

Extraction of Characteristics in IT Gifted Children

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Abstract

Providing special education for the gifted who have infinite potential energy is necessary to have international competitiveness in scientific technology field. This process can be achieved by creative scientific cultivation which is proper and unique solution no matter what is assigned to the gifted. Especially, the IT special education for the gifted is as much important as the education in science and mathematic field because the current society is knowledge and information based. In this research, we make the list of characteristic by two methods. One is to research experts who already studied on the gifted children and who are professional in IT. The other is interview with gifted children and IT scientist who has remarkable achievements in this field. Then we define those characteristics which can be standard criterion

1. Introduction

In today's knowledge-based society, national superiority is determined by brain competition. Therefore, the early identification and systematic education of gifted children are essential in strengthening national competitiveness in science and technology through the cultivation of creative scientific capability, i.e., the ability to generate appropriate and unique solutions to specific problems [1]. Given the rapid shift to the knowledge information society, the education of IT talents has become as important as that of scientific and mathematical talents.

Therefore, the addition of IT to science and mathematics in the education of gifted children

can be interpreted as the logical result of social demand and environment. Unlike the education of mathematically gifted children, however, research on identifying and educating IT talents are few and far between both here and abroad.

The IT area is much broader compared to mathematics or science. Since IT is widely applied not only in natural science but also in liberal arts and society in today's modern society, it is difficult to define its domain with specific factors. Therefore, having superior IT talent is not tantamount to simply having outstanding command of the information device or computer.

Although many studies on defining the characteristics of IT talents have been conducted here and abroad, the methods and viewpoints are

still insufficient. Specifically, previous studies lacked the following: (1) the characteristics were defined by combining the characteristics of the IT area with the existing basic characteristics of generally gifted children, and; (2) the definition was made based on personal presumptions and hypothesis without conducting experimental research and case studies.

Therefore, this paper assumed the viewpoint of behavioral analysis and conducted face-to-face interviews with gifted children to extract the specific elements that could be concretized in reality.

2. Extraction of Characteristics

This paper assumed the viewpoint of two analysis method to extract the specific elements that could be concretized in reality.

First, Top-Down method: we studies on IT gifted definition by existing studies and Delphi study were investigated by experts in IT to analyze their problems and extract the common factors of the characteristic. Likewise, the characteristics of gifted children in science and mathematics as the basis of IT were studied to extract the common factors.

Second, Bottom-Up method: The specific characteristics of IT gifted person were also extracted through personal interviews with an IT scientist as well as gifted children in IT.

Then we arrange characteristics which be extracted by two methods and classify into two large groups: cognitive and affective area.

2.1 Characteristics which experts in IT say (Top-Down)

Analysis of related research :

Since the research field is still in the early stages, studies on the characteristics of gifted children in IT are still ongoing. Table 1 lists the common factors of gifted children in IT as

defined by related studies in Korea. The researchers cited creativity, Applicability, problem solving ability, etc., as the most important characteristics [2, 3, 4, 5, 6].

Researchers	Common Characteristics
Dong-seop Na	Task persistency
Seung-yong Shin	Creativity
	Applicability
Se-goon Oh	Discrete thinking ability
	Problem solving ability
Gil-bog Lee	Capability for quick and flexible IT application
	Capability to gather, process, and recreate new information
Seong-won Kang	

Table 1 Analysis of Related Studies on Gifted Children in IT

Delphi survey :

And The Education Center for the Gifted and Talented at the Korean Educational Development Institute carried out the Delphi study to support the education of gifted children in IT by incorporating the opinions of experts [7](table 2). In the survey of characteristics among gifted children in IT, experts(mainly professors of computer science and educators of gifted children in IT) cited creative thinking ability, task persistency and concentration, ability to cope with new, complex, and difficult tasks, and strong adventurism as the most important characteristics. (Full marks: 100points)

Rank	Avg	Characteristics
1	95.2	Excellent originality-thinking
	95.2	Excellent subject tenacity and concentration
	95.2	The challenge consciousness to a subject it is new and complicated and difficult, and a strong speculative disposition
4	93.4	Excellent mathematical-logical thinking
5	91.4	Excellent Problem discovery, problem-solving power
6	90.4	Excellent logic deployment (algorithm design) capability
7	87.6	There are many questions and indication curiosity is high.
8	84.8	Excellent powers of observation, scientific thinking
	84.8	Excellent intuition power, and insight

	84.8	There are much concern and interest about IT
11	83.8	Rich imaginative power and a free accident
12	82.0	New information creation capability
13	81.0	High IQ

Table 2 Result of Delphi Survey

Mathematics and Science :

IT has been historically based on mathematics. The starting point of IT was discrete mathematics as a restructured and reprocessed form of existing mathematical theories. Furthermore, IT has traditionally been considered a subcategory of science, sharing the same basic structure. As such, the characteristics of the mathematically and the scientifically gifted were compared, and the common factors, regarded as the characteristics of gifted children in IT. The following common factors were identified [8, 9, 10, 11]:

- Problem solving through insight and intuition
- Ability to apply the learned contents to new situations and generalize quickly the algorithm applied to specific problem solving
- Quick identification of an alternative solution in case the main one is unsatisfactory
- Easy linking of the problem to real life and comprehension of their correlation
- Interest in mathematical analysis and outstanding ability to measure and analyze data

2.2 Characteristics which Gifted Children in IT have (Bottom-Up)

The specific characteristics of IT talents were also extracted through personal interviews with an Information scientist as well as gifted children in IT.

With IT Scientist :

The characteristics of gifted children in IT

were also extracted through the autobiographies and interview articles featuring the thoughts and anecdotes of the computer scientists who established the computer science field in the 50's by developing computer programming languages and algorithms. Specifically, the behavioral characteristics of those who made their mark in the computer science field including FORTRAN Developer John W. Backus, E.W. Dijkstra who developed the shortest path algorithm, Donald Ervin Knuth who developed the compiler, and Graph Algorithm Pioneer Robert E. Tarjan were studied.

Outstanding scientific creativity must be included as key to the education for the gifted. In particular, outstanding IT creativity was included by reflecting the innovative discoveries of outstanding scientists through imaginative experiments involving the best application of their personal knowledge and functions.

- Dislike for inefficiency
- Ability to identify the intrinsic problem and to identify and separate incorrectness from correctness
- Passion for language and syntax, broad, outstanding knowledge of mathematics, aesthetic sensitivity, will to understand, and passion for programming
- Silent pursuit for minimalism, refinement, and universality

With Gifted Children in IT :

For the interview with the gifted children, a questionnaire consisting of 100 questions based on the result of the existing studies on gifted children in IT and Delphi study was used. If face-to-face interview was not possible, communication through several email messages was used instead.

- *First Gifted Child* – Eight-year old 'A' was the youngest person to have passed a national certification examination at 6 years old. Aside

from the national certification, his gift has also been verified by several organizations.

- *Second Gifted Child* – Twenty-three-year old 'B' scored high during the Korean Information Olympiad. He could tell the behavioral and cognitive characteristics of other Information Olympiad winners.
- *Third Gifted Child* - Nineteen-year old 'C' was the developer of an open source Web browser giving MS Internet Explorer a run for its money. He is currently a computer science major at Stanford University.
- *Fourth Gifted Child* – Twenty-six-year old 'D' is an internationally recognized programming guru, having received the MVP award given to programmers by Microsoft for three years in a row.
- *Fifth Gifted Child* – Twenty-six-year old 'E' is a student of computer science in Seoul National Univ. He had excellent grade and skills compared with other students.

The following main characteristics were extracted:

- A: He has excellent mathematical-logical thinking ability and capability of the revision and development of the system are essential in overcoming the inconvenience in actual life.
- B: Highly creative, he enjoys searching for intrinsic truth and has a strong will to create something. And he has Rich imaginative power and a free accident.
- C: He criticizes the established objects, which is indicative of a strong desire for a better system.
- D: He searches for a reason from a highly critical viewpoint.
- E: He has much interest and concern about IT. And he has capability for quick and flexible IT application and capability to gather, process, and recreate new information

3. Domain

A details-domain is defined in order to classify characteristics of IT Gifted and others characteristics according to a cognitive domain and Affective domain based on Bloom's Taxonomy. On a basic target If characteristics of IT Gifted is extracted and seen, a cognitive domain can be classified according to logical thinking power, creativity (originality and facility power) and a problem-solving power portion, and a Affective domain can be classified according to interest and attitude portion.

Creativity :

Creativity is the important theme in special education for gifted children. Creative-people are independent-like and have many feeling of confidence and though crisis coping ability excels and is passionate, a speculative disposition and curiosity are high. Moreover, their lateness power is very excellent and they are 'intuitive'(Sternberg, 1988). Originality nature means the synthetic thinking power which adds critical thinking to logical thinking power, and contains a new idea in it[12]. Most of such the fundamental characteristics revealed through the research to originality-builders, writers, and mathematicians. Characteristics extracted are contained in creativity category for many portions[13].

Problem Solving Ability :

Problem Solving Ability is Capability which is newly applied in the knowledge and conceptual, principles, laws and functions which are already known, and solves a problem the problem-solving methods. Or they originate a new concept, a principle, law and the problem-solving method, solve a problem. It is one in the fundamental requirements which gifted children have to have a variety of in stock.

Logical thinking power :

The accident technique for logical thinking power is knowledge, an understanding, application, analysis, inference, synthesis, and evaluation. Seven sorts Logical thinking means the accident which arrived at a conclusion, leaving many data and propositions, collecting narrowly increasingly, and going.

Since gifted children are very logical, he or she does not regard the reply of rough as the method of acceptance.

Interest :

It is the inclination which is going to participate in the concern or what activity about phenomenon and things that are called interest into a Affective-domain. Gifted children have a high motive and endurance is strong. The desire which receives learning combines with understanding [of curiosity and a high level], logical thinking power, etc., and guides high order origin-accomplishment.

Attitude :

Attitude in affective domain means preparation state or tendency of reaction in what kind of situation.

Since all people have differences in motive, attitude and human nature, etc., according to experience. So, affective characteristics must be low evaluated compared with cognitive characteristics.

4. Mapping between Domain and characteristics

It will seem to be the following table if the extracted characteristic is mapped in a domain.

Creativity	
1	The child tends to solve a problem uniquely and creatively
2	The child has many ideas are computed when responding to a problem or a question..
3	The child has good insight.
4	The child has capability that one situation can be

	variously seen in a viewpoint
5	The child has capability that a detailed matter can be analyzed and the whole can be analyzed into a portion
6	The child has capability which can combine a portion by the originality-whole in search of relevance
7	The child has capability using [transcend an ordinary idea and] what kind of object with a new method
8	The child has capability to begin to grasp relevance well even when information is inadequate
9	The child has rich imaginative power and a free accident
10	The child has keen intuition.

Table 3 Cognitive characteristics of Gifted Children in IT – (1) Creativity in IT

Problem solving Ability	
1	The child has Capability to gather, process, and recreate new information.
2	The child has remarkable ability to analyze the given data.
3	The child has applicability
4	The child has Capability for quick and flexible IT application
5	The child has Ability to apply the learned contents to new situations and generalize quickly the algorithm applied to specific problem solving
6	The child shows highly advanced reasoning power in a short period.
7	The child can Easily link of the problem to real life and comprehension of their correlation
8	The child has Convergence-thinking and diffusion-thinking

Table 4 Cognitive characteristics of Gifted Children in IT – (2) Problem solving ability in IT

Logical thinking	
1	The child has capability which begins to separate a suitable thing by the unsuitable thing, and draws a rational conclusion
2	The child has remarkable ability to analyze the given data.
3	The child has discrete thinking ability
4	The child has quick comprehension.
5	The child enjoys logical thinking and expresses himself/herself logically.
6	The child has logic deployment (algorithm design) capability – excellent
7	The child has powers of observation, scientific thinking
8	The child has Ability to identify and separate incorrectness from correctness

Table 5 Cognitive characteristics of Gifted Children in IT – (3) Logical thinking in IT

Interest	
1	The child shows considerable interest in new computer technologies or related issues.
2	The child has interest in mathematical analysis
3	The child prefers working on a difficult problem rather than an easy one.
4	The child strives to minimize, simplify, and/or reduce a problem.

5	The child has passion for language and syntax and programming
6	The child has aesthetic sensitivity
7	The child likes breaking up a problem into smaller ones.

Table 6 Affective Characteristics of Gifted Children in IT – (1)Interest

Attitude	
1	The child prefers his/her own initiated activities to being led by others.
2	The child prefers actual experience to theoretical learning.
3	The child waits for the result instead of giving up altogether (Task persistency)
4	Beyond simply recognizing the problem, the child demands better system.
5	The child responds actively in case of an error.
6	The child has strong desire to apply a situation in computers.
7	The child has strong desire to correct inefficiency.
8	The child strives to find the intrinsic cause of a problem rather than the superficial one.
9	The child frequently skips the steps in problem solving.
10	The child correctly pinpoints the problem with the inefficient system (overall term for the program, s/w, and IT devices).
11	The actual implementation is most likely to be successful.

Table 7 Affective Characteristics of Gifted Children in IT – (2)Attitude

5. Conclusion

In this paper, an IT talent was defined as a person with potential to contribute greatly to the IT field by solving the real problem using logical thinking based on his/her computer science background or by developing the system or theory applying creative ideas.

We can apply Characteristics extracted to following cases: (1)An evaluator can use these criteria as checklist for identifying gifted children in IT. (2)These criteria can be used in developing the evaluation questionnaire for use as a tool for assessing gifted children in IT. (3)A special education program can be developed based on these attributes and used for the education of gifted children in IT.

The most difficult part of extracting the characteristics of gifted children in IT was finding true IT talents. The problem lies in the lack of sufficient computer education, since IT is yet to be established firmly as part of the regular

education system in Korea. The gift of a child in a specific field can become clearer when he/she has more opportunities to access the field. Unfortunately, children's exposure to computer application is mostly limited to games and Web surfing even though Korea is an IT powerhouse. Therefore, there will be more opportunities to discover gifted children in IT earlier if they are given more experience through methodical IT teaching programs and contents.

Considering the pace of the change or life cycle of IT, it is very important to discover gifted children in I IT while they are young and foster them systematically. As mentioned earlier, the chances of discovering gifted children in IT are expected to improve through the nationwide recognition of the importance of computer science education and active support for systematic education.

This paper suggested the detailed assessment criteria for the evaluation of gifted children in IT by a teacher or an observer.

In the future, studies on the development of tools for the selection of gifted children in IT based on these extracted criteria as well as the development of education goals and programs for gifted children in IT are recommended.

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