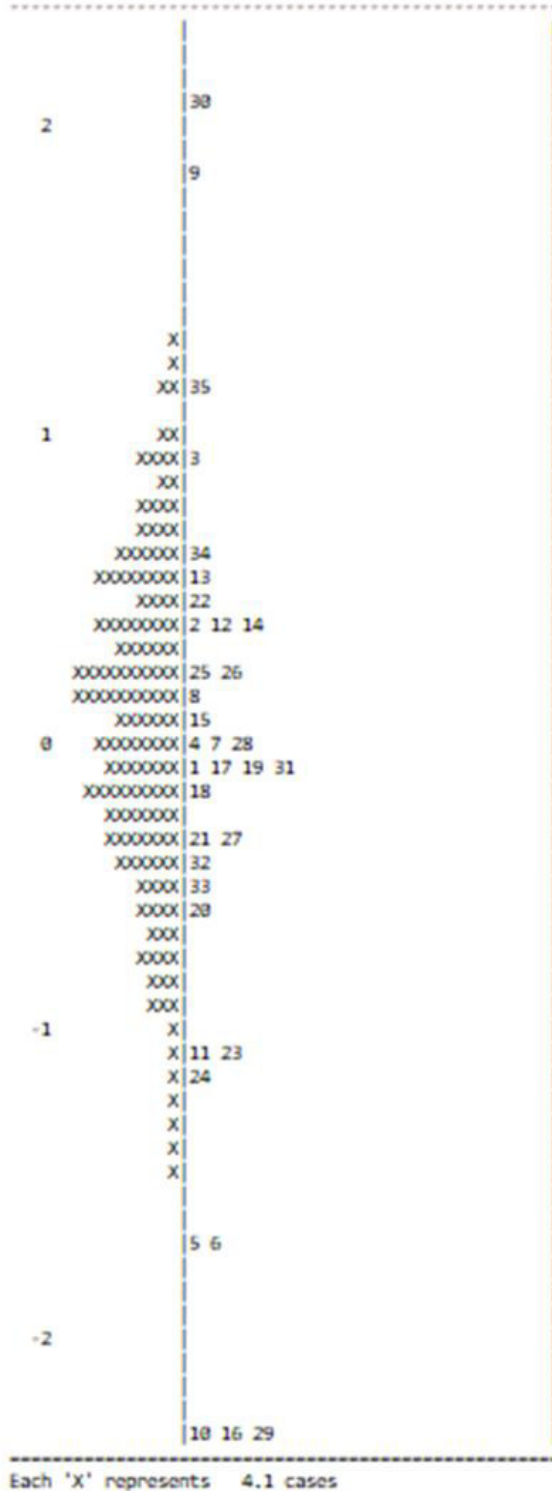
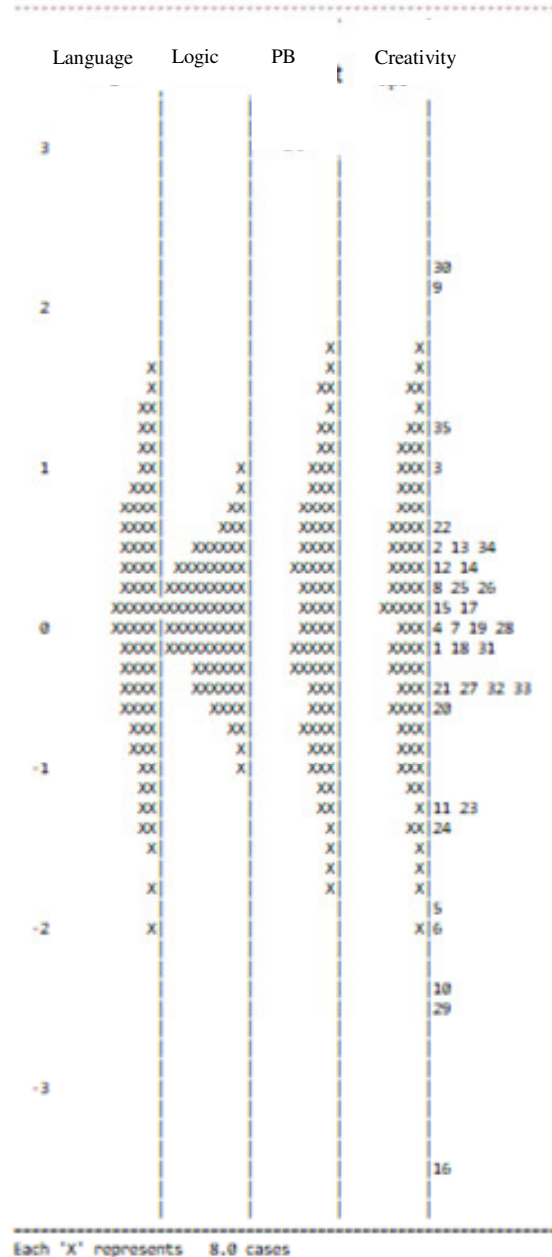


Figure 4. Candidate competency distribution and test question difficulty level



Each 'X' represents 8.0 cases

Figure 5. Candidate competency distribution and question difficulty measure 4 component competencies

**Table 2.** Competence of candidates in each intelligence (logit scale)

MAHS	General	Language	Logic - Math	Problem-Solving	Creativity
T068	1.4073	1.49165	0.66703	0.83094	2.67358
T128	-0.18646	0.13578	-0.11693	-0.64152	-0.38287
T233	0.07304	0.13522	0.18523	0.83094	-0.85477
T259	0.31421	-0.53711	0.47445	0.83094	0.49788
T292	0.3868	0.48229	0.66703	-1.37086	0.49788
V001	0.54274	0.47617	1.42062	-1.90466	0.03379
V002	0.24951	0.20658	-0.18469	0.69369	1.36093
V003	0.34483	0.47617	0.45988	-1.90466	0.65544
V004	0.64719	0.79341	0.69336	0.69369	0.03385
V005	-0.02012	-0.56259	0.33549	0.69369	0.03385

the candidates who enter the first grade of experimental schools are selected from high to low according to the common competency value 'g'. And the values of own capacity 's' will be of interest to the school, focusing on promoting the potential according to the field for each child according to the detailed profile.

## CONCLUSION

- 1) The intellectual potential of every individual does truly exist and is measurable. With 630 candidates, who have never been to primary school, through behaviors of watching videos, pictures and drawings, listening and answering questions of interviewers, they have shown their abilities of analyzing logic, thinking, imagining and creating words, using things in new ways;
- 2) The application of the STAT structure of Sternberg to simultaneously measure the Analysis, Creativity, Practice for children aged 5 and 6 in Vietnam is perfectly suitable. The STAT structure has been flexibly adjusted by the research team by designing question blocks that measure Language, Logic - Math, Problem Solving, and Creativity competencies, which will help diagnose potential and children's readiness for these 4 competencies;
- 3) The results have strengthened the belief for the team to continue to measure Fingerprint Biometrics and the Communication and Cooperation competencies of the successful candidates in the first semester of the 2020-2021 school year; and
- 4) The children's potential diagnostic results in genetic, cultural, educational and experience factors in Eysenck's three-conception intellectual model have contributed to providing information for pedagogical intervention

planning, thus realizing the potential of individuals, meeting the requirements of the new education program and contributing to the objectives of the fundamental and comprehensive renovation of education and training.

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