Exploring the genealogy of the concept of 'innate mathematical ability' and its potential for an egalitarian approach to mathematics education

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Shape of this paper

- Naturally good or bad at mathematics?

- This paper will provide evidence that all of us have an innate, natural ability to do mathematics to the highest level: we are all endowed with a 'maths gene'

- Begins with Kant , and moves onto Peuquet, Devlin, and Butterworth

- Conclude with discussion and suggestions

Immanuel Kant brought about a transformation in western philosophy the likes of which had not been seen since the ancient Greeks

The Noumenal and Phenomenal World

- We may speculate about the noumenal world, humans cannot 'know' it

- We can 'know' the phenomenal world because we have mediated access to this world through our senses.

Empiricism and Rationalism

- From the Empiricists Kant accepted that our senses provide access to the phenomenal world only

- From Rationalists he derived that the human knowing process is available innately, or, in Kant's term, *a priori*; unadulterated and without reference to human experiences and so 'pure'.

- His conclusion is that humans have a capacity for receptivity through the senses (content), and a capacity for conceptualising through the intellect (concepts). Both are universal and necessary for the possibility of human knowledge.

Innate Space and Time
- **The 'bridge' between the experienced world and the intellectual apparatus is human intiotions of *space* and *time***
- **These help us form expereinces (perceptions, impressions) into intellectual concepts**

Exploring Space
- external experiences are possible only with the *a priori* intuition of space
- Exploration of chiral objects: cannot be superimposed onto or does not coincide with its mirror image.

Moving on to Time

- All appearances ((sensed impressions) are connected to time and cannot be contemplated outside the substratum of time i.e. past, present, and future

Space and Time as the basis for geometry and number

- Kant connects the intuition of space with the more formal science of Euclidian geometry; and the intuition of time with number and motion (sequences, series)

- This is the source of the concept of 'innate mathematical ability'

Space and Time as Causality

- *… Causality is therefore not the succession of states in mere time, but … succession in respect of a particular space, and … in this place at a particular point in time. Causality … always concerns a particular part of space and a particular part of time,* **simultaneously** *and in union. Consequently, causality unites space and time* (Schopenhauer, 1818 p. 10).

Peuquet - Representations of Space and Time

- *All our senses are temporally extended…. [With regard to listening, which] is perhaps a more temporally extended activity that other senses… there is typically no single moment in which one hears anything, because sound waves themselves are a space-time phenomenon*

- Peuquet concludes that '*it does seem to be the case that spatial language encodes the world*'.

Devlin's – The Maths Gene

- The two faculties [mathematics and language] are not separate: both are made possible by the same feature of the human brain … [our] genetic predisposition for language is precisely what you require to do mathematics … thinking mathematically is just a specialised form of using our language faculty

Butterworth's – The Mathematical Brain

- Our mathematical brain … contains two elements: a Number Module and our ability to use the mathematical tools supplied by our culture

- Most of us are born to count, but beyond that the only established limits to mathematical achievement are … zeal and very laborious work.

Summarising the argument for innate mathematical ability

- Kant provides the basis for innate numbers and geometry

- Peuquet, Devlin, and Butterworth provide support for innate space, time, mathematics is integral to human language, and while we all have an innate ability to do mathematics it takes work.

Innate mathematical ability as the basis for a more egalitarian approach to mathematical education

If we:
1. Believe that students are capable mathematicians irrespective of the level at which we meet them
2. Provide a learning environment where students can unlearn the negative emotions
3. Then we can provide a more egalitarian mathematics education.

Discussion

Assessment of the basic argument – suggestions, questions, recommendations

If accepted, what are the implications for practice?