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Some Factors Discriminating Mathematically Gifted and Non-Gifted Students[1]

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"This paper deals with factors discriminating mathematically gifted and non-gifted students. Discussion of some characteristics of mathematically gifted students is done in the first session. Several factors distinguish mathematically gifted from the non-gifted students. High mathematical creativity, high intelligence and opinion of teachers are some of the key factors that can be used for discriminating mathematically gifted and non-gifted students. Research studies have revealed that cognitive as well as affective factors will enhance giftedness. In this study the investigator wishes to look in detail about the characteristics of mathematically gifted students and how they can be identified. Anyway, teachers can change environmental factors and maximum outcome of giftedness can be ensured."

Keywords: high mathematical creativity, high intelligence, opinion of teachers, teaching method, environmental factors
ZDM Classification: C40, D40, D30
MSC2000 Classification: 97C40, 97D40

INTRODUCTION

Gifted children are the treasures of any nation. Any society needs able industrialists, scientists, educationalists and leaders of talent to represent the country and to meet the challenges of modern world. Gifted children are talented with novel and fruitful ideas and have the ability to invent new things for the betterment of the society.

Gifted students are the potential leaders for different walks of life if given proper education and provided suitable opportunities they can make significant contribution to

[1] This article is an extended version of the paper (Johny, 2008) presented at Topic Study Group 6 (Activities and Programs for Gifted Students) of the 11th International Congress on Mathematical Education (ICME-11) held at the Universidad Autonoma de Nuevo Leon (UANL), Monterrey, Mexico, July 6–13, 2008.

the overall progress of the society. First step in this process is to find out factors discriminating mathematically gifted and non-gifted students.

GIFTED AND MATHEMATICALLY-GIFTED STUDENTS AND THEIR CHARACTERISTICS

Learners who are gifted in Mathematics require special attention within the mathematics classroom. Due to their special abilities, some of them hardly adjust in the school and society and their talent is wasted. Special planning and educational arrangements are available for them at very few places only. Opportunities for these students to develop their talents usually do not arise spontaneously in their environment and need to be provided through careful consideration and planning.

Many authors have described characteristics of gifted and talented students, some in general terms across several domains, while others have described them for specific areas. The definition of giftedness is a socio-cultural phenomenon that varies from community to community. Lucito (1963) has defined that "the gifted are those children whose potential intellectual powers are at such high ideational level in both productive and evaluative thinking that it can be reasonably assumed that they could be future problem solvers, innovators and evaluators of culture if adequate educational experiences are provided to them."

According to Guilford (1967) the gifted are those students with multiple cognitive abilities involving creative talents and conceptual thinking, which are not measured by tests of general intellectual ability. Guilford remarked that traditional IQ tests assess only ability to think convergent; in other words, to deduce a single answer, either right or wrong. He proposed that more tests should be constructed to assess the potential for creative or productive accomplishment, such as tests of divergent thinking.

There is no universal definition for giftedness. Some professionals define "gifted" as an intelligence test score above 130, two or more standard deviations above the norm, or the top 2.5%. Others define "gifted" based on scholastic achievement: a gifted child works two or more grade levels above his or her age. Still others see giftedness as prodigious accomplishment, adult-level work while chronologically a child.

Terman (1965), in his famous longitudinal studies of the gifted, identified gifted as youngsters who scored at or above 140 on the Stanford-Binet scale.[2]

Many gifted children learn to read early, write early with better comprehension of the language. As much as half the gifted and talented population has learned to read before entering school. Gifted children often read widely, quickly, and intensely and have large

[2] http://en.wikipedia.org/wiki/Stanford-Binet_IQ_test.

vocabularies. Gifted children commonly learn basic skills better, more quickly, and with less practice. They are better able to construct and handle abstractions. They have well-developed powers of abstraction, conceptualization, and synthesis. They readily see cause-effect relationships. They often display a questioning attitude and seek information for its own sake as much as for its usefulness. They are often skeptical, critical, and evaluative. They are quick to spot inconsistencies.

Mathematically gifted children show some or all the above characteristics of gifted children. Mathematical talent refers to an unusually high ability to understand mathematical ideas and to reason mathematically, rather than just a high ability to do arithmetic computations or get top grades in mathematics. They exhibit special mathematical abilities and interests. Some characteristics of mathematically gifted children are as follows:

1. Mathematically gifted students are distinguished from their non-gifted peers by their exceptional reasoning ability (House, 1987).
2. These students may also exhibit an exceptional memory, the ability to solve problems in unexpected ways, success in identifying patterns and relationships and enjoyment from posing original problems (House, 1987).
3. Quickness in learning, understanding, and applying mathematical ideas.
4. Ability to transfer learning to new, untaught mathematical situations.
5. Preference for working abstractly, rapid learning and enjoyment from mathematical puzzles, activities and games.
6. They perform better on spatial, non verbal reasoning, speed, memory and mechanical comprehension (House, 1987).
7. Keen awareness and intense curiosity about numeric information.

In order to investigate how mathematicians create mathematics, Sriraman (2004) conducted a qualitative study involving five creative mathematicians. The results indicated that, in general, the mathematicians' creative process followed the four-stage gestalt model of preparation-incubation-illumination-verification. It was found that social interaction, imagery, heuristics, intuition and proof were the common characteristics of mathematical creativity.

Some mathematically talented students do not demonstrate outstanding academic achievement, display enthusiasm toward school mathematics programs, or get top grades in mathematics class. It is important to know that there are students like this, for their ability in mathematics is easily overlooked, even though they may exhibit other clues suggesting high ability in mathematics.

It has to be truly noted that there are so many cases of prodigies who are throne out from the schools and institutions. Einstein was four years old before he could speak and

seven before he could read. Isaac Newton did poorly in grade school. When Thomas Edison was a boy, his teachers told him he was too stupid to learn anything. Identification of gifted and talented should be done so carefully not to miss any of the prodigies.

IDENTIFICATION OF MATHEMATICALLY GIFTED STUDENTS

Renzulli (1977) depicted intelligence, creativity and task commitment as three necessary but not sufficient conditions for giftedness. Later, Sanders, Monks, van Boxtel, & Roelofs (1986) included a fourth dimension viz., social environment. Getzels & Jackson (1962) and Torrance (1974) found that when IQ is considered as the sole criterion of the identification of giftedness, about 70 percent of the creatively talented youth are missing.

In a year long research study of "supernormal" children in China, Zha (1985) found that strong cognitive interests and intellectual curiosity, concentrated attention and good memory, keen perception and power of observation, quick thinking good comprehension creativity and confidence, competitiveness and persistence as the five characteristics of "supernormal" child.

Whitmore (1985) found that gifted behaviour is characterized by highly creative behaviour in production of ideas, things and solutions, aspiration of high standard of achievement and desire to excel. Zha's exceptionally able pupils in China showed creativity, curiosity, persistence and self-confidence. Research studies have shown that creativity is an inseparable and inherent component of giftedness (Zha, 1985; Renzulli, 1977; Sternberg, 2006). The above research studies suggest that IQ and mathematical creativity should be used for identification of mathematical giftedness.

The research findings of Hong & Aqui (2004) suggest an apparent detachment between school mathematics and mathematical accomplishments. Not only are the identified mathematically gifted being neglected, there is a significant probability that some talented students are overlooked by current practices in school.

Often the earliest identification of gifted children takes place by simple observation of the child's behaviour by an educational professional, a parent or a friend. Parents are first teachers of every child. Glimpses of giftedness will be revealed to the peers and teachers who are in close contact with able children. Hence it will be reasonable to take the opinion of parents, teachers and peers for the identification of mathematically gifted children.

Affective, cognitive and motivational factors are extrinsically linked in the learning, achievement and creativity in mathematics. Motivation is that which prompts people to action. Whitmore (1985), Chan (1996) found that gifted students come to see them as

competent and thereby have greater achievement motivation. Stanley (1984) linked motivation to gifted behaviour in the classroom by referring it to the "academic hunger" of outstanding able mathematics students. Non-intellectual factors like effort, motivation, willingness to take risks, task-commitment, health, self-concept etc., also contribute to success (Chan, 1996; Fennema & Sherman, 1976; Whitmore, 1985; Singh, Granville & Dika, 2002).

According to modern trends of research in mathematics education, attitude towards mathematics is a very important construct to interpret student behaviour (Fennema & Sherman, 1976). In recent research, affective variables have emerged as leading factors affecting success and perseverance in mathematics and sciences (Singh, Granville & Dika, 2002). For good educational outcomes, there is a need to develop positive student attitude towards mathematics.

The objective of any mathematics curriculum includes fostering favourable feelings towards mathematics. Attitude of students towards the subject play a very important role in the way students comprehend the subject and the way they perform the subject.

Fennema & Sherman (1976) explains mathematics performance as merely an interaction of affect (attitudes and math anxiety tasks) and behaviour during learning tasks. Singh, Granville & Dika (2002) found motivation, interest and academic engagement as factors contributing to mathematics and sciences performance. The above studies conclude that there are certain affective factors like attitude towards mathematics, motivation in mathematics, self-concept in mathematics etc. which contribute to mathematical giftedness. Hence these variables can be considered for identification of giftedness.

The criteria that can be used for the identification of mathematically gifted children can be diagrammatically represented as four rings as follows:

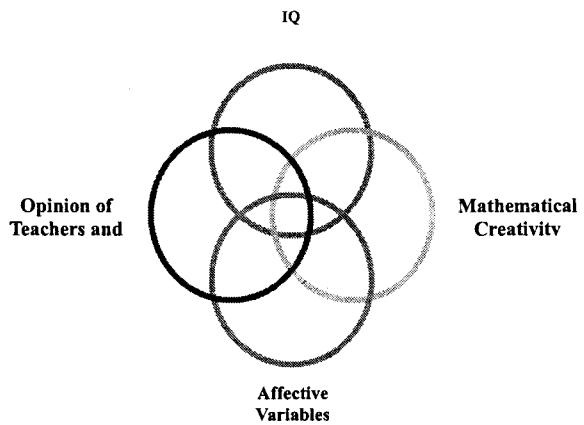

*Figure*1. Criteria for identification of mathematical giftedness

CONCLUSION AND RECOMMENDATIONS

Mathematically gifted students should be identified and encouraged properly. If teachers and parents can spot giftedness at an earlier stage, special activities and programs can be given to them. It is a commonly accepted notion that mathematically gifted students will have high IQ scores (Lucito, 1963; Guilford, 1967; Terman 1965). Apart from intelligence, mathematical creativity also can be considered as another factor for mathematical giftedness (Renzulli, 1977; Sanders, Monks, van Boxtel & Roelofs, 1993).

Along with this cognitive factors affective factors like attitude towards mathematics, self concept in mathematics and motivation in mathematics can also be considered as characteristics of mathematically gifted children (Singh, Granville & Dika 2002; Fennema & Sherman, 1976; Chan, 1996; Whitmore, 1985; Stanley, 1984). Parents are the first teachers and role models of most of the children. Hence they can identify the talents of their children at first. Teachers are friends, guides and guardians of children. Within and outside the classroom they can observe glimpses of giftedness. Hence opinion of parents and teachers also can be considered as another factor for identifying giftedness.

This study can be further extended by including the following features:

1. Apart from the above mentioned characteristics, other characteristics like mathematical reasoning and mathematical imagination also can be studied.
2. Formulation of an extended curriculum to supplement the normal curriculum can be done to meet the special needs of mathematically gifted children.
3. The effective use of ICT (Information Communication Technology) for fostering and enhancement of mathematical giftedness can be studied.
4. The environmental factors which promote mathematical creativity can be studied.
5. The role of teachers in promoting mathematical giftedness may be studied.
6. There can be a study to know how much the teachers are aware of special programmes and are they actually promoting and identifying mathematical giftedness.

REFERENCES

Chan, Lorna K. S. (1996). Motivational Orientations and Metacognitive Abilities of Intellectually Gifted Students. *Gifted Child Quarterly* **40(4)**, 184–193. ERIC EJ539218

Coleman, L. J. & Sanders, M. D. (1993). Understanding the Needs of Gifted Students: Social Needs, Social Choices and Masking One's Giftedness. *Journal of Secondary Gifted Education*

5(1), 22–55. ERIC EJ4944746

Fennema, E. & Sherman, J. A. (1976). Fennema-Sherman mathematics attitude scales: Instruments designed to measure attitude toward mathematics by females and males. *Journal of Research in Mathematics Education* **7(5)**, 324–326. ERIC EJ148896

Getzels, J. W. & Jackson, P. W. (1962). *Creativity and intelligence*. New York: John Wiley & Sons, Inc.

Guilford, J. P. (1967). *The Nature of Human Intelligence*. New York: McGraw-Hill.

House, P. (1987). *Providing opportunities for the mathematically gifted K–12*. Reston, VA: NCTM. MATHDI **1987f.**02689 ERIC ED281719

Hong, E. & Aqui, Y. (2004). Cognitive and motivational characteristics of adolescents gifted in mathematics: comparisons among students with different types of giftedness. *Gifted Child Quarterly* **48(3)**, 191–201. ERIC EJ696334

Johny, S. (2008). *Some Factors Discriminating Mathematically Gifted and Non-Gifted Students*. A paper presented at Topic Study Group 6 (Activities and Programs for Gifted Students) of the 11th International Congress on Mathematical Education (ICME-11) held at the Universidad Autonoma de Nuevo Leon (UANL), Monterrey, Mexico, July 6–13, 2008. Retrieved from: http://tsg.icme11.org/document/get/594

Lucito, L. J. (1963). Gifted children. In: L.H. Dunn (Ed.), *Exceptional Children in Schools*. New York: Holt, Tinehart and Winston, Inc.

Renzulli, J. S. (1977). The enrichment triad model: A plan for developing defensible programs for the gifted and talented. *Gifted Child Quarterly* **21(2)**, 227–233. ERIC EJ169896

Sanders, M. P. M.; Monks, F. J.; van Boxtel, H. W. & Roelofs, J. J. W. (1986). The identification of gifted children in secondary education and a description of their situation in Holland. In: K. A. Heller & J. F. Feldhusen (Eds.), *Identifying and nuturing the gifted*. Toronto: Huber.

Singh, K.; Granville, M. & Dika, S. (2002). Mathematics and Science achievement: Effects of motivation, interest and academic engagement. *Journal of Educational Research* **95(6)**, 323–332. MATHDI **2002f.**04806 ERIC EJ660154

Sriraman, B. (2004). The characteristics of mathematical creativity. *The Mathematics Educator* **14(1)**, 19–34. MATHDI **pre**02364182

Stanley, J. C. (1984). Use of general and specific aptitude measures in identification some principles and certain cautions. *Gifted Child Quarterly* **28(4)**, 177–180. ERIC EJ310145

Sternberg, R. J. (2006). The nature of creativity. *Creativity Research Journal* **18**, 87–98.

Terman, L. H. (1965). The discovery and encouragement of exceptional talent. In: W. B. Barbe (Ed.), *Psychology and education of the gifted-selected readings*. Upper Saddle River, New Jersey: Prentice-Hall, Inc. ERIC ED026762

Torrance, E. P. (1974). *Torrance tests of creative thinking*. Bensenville, IL: Scholastic Testing Service, Inc.

Whitmore, J. (1985). New challenges to common identification practices. In: J. Freeman

(Ed.), *The psychology of gifted children.* New York: John Wiley and Sons.

Zha, Zi-Xiu (1985). Psychological development of supernormal children. In: J. Freeman (Ed.), *the Psychology of Gifted Children: Perspectives on Development and Education.* New York: John Wiley.