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# High Abilities and Information Technologies: The *Talento Metrópole* Brazilian Program

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## Abstract

**The study presents the Brazilian experience of the *Talento Metrópole* program, linked to the Digital Metropolis Institute of the Federal University of Rio Grande do Norte, located in Brazil's Northeast. The *Talento Metrópole* program aims to develop the interest of young people with high abilities/intellectual giftedness in scientific research, expand skills and abilities, and get creative in the fields of information technology and its interfaces, always seeking innovation and entrepreneurship. It also aims to create opportunities for the dissemination of new knowledge and to explore career opportunities related to this area, with the purpose of creatively inserting young people into the labor market and into solidary social participation. The participants are students from public and private schools, colleges and universities, aged between 13 and 21 years. The steps that comprise the structure of the program are described and characterized. In addition, the selection process for admission to the program is described, with emphasis on the stage which illustrates the development and characterization of the instrument which investigate the sources of skills and expertise subjacent to the field of information technology.**

## Keywords

**Technology, Education, High Abilities/Intellectual Giftedness**

## 1. Introduction

The present article discusses the development of the *Talento Metrópole* program, under implementation at the Federal University of Rio Grande do Norte, Brazil. Its main goal is to develop the interest of young people with

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high abilities/giftedness in scientific research, to expand skills and abilities, and to get creative in the fields of information technology and its interfaces, always seeking innovation and entrepreneurship. It also aims to create opportunities for the dissemination of new knowledge and to explore career opportunities related to this area, with the purpose of creatively inserting young people into the labor market and into solidary social participation. Two main reasons justify the offer of IT education for youths in general, and talented/gifted youth in particular: 1-IT is part of the life of young people in contemporary times; 2-Youths with high abilities possess characteristics of cognitive functioning that are important and valued in the IT domain.

Information Technologies (IT), such as other types of technology, is created by human beings as their own projections and extensions, and can be considered means through which people act in the world. Therefore, information technologies affect and shape the structure, functioning and development of the human mind and actions, having a direct impact on perception, cognition, emotion and the communication of people (Kaptelinin & Nardi, 2012). In fact, any type of technology alters the way people build knowledge, but the introduction and growing of information technologies have reinforced the recognition of this fact (Noss & Hoyles, 1996). On the other hand, these new mediation tools demand critical, creative, flexible and critical thinking in order to truly amplify cognitive abilities. Critical thinking refers to a set of executive abilities (Sheffield, 2007) that allow identifying relevant information of the problem, understanding and using language, evaluating data and information, anticipating conclusions, reconstructing personal beliefs, identifying solutions to problems, interpreting data, formulating conclusions, and producing and defending arguments.

However, despite such potential, in the everyday reality of schools, computers have mainly been used as tools for information searching, text editing and presentations, with little stimulation of creativity and flexible thinking (Keay-Bright, 2008; Passey, Rogers, Machell, & McHugh, 2004). In order to address this concern, a trend in educational technology proposes the creation of exploratory, dynamic, and interactive learning environments, where learners can create digital representations to investigate ideas and abstract conceptual relationships (Florian, 2004; Papert, 1980). In educational contexts, the popularization of interactive and multimedia technology has profoundly changed the standard ways of performing some traditional activities like writing, communicating and planning. It is a new, qualitatively different extension of memory and linear reasoning, based on simulation, experimentation, and a new language involving writing, orality, images and instantaneous communication (Borba & Villareal, 2005).

Computer systems, tools and symbols are increasingly among the artifacts that collectively constitute human activity. Borba & Villareal (2005) suggest that knowledge is produced by a collective of humans-with-technologies and not by humans alone. However, it is important to note that, from a mediational perspective, technologies do not have, *per se*, an automatic effect of extending the human mind. The influence of technologies in mental processes depends on its integration as mediators of socially situated meaningful human activities (Kaptelinin & Nardi, 2012; Winograd & Flores, 1986).

Generally speaking, disciplines specific to the IT field simultaneously stimulate and demand critical thinking. Knowing how to use IT tools to search for information to create a presentation, as it is commonly done in educational contexts, is very different from knowing how to apply IT fundaments to build such tools or algorithms that will allow solving problems. Studies point to logical-mathematical ability as an indicative of good performance in IT courses, and the learner's self-perception about their own learning also seems to contribute to success in programming courses (Bergin & Reilly, 2005; Byrne & Lyons, 2001). On the other hand, many difficulties faced by IT students are related to a lack of abstraction ability for problem solving, or a lack of logical-mathematical reasoning sufficiently developed (Gomes & Mendes, 2007).

Considering the definition of high abilities put forward by Renzulli (2004), they present themselves in the interaction of three factors, namely, above average ability, involvement with the task, and creativity. Above average ability can present itself in two forms: general or specific. Respectively, one stands out for its ability to adjust to new situations, to the individual's high levels of abstract thought, to spatial relations, to memory, to verbal, and to numerical reasoning; the other involves the ability to acquire knowledge for performing one or more activities in specific or general areas. The second factor is the involvement with the task, which depicts the student's level of motivation toward the activity; and the third is creativity, which shows innovative ways to perform activities.

Renzulli brings in his studies the existence of two types of giftedness, namely, academic and creative-productive. Academic giftedness is characterized by individuals who have exceptional performance in tests that measure the intelligence quotient (IQ); creative-productive giftedness includes individuals who exhibit aspects of human activity and involvement that comprise the new ideas, products and original works of art.

Thus, the process of acquiring new skills and competencies by young people with high abilities/giftedness characterized as academic is basically deductive, characterized by the steps of acquisition, storage and retrieval of information. In turn, young people with high ability/giftedness with creative-productive profiles, in general, have their learning processes characterized by the development of materials and unique products; here, the emphasis is on the use and application of information, which characterizes the process as inductive, usually oriented to real life problems (Renzulli & Reis, 1997).

The peculiarity inherent to the learning processes of young people with high abilities/giftedness promotes the need to develop and implement programs that address the diversity and idiosyncrasies inherent to this population. It appears that traditional teaching, in most cases, fails and becomes uninteresting, as it tends to ignore the active role of the student in the learning process, homogenizing interests and paths, establishing the validity of certain content and ignoring others, and restricting creativity and alternative routes for the construction of knowledge. *Talento Metrópole* program proposes, therefore, an innovative educational program focusing on talented/gifted youths, and offering learning contexts in order to promote critical, innovative thinking.

## 2. The *Talento Metrópole* Program

The Digital Metropolis Institute (IMD) is a Supplementary Unit of the Federal University of Rio Grande do Norte (UFRN), a public university which has technical, graduate and post-graduate courses, with actions that integrate social and digital inclusion for young people from basic learning until their post-graduation studies. In addition to that, the university has research and technological innovation activities, and incentives to entrepreneurship, which resulted in the creation of the *Inova Metrópole*, an incubator for technology companies from the area of Information Technology (IT). The IMD has the goal of encouraging the creation of a technological hub in the state of Rio Grande do Norte, comprising initiatives from the public, private, and scholar sectors.

That said, IMD created a Program aimed at the development of talents and the enrichment of high abilities in the area of information technology. With the broadening of its actions, adapting them to the demands of the different levels of educational actions present in Brazil, it contributes greatly for assuring the existence of mechanisms which allow the complete fulfillment of the special educational needs young people with high abilities/giftedness have, according to what is stated on the National Law number 9.394, from December 20th, 1996.

The *Talento Metrópole* program is directly connected to the Digital Metropolis Institute (IMD), but has the participation of other academic departments with which the IT area interfaces. These departments form the Integrated Units, where students develop activities on research, innovation and/or extensions.

The Program has a basic structure composed of two semesters, as summarized below (**Table 1**). However, at the end of this basic, initial phase, the student may opt to remain in the Program, presenting an Individual Plan of Activities every semester. This Plan must reflect the student's interests and motivations and be approved by a professor and the coordination of the Program. The goal is to be able to systematically accompany the student during his or her formation in different levels: technical, undergraduate, and post-graduate.

It is important to point out that the *Talento Metrópole* Program foresees the possibility of a break in the hierarchy in the formation of the students. That is, if the professor or the coordination of the Program identify the student has motivation and capacity to take part in isolated classes from levels of education above the one he or she is in, or to graduate in different levels of education at the same time, a request is sent to the Education Council of the IMD. Thus, a high school student, for example, may take part in an undergraduate or graduate class. Another student might do his undergraduate and graduate students at the same time, obtaining two degrees at the same time.

This initiative breaks with the rigidity of formal education, which is not adapted to the cognitive and motivational profile of students with high abilities. In this scenario, progressive education opens space for transversal

**Table 1.** Summary of two-semester organization of *Talento Metropole* program.

| Semesters | Contents |
|---|---|
| 1 | First Individual Plan of Activities (covering information technology, development of scientific thinking, innovation and entrepreneurship, foreign languages). |
| | Integrated units 1, 2 and 3: thematic workshops. |
| | Research, innovation or extension project connected to one of the units where he took part in workshops. |
| 2 | Second Individual Plan of Activities: broadening of research, innovation or extension project previously initiated. |

education, since it is necessary to take into consideration that students with high ability/giftedness will develop their abilities in the higher level, with more complex thinking skills (including critical, creative, and productive thinking) that are extensions of regular curriculum. The two-semester proposal mentioned above is summarized by the scheme in **Table 1**.

## 3. Identifying and Selecting Students

As already discussed, the *Talento Metrópole* Program engages talented youths in order to offer a special way of formation inside IMD technical broader formation in TI. The motivation towards the engagement of these talented participants justifies the promotion of Winter Courses, during the months of June and July, where activities are offered to fifty students from elementary school (13 to 15 yo), high school (16 to 18 yo), and undergraduate schools (over 18 yo), from both private and public institutions. The participants are forwarded by their schools, colleges and universities through their Unit of High Abilities/Giftedness (NAAH/S), connected to the Department of Education of the state of Rio Grande do Norte. Students from state schools who were best places in the Brazilian Olympics of Informatics and Mathematics are also enrolled in the courses. During the Winter Courses, the Program offers advanced courses, minicourses and seminars by researchers connected to the different Integrated Units, with themes centering on information technology and its interfaces.

Over the Winter Courses an individual evaluation of the participants is done with the goal of prospecting new students who may participate in the *Talento Metrópole* Program during that year. The selection is composed of three different phases which evaluate the intelligence and executive functions, abilities and competencies in information technology, as well as behavioral aspects, especially motivation and creativity.

1) Evaluation of intelligence and executive functions

The Raven Progressive Matrices test is used for the evaluation of intelligence. This test is composed of five series of 12 items each. At the beginning of each series are the easiest items, which introduce a new type of reasoning that will be needed for the next items. This activity consists of a drawing or matrix with one part missing; below are presented figures, among which one completes the drawing correctly. This way, the person being examined must select the alternative he or she believes is the right one. This test was developed from Charles Spearman's fator intelligence theory and has the goal of evaluating what the author calls general intelligence-the "g" fator. More specifically, Progressive Matrices evaluate one of the aspects that integrate the "g" factor, namely, the eductive ability. This ability consists of the extraction of new insights (comprehensions) and information from what is perceived or known (Bandeira et al., 2004).

In addition to that, executive functions are evaluated-they are described here as a group of cognitive abilities which act in an integrated way and allow the individual to plan, accomplish and regulate complex behaviors aimed at a specific goal. For the evaluation of the executive functions, the Wisconsin Card Sorting Test (WCST) was used. This test is commonly used in the evaluation of executive functions, since it measures the individual's ability of abstract reasoning, and also the ability to change cognitive strategies to answer to alterations in the environment. For that, the test is composed of two identical decks of cards with 64 cards each, and four stimulus cards which present geometrical figures which differ in three aspects: color, shape, and number of elements.

At the moment of application of the test, the four stimulus cards are put in front of the subject, who is told that his job is to take one card from the deck and associate it to one of the four stimulus cards. The subject is told that it is not possible to give any more information about the task; the only information will be if the association he or she makes is correct or not. In this perspective, the goal is that the subject be able to associate cards in terms of color, shape, and number, respectively, until completing ten associations for each category. For such, the subject must use different strategies of association, altering his or her cognitive resources according to the feedback by the examiner. Therefore, the task requires that the subject plan, build and evaluate his or her resolution strategy, aiming to complete the categories in the lowest number of trials possible (Lézak, 2004).

2) Evaluation of abilities and competencies in information technology

To execute the Project *Talento Metrópole* there was a need for developing specific procedures of selection and evaluation that would make possible to build an instrument of selection with items that were clearly connected to the constructs ability for Informatics/ability for IT.

Such instrument, developed by researchers in psychology, assumed some premises on the composition of competences and abilities considered necessary and/or desirable for the selection of students. Competences here are seen as structuring modalities of intelligence used in the procedural field, or knowing how to do; they can be more or less complex, and are formed of other more specific abilities. In the light of such an approach to abilities and competences, these cannot be restricted to information and concepts specifically related to content: ra-

ther, they consider strategies of interpretation and management of information, in the search for solutions to problems. In this sense, the instrument of selection proposed was not characterized by questions on specific school contents, as it traditionally happens with instruments of evaluation of school performance.

The version in use of the selection instrument for the Talento Metrópole Project proposed thirty multiple-choice questions with a unique correct answer among five options. Such instrument was meant to cover the set of competences and abilities considered necessary for IT students and summarized by **Table 2**. This table sum-

**Table 2.** Descriptive synthesis of matrices of competences and respective abilities in IT, which formed the basis for the first version of the evaluation instrument.

| Component matrices | Description | |
|---|---|---|
| | **Competences** | **Abilities** |
| **1. Systematic thinking** | 1.a. Use models and simulations to explore systems and complex situations. | (1.a.i) Identify the location/movement of objects in maps and other graphic representations.<br>(1.a.ii) Associate information presented in lists and/or tables with graphs that represent them and vice-versa. |
| | 1.b. Identify tendencies and predict possibilities, given a specific set of functioning rules of a system. | (1.b.i) Identify tendencies in statistical graphs.<br>(1.b.ii) Identify mathematical reasons (n/m) as indicators of possibilities.<br>(1.b.iii) Relate concepts of possibility, chance and systematic character of events. |
| **2.Communication and collaboration** | 2.a. Communicate ideas through diverse forms of record. | |
| | 2.b. Develop an appreciation and understanding of different linguistic and cultural practices. | (2.b.i.) Recognize the diversity of ethno-cultural and artistic patrimonies, identifying them in their manifestations in different societies, times and places.<br>(2.b.ii) Take cultural diversity into account when interpreting/contextualizing socio-historical situations, acknowledging the role of language. |
| **3. Search and management of information** | 3.a. Locate, organize, analyze, evaluate, synthesize, and ethically use information from diverse sources and media. | (3.a.i) Identify relevant data in a given situation/problem to seek possible solutions.<br>(3.a.ii) Read and interpret data or information presented in different languages and representations such as tables, graphs, diagrams, possibility trees, formulas, equations and geometric representations. |
| | 3.b. Evaluate and select appropriate sources of information for specific tasks. | (i) Read and interpret different types of text, from books to articles of economic, social or cultural content, technical manuals, and newspaper and magazine articles. |
| **4. Critical thinking and problem solving** | 4.a. Relate a contextualized problem, presented in a domain-specific language, with its formulation in other languages. | |
| | 4.b. Collect and analyze data within a process of decision-making in specific situations. | (4.b.i) Given the discursive or pictorial description of a phenomenon of scientific, technological or social nature, identify relevant variables and select the necessary instruments for realizing or interpreting it.<br>(4.b.ii) In a Cartesian graph of socio-economic or technical-scientific variables, identify and analyze values of variables, increasing or decreasing intervals and variation rates. |
| | 4.c. Management of perspectives, opinions and/or arguments for the solution of open or non-canonical problems. | (4.c.i) Confront diverse interpretations of situations or facts of historical-geographical, technical-scientific or artistic-cultural nature, or everyday life situations or facts, comparing different points of view, identifying the assumptions of each interpretation and analyzing the validity of the arguments used. |
| **5. Concepts and procedures in technology** | 5.a. Acknowledge diversity and understand the uses of devices and computer systems in contemporary society. | (5.a.i) Identify the main current activities and contexts of use of information and communication technologies. |
| | 5.b. Select applications and digital platforms in an effective and productive way. | (5.b.i) Select computing devices, applications or digital environments whose functions and functionalities respond in an adequate and effective manner to demands of specific situations. |

marizes the set of talents, vocations and competences that respond to such pragmatic aspect of the evaluation, inspired in indicators from the International Society for Technology in Education (ISTE, 2007).

c) Evaluation of motivation and creativity.

For the evaluation of the behavioral aspects of the students, the Scales for Rating the behavioral characteristics of superior students (SRBCSS) are used. These scales have the purpose of investigating, through reports given by teachers, the behavioral characteristics of their students (Renzulli, Hartman, & Callahan, 1971). This test was developed to obtain information about the areas of learning, motivation, creativity, leadership, art, music, theater, communication, planning, mathematics, reading, technology, and science. The items derive from the reading of scientific literature about gifted and talented individuals. Each component of this scale must be evaluated individually and must reflect a measure in which the teacher had perceived the presence or absence of each characteristic. The 14 dimensions of the instrument represent different types of behavioral groups, therefore, the score obtained in each scale separately must not be added up to a total score (Renzulli, Smith, White, Callahan, Hartman, & Westberg, 2002).

## 4. Conclusion

The Brazilian program *Talento Metrópole* has the goal of developing and broadening the abilities and competencies of young people with high abilities/giftedness in the area of information technology and its interfaces, always aiming to promote innovation and entrepreneurship. Its purpose is to offer quality degrees which contemplate the interests of the students, considering their potential and talent, breaking with the hierarchy and rigidity of traditional education.

This article argues that technology can promote the development of potentials, since it stimulates cognitive flexibility, at the same time empowering individuals in their learning processes (Nugeni, 2004). When technology learning is integrated into the curriculum of students with high abilities/giftedness, they develop more autonomy in their learning processes, working according to their own rhythm and level of ability, creating innovative and original products, empowering themselves in new leadership parts, researching independently, exploring topics more deeply and broadly, and thinking critically in everyday situations (Nugeni, 2004).

Lastly, the program explores possibilities of professional careers related to the domain of Technology of Information, with the purpose of creatively inserting the students into the labor market, and involving them in solidary social participation.

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