Mathematical abilities and life success

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Eleanor Roosevelt in 1930: “What is the purpose of education? This question agitates scholars, teachers, statesmen, every group, in fact, of thoughtful men and women.”
Goals

• Provide an overview of research studying mathematical abilities through a developmental perspective
• Find the key to life success?
• Study the link between mathematical abilities and academic success; high-rated employment (bigger salaries); socio-economic influence
Objectives

• Define mathematical abilities
• Understand the difficulty in defining life-success
• Measuring unmeasurable - “soft” outcomes
• Understand mathematical abilities as a brain function
• Give an overview of how to nurture mathematical abilities
Mathematical abilities

Learnt or inborn capabilities to process numerical data and conclude a mathematical calculation based on that data

Mathematics is empowering – discovering the wonderful feeling of knowing things for certain, the proverbial “mathematical certainty.”

Like music:
• a personality-building activity
• shapes the way the learner thinks and sees the world
• has a profound educational impact
• Depends on systematic, cumulative learning, and each new skill needs to be built on a solid foundation laid at earlier stages
Innate (inborn) ability

- Innate to territorial animals - ability to recognize quantity
- Widely spread in the population at large (social, ethnic)
- Different mathematical traits appear at different ages
Mathematics in brain - IPS

• All domains of mathematics (algebra, analysis, geometry, and topology) recruit a bilateral network, of prefrontal, parietal, and inferior temporal regions = region which is activated when numbers are mentally recognized and manipulated.

• High-level mathematical thinking makes minimal use of language areas and instead recruits circuits initially involved in space and number.

• Amalrica M, Dehaenea S. Origins of the brain networks for advanced mathematics in expert mathematicians. PNAS; 113 (18): 4909–4917. doi: 10.1073/pnas.1603205113
Predictor of success in preschool years

• Mathematical abilities = a manifestation of brain function.

• An indepth high-level mathematical thinking requires minimal use of language areas - it recruits circuits initially involved in space and number processing instead. Since these are the circuits which are active during early years of development, this could be the reason, why knowledge of number and space, already during early childhood, predicts later mathematical achievement.
Mathemathical abilities

A continuous spectrum:

• the top 20% in the school:

end up in: engineering, information technology, the financial sector, etc.
sufficiently large group to warrant the allocation of resources to be supported and nurtured within every school
we need some of the top 20% (and the best of them) to return to school as teachers of mathematics.

• top 1% in the school:

professional academic community, mathematicians and computer scientists, users of advanced “hardcore” mathematics in science, engineering, biotechnology and the financial sector
Life success

• Subjective notion
• SES, payment, educational level, happiness, drug consumption, number of children...
• What about if the higher you are on Maslow's hierarchy of needs, the better you are doing?
Literacy and numeracy problems have a robust structure of life course associations

• Prolonged education has significant long-term health benefits for all children, such as reduced risk of dying between the ages of 40 and 70 years of age, particularly from cancer, ischaemic heart disease, and accidents.

• Higher literacy and numeracy mean better health in general.

• Knowing that numeracy and literacy at school completion predict employability and wages in adulthood (basic quantitative and preliteracy skills at school entry presage numeracy and literacy at school completion) ->

• Mathematical skills for academic achievements, general health, and socioeconomic status on individual level.
Feelings of dread, fear of mathematics:
- psychological epiphenomena OR
- visceral sensation – such as pain

When anticipating an upcoming math-task, the higher one’s math anxiety, the more one increases activity in regions associated with visceral threat detection, and often the experience of pain itself (bilateral dorso-posterior insula).

Not during math performance but rather, the anticipation of math is painful.
Women are not for mathematics

• Women who believed their math skills were fixed and unchangeable showed less math identification and less interest in math tasks than women who believed their math skills were malleable.

• Women with fixed-trait beliefs are more likely to fall prey to the gender gap that exists in mathematics fields.

IQ + believing in malleable talent for math

- 3,520 students for five years — from 5th grade till 10th grade
- Performance measure on the PALMA Mathematics Achievement Test (basic arithmetic, algebra, and geometry).
- Self-assessment: study habits and interest in math.
- High-growth students believed they could get better at math the more they practiced and used in-depth study techniques.
- Students listed as low-growth were more likely to believe that math ability is something you're born with and it can't be improved, and they relied more on memorization when studying.

- BUT
- a high IQ generally meant a high math score!
- Intelligence is strongly linked to students' math achievement, but only in the initial development of competence in the subject
Mathematics prodigy

1970s USA researchers identified 13-year-olds who were exceptionally talented in math (the top 1 percent of mathematical reasoning scores on SAT tests) -> 40 years: wunderkinder are now midcareer:

“For both males and females, mathematical precocity early in life predicts later creative contributions and leadership in critical occupational roles.”

How to raise a genius: lessons from a 45-year study of super-smart children


The Study of Mathematically Precocious Youth (SMPY) founded by Julian C. Stanley, on 1 September 1971, at Johns Hopkins University. Camilla P. Benbow and David Lubinski co-direct SMPY at Peabody College of Vanderbilt University. https://my.vanderbilt.edu/smy/
How to nurture mathematical abilities?

- Sweden (large group experiment):
  - the government proposed new school system from 1949 to 1962
  - all 1.2 million children were set on one of two paths:
    - compulsory for 9 years or mandatory schooling for 8 years, with the most academically gifted children remaining in school for up to 10 years
  - -> new, prolonged education for all children in 1962.
- Because
  1) long-term health benefits - reduced risk of dying between the ages of 40 and 70, particularly from cancer, ischaemic heart disease and accidents. The two groups had an identical risk of dying before the age of 40
  2) longer schooling – higher literacy
  3) higher literacy – better health

Marcus Richards, a cognitive epidemiologist at University College London, followed two cohorts of British children, born in 1946 and 1958: the younger group, which had received an extra year of schooling owing to UK educational reform, had consistently higher literacy. (Other confounding factors?)
How to nurture mathematical abilities?

• The Munich Longitudinal Study of Giftedness
• 26,000 gifted students in the mid-1980s
• Cognitive factors were the most predictive, but that some personal traits — such as motivation, curiosity and ability to cope with stress — had a limited influence on performance. Environmental factors, such as family, school and peers, also had an impact.
• Smart mum: intelligence inherited by mum?
Chocolate consumption and Nobel Prizes: A bizarre juxtaposition if there ever was one

Mathematical abilities and life success

• Have a smart, high expectant, working and wealthy mum
• Have a healthy brain (no developmental delays)
• Have high IQ
• Eat chocolate – a lot of it
• Believe in malleable abilities
• Believe in Yourself
• Do chores
• ?
Just enjoy...