

# 12th International Seminar of Mathematics Education

## Developing Creativity for Mathematically Talented: Past, Present and Future

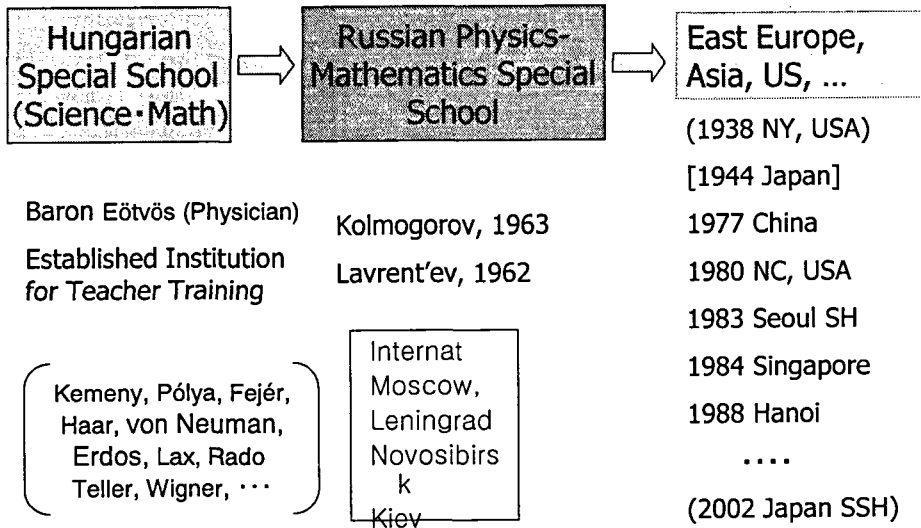
Seoul National University of Education, Korea  
10 Feb. 2007

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### Topics Covered

- A Brief History of Education for Mathematically Talented
- Present State: Some Cases from European, American, and Asian Countries
- Super Science High School (SSH) in Japan
- Future Perspectives and Challenges

## A Brief History of Education for Mathematically Talented



## A Century of Gifted Education

- At the beginning of twentieth century, popular respect for the intellectually gifted was not high. (Vogeli, B. 1997)
- The idiosyncrasies of genius were attracted people's attention.
- Public belief that gifted are peculiar : “Math nerds”, “Science geeks”, or “computer hackers” and so on.

## Psychological Research on the Gates

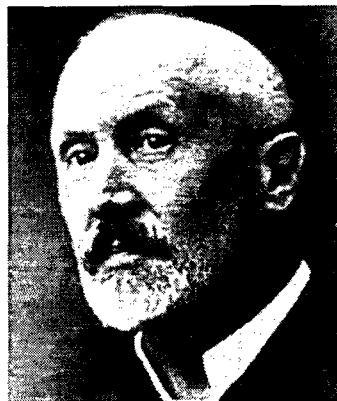
- Binet (1909) had recommended that special classes be established for gifted French children.
- Terman's study (1921) of 1500 gifted children refuted the public perception of relationship between intellectual gifts and personality.



Lewis Madison Terman

## Hungarian Origin of Special School

- Baron Eötvös became Minister of Education in 1894 led to the foundation of a special school for the mathematically and scientifically talented.



Baron Lorand Eötvös

- Eötvös believed that preparation of cadre of secondary school teachers as crucial for the advancement of the nation.
- He established Eötvös Jozsef Kollegium to increase the numbers of qualified teacher-scientists.

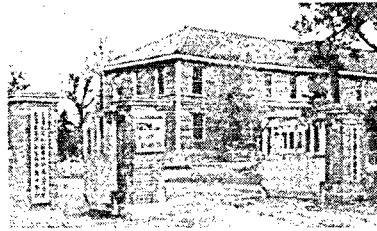


Eötvös Jozsef Kollegium

- Graduates of the Kollegium became teachers of gymnasias and offered superior mathematics programs.
- Lutheran Gymnasium was most famous. von Newman and Eugene Wigner graduated the Gymnasium.
- By mid-century, Hungarian gymnasias served as models for schools in the Soviet Union.
- In the last two decades of 20<sup>th</sup> century, Soviet schools inspired in school in the U.S., Korea, China, Vietnam, Cuba and other nations.

## First Special Science & Math Class in Japan

- Ministry of education established five special science & math classes in higher normal school in Dec.1944.
- Tokyo, Hiroshima, Kyoto, and Kanazawa.



特別科学学校 英林英館 金沢大学資料館蔵

## Student and Curriculum

- Student's are enrolled from 4<sup>th</sup> to 6<sup>th</sup> grades of elementary and Junior secondary (four years).
- Class size was about 20 to 30 students.
- By the end of junior secondary school, students were expected to learn content of 2<sup>nd</sup> grade of high school.
- At 7<sup>th</sup> grade, student learned exponential and logarithmic functions. At 9<sup>th</sup> grade, calculus (ex. differential equation).

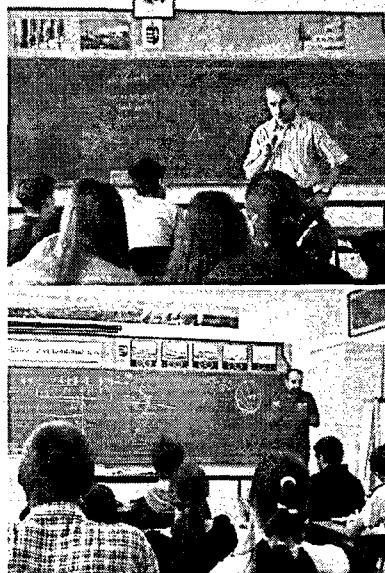
## Present State: Hungary

- Seven schools for mathematically talented were established in 1962. By 2001, number of schools increased to 20.
- At Present, Fazekas Gymnasium in Budapest occupies the first position specializing in mathematics.
- From 7<sup>th</sup> grades one class of 30 students are enrolled. More than 8 math lessons with 15 students in a week.



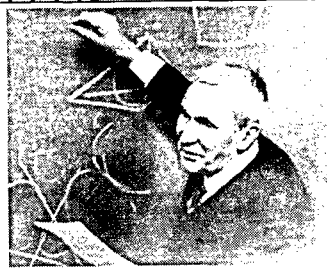
## Lessons of Fazekas Gymnasium

- 7<sup>th</sup> grade: Introduction of graph theory (normally elective topic in 11<sup>th</sup> grade).
- 11<sup>th</sup> grade: Contest problem.  $N$ th regular polygon which is inscribed unit circle. Prove that multiples of lengths of diagonal drawn from a point equals to 1.

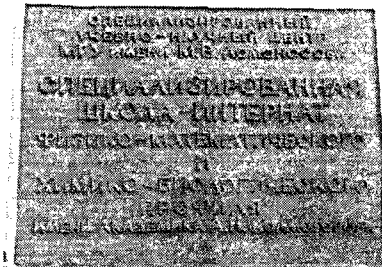


## Present State: Russia

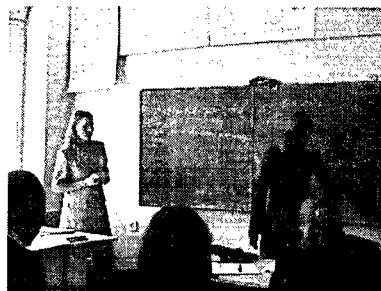
- Internat
- Specialized educational scientific center of Moscow University: Physics– Mathematics School named after A. N. Kolmogorov No. 18.
- Established 1963.
- Reorganized 1988.



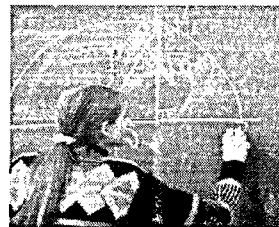
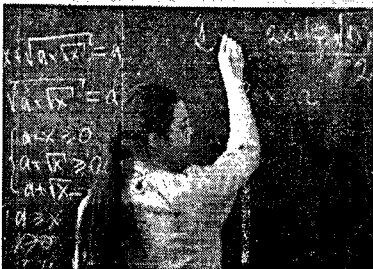
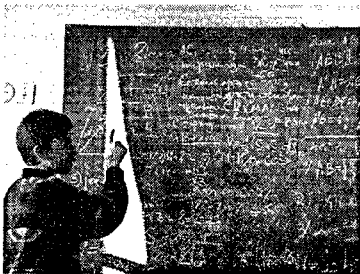
- Three Kinds of Activity (1) Internat for 11–12 graders; (2) Two Profile: Physics–Mathematics, Chemistry–Biology; (3) Curriculum & Program Development.
- 150 students and 150 teaching staff (100 full-time, 50 concurrent)



- Specialized Educational Scientific Center of Novosibirsk University: Physics– Mathematics School named after M. A. Lavrent'ev.
- Physics, Mathematics, Chemistry, Biology Profile
- 250 students and 50 mathematics teaching staff.



## Emphasis on Student's Practice





## Present State: Korea

1997: Gifted Education in Science & Technology

2001: Gifted Education Promotion Law

Elementary & Junior Secondary

2003.3 Pusan Science HS  
Gifted School for Science (1)

Science High School (16+1)

Center for Gifted Education (15)

Special Class

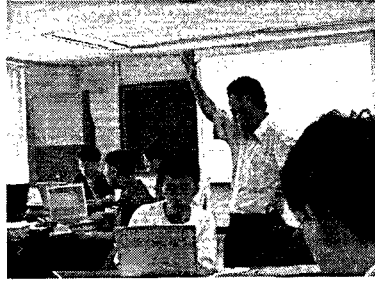
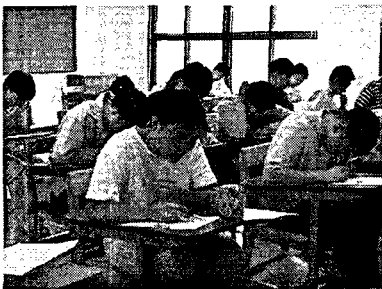
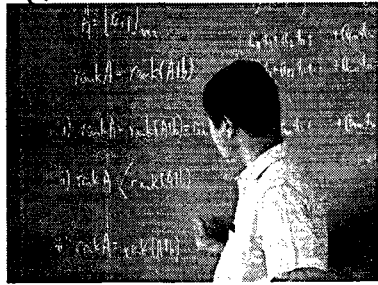
KEDI

## Seoul Science High School

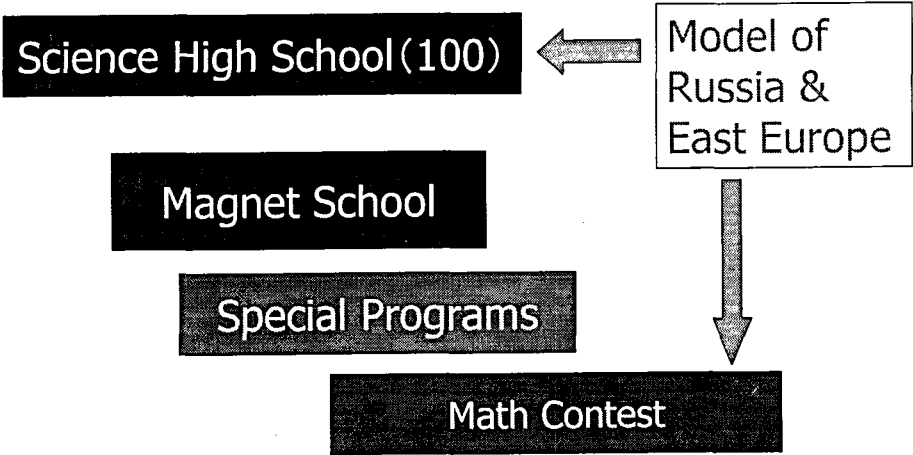
- Established in 1989 because of equalization of educational policy
- After 2<sup>nd</sup> years of study, about 2/3 of students enter KAIST et al.
- Mathematics II (compulsory) 14unit, Mathematics III 8unit
- Acceleration Program rather than Enrichment



# Pusan Science Academy: Lesson

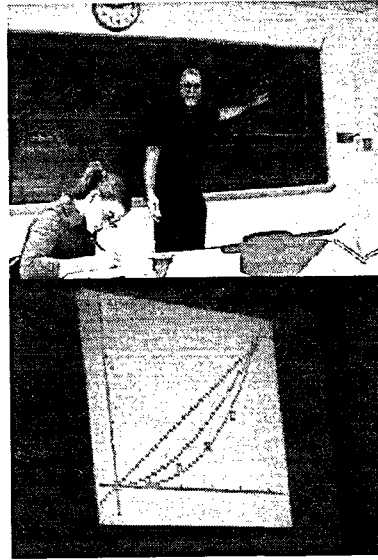


## Present State: USA



## North Carolina High School of Science and Mathematics

- First State-funded Boarding Science & Mathematics High School (1980)
- Both Enrichment & Acceleration Program
- Emphasis on Mathematical Modeling



## Lesson on Mathematical Modeling

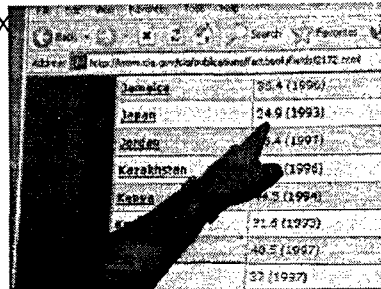
- Show a table of distribution of American citizen's income

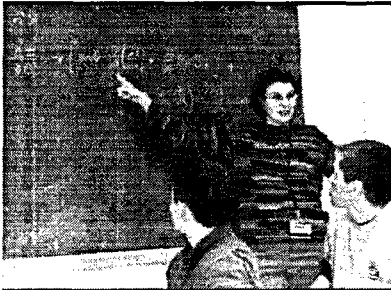
Income interval	20%	40%	60%	80%	100%
Income Sum	0.036	0.089	0.149	0.23	0.497

- $G$  = Area of difference between ideal distribution and cumulative income sum (Gene Index)

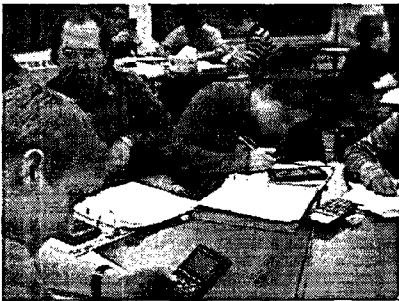
$$G = 2 \int_0^1 (x - x^n) dx = \frac{1}{n+1}$$

- In case of US,  $n = 2.485$ ,  $G = 0.426$
- Using ICT,
- In case of Japan,  $G = 0.249$





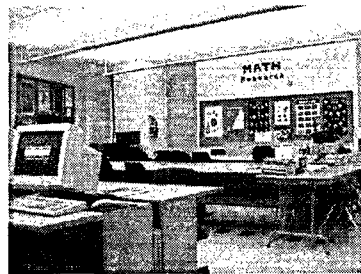
- NCSM
- ⇐ ■ Partial Differentiation (Chain Rule)



- IMSA
- ⇐ ■ Mathematical Investigations in Small Groups

## Special School in NY

- First Science High School in US: Stuyvesant High School (1938)
- "Independent Inquiry" covers Pure and Applied Mathematics
- Brooklyn Technical High School (1940's)
- Lessons on continued fraction and golden ratio
- Emphasis on student's interests in mathematics



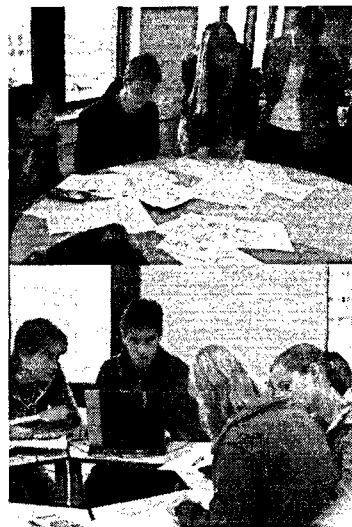
## Present State: The Netherland

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- There has been strong tension between “Math for Excellence” and “Math for All”.
- The Freudenthal institute of Utrecht university organizes unique mathematics competitions: Math-Alympiad and Math-B day. Math-Alympiad is for humanity orientation and Math-Bday for science orientation.
- Every students of last grade of secondary general school attend these competition.

## Math A-lympiad and Math B-Day

- One day in November, students of group of four or five tackle a set of problem from 9 am to 4 pm. They have to submit a report with solution to the problem.
- Problems are open ended and have close connection with reality.



## Present State: Japan

- We don't have special school for gates.
- From 2004, Ministry of Education started Super Science High School. 99 High School are nominated for 3 to 5 years.
- It aims at improvement of curriculum and
- It aims at education for the elite or high achiever in the field of science and technology, not for the gates.
- More emphasis is laid on science than mathematics.



### Who's playing against whom?

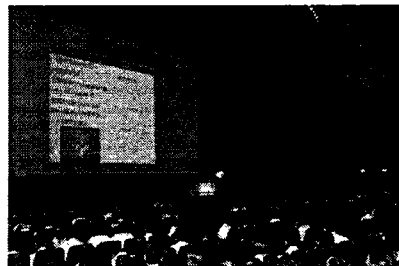


- *The tournament is being held in sports centre 'De Appelboom'*
- *A game lasts 20 minutes.*
- *In between games there is a 15 minute break, to rest, change playing fields etc.*
- *Each team will play no more than eight games.*
- *The tournament starts at 10.00*
- *Price-giving is at 18.00*

- ***FINAL ASSIGNMENT: THE GUIDE FOR HANS***
- ***Write a guide for making a playing schedule for tournament for Hans.***
- Hans wants to go to work on the schedule as soon as the number of entries is known. A book with playing schedules for all possible combinations of numbers of boys' and girls' teams would be ideal. But that is not feasible.
- However, the findings from the preliminary investigation give rise to making a guide which describes the *method* Hans has to use.

## Super Science High School

- Group of students engage in certain project or investigation as a part of curriculum in coordination with university.
- Twice a year, the group made their activity in session meeting and poster presentation.
- Selected group from each session meeting makes plenary session.
- Only one among four session concerns mathematical topics.





## Session Meeting on Mathematics

Investigation into Geometrical Design
ORIGAMI: A Mathematical – folded Container
Making of 3 Dimensional Kaleidoscope
On the Minimum Surface
On the Möbius Bundle (plenary session)
Graph of Functions and Complex Numbers



## Future Perspectives

- Harmonize enrichment program with acceleration program.
- Develop supporting system for special school and teachers, which include educational administration, research association, higher institution, NGO, NPO.
- Rethink of Content and Type of Contests or Competitions in the ICT environment (eg. Math-Olympiad and Math B-day in the Netherlands).