



Implementing the Mutualism Theory of Intelligence in the Classroom

COMMUNICATION | EDITORIAL | INVITED CONTRIBUTION | **PERSPECTIVE** | REPORT | REVIEW

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ABSTRACT

General intelligence, broadly defined as the ability to perform well on many and even seemingly unrelated cognitive tasks (e.g. maths and reading), is one of the most documented and empirically supported findings in psychology. Moreover, general intelligence has consistently been associated with important life outcomes such as educational achievement and occupational success. For instance, people with greater general intelligence (often measured by IQ tests) tend to get better grades in school and earn more income over their lifetime. However, despite the robustness of and cultural attention given to intelligence research, little is known about how it develops, especially in childhood and adolescence. In this Perspective, I introduce a theory of cognitive development known as mutualism, which derives its name and theoretical origins from the ecological interaction between two species in which each receives a net benefit (e.g. bees extracting nectar for nutrients from flowers in exchange for pollination). According to mutualism theory, general intelligence emerges from positive interactions between cognitive abilities such as reading and maths so that, over time, they become more related to one another. This would explain why people who are good at one task also tend to perform well on others. Lastly, I discuss possible applications of mutualism to education policy, particularly focussing on ways to improve the performance of students who struggle to learn in school.

The discovery of general intelligence and its association to important life outcomes

In the early 20th century, English psychologist Charles Spearman discovered that children (under 18 years old) who performed well in one school

subject (e.g. maths) also tended to perform well in other school subjects (e.g. reading), even if they seemed unrelated to each other [1]. In other words, performance on these cognitive tasks were positively correlated or associated with each other, which later became known as the ‘positive manifold’ of cognitive abilities. Furthermore, Spearman theorised that a single mental construct underlies these positive associations between cogni-

tive tasks, which he termed ‘general intelligence’ [1]. Since then, over 100 years of studies on human intelligence have not only replicated Spearman’s original findings but also suggest that general intelligence is a universal phenomenon, in spite of differences in how various cultures define it [2].

Moreover, subsequent research has indicated that measures of general intelligence, such as IQ, reliably predict numerous important life outcomes including educational achievement and occupational success. Specifically, higher scores on IQ tests were associated with higher performance on National GCSE/GNVQ public examination results [3] and larger gross income [4]. Together, these studies suggest that general intelligence, especially in childhood and adolescence, plays a pivotal role in successful attainment of important life outcomes, even after formal education has ended (e.g. in the case of occupational income). But how can these findings guide us in helping children who are struggling in school to learn better? Can educators improve general intelligence through cognitive training programs, which at best have yielded inconclusive results [5–8], or is there no hope for low-performing children?

In order to answer these questions and better inform policy, we need to look beyond simple correlations between IQ scores and life outcome measures and try to understand how intelligence develops in the first place. Only then can we hope to create viable interventions that can improve children’s general intelligence. This is where the mutualism theory of cognitive abilities comes in handy.

The mutualism theory of general intelligence

Despite the numerous theoretical attempts to explain the positive manifold, the nature of general intelligence remains one of the most outstanding questions in psychology. Crucial for such an account is an understanding of how general intelligence originates, specifically during childhood and adolescence. A hypothesis put forward in the psychological literature that has gained considerable attention in recent years is the mutualism theory of intelligence [9]. According to mutualism, various cognitive abilities such as maths and

reading are uncorrelated in the first few years of life. Put simply, general intelligence doesn’t necessarily exist in infants but rather arises over the first several years of development. The mechanism for the emergence of general intelligence borrows from the notion of mutualism found in ecosystems: ‘positive beneficial interactions’ [9]. Similar to how diverse arrays of species can interact and mutually aid in each other’s growth and survival, seemingly very different cognitive abilities (e.g. maths and reading) might interact and become increasingly correlated with each other during early development, eventually producing general intelligence.

While the scientific basis of mutualism is still being determined, initial studies have supported the theory. For example, in a large ($N > 500$) sample of adolescents and young adults (ages 14 to 25 years old), researchers [10] used advanced statistical models to test mutualism against competing theories of cognition, which was assessed by measures of reasoning and vocabulary. They found that starting higher in one ability (e.g. reasoning) led to greater increases in the other (e.g. vocabulary), and vice versa, over approximately two years. Their results suggest that reasoning and vocabulary skills directly and positively interacted with each other during development, in line with mutualism. Since then, this effect has been replicated in another study in a younger (6 to 8 years old) cohort [11] and rigorously verified in a large ($N = 1,800$) adult sample (ages 16 to 89 years) [12], suggesting general intelligence might still be developing even after adolescence.

Applying mutualism theory to education policy

Imagine a standard classroom comprised of young students (e.g. 8 to 9 years old), some with good grades, some with average grades, and some with low grades. Now focus on one of the underperforming (low grades) children who currently struggles in maths. This student is having trouble solving word problems involving simple arithmetic (addition, subtraction, multiplication and division). However, they perform well on exams that only test arithmetic. Moreover, they also score high on reading assessments. What does mu-

tualism suggest could be done to improve their academic performance in maths? One interpretation of mutualism is that a central component of general intelligence is developing the ability to synthesize information from disparate sources. In other words, it might be that this child is struggling to make connections between the arithmetic they are already proficient in and the new format (reading comprehension in the form of word problems) in which the maths is presented. Therefore, an approach could be to train this child in *reading comprehension* rather than continue to drill maths word problems. Doing so could help take their minds off their maths deficiency and refocus them toward something they're good at. Next, the child could be given another *maths word problem* that requires significant reading comprehension. Lastly, once the student successfully solves the maths problem, a teacher could point out to them that it was their *reading* skills that assisted them with their maths.

But what would such a strategy accomplish? First, by explicitly stating to the students the relevance of reading to maths, the teachers are establishing intellectual links between their studies. Second, doing this might boost their curiosity and motivation to further explore, especially if they already enjoy maths but just aren't confident enough in their abilities due to their low grades. Lastly, if this style of pedagogy is also done with other (applicable) subjects such as science, children might find ways to apply what they have learned inside the classroom to the outside world.

One way policymakers could implement this instructional strategy is to create a curriculum that is *inherently interdisciplinary*. This is different to how most present-day educational programs are structured, which teach individual subjects in a procedural fashion. Conversely, an inherently interdisciplinary curriculum would emphasise the use of *critical thinking*. Traditional subjects (e.g. maths, reading, etc.) would still be taught, but as foundational knowledge needed to integrate information needed for real-world problem-solving. It is vital that society doesn't view education solely as an academic endeavour. After all, most people spend most of their lives not in school but in the workforce. Therefore, students must find practical applications from school to the real world to be productive citizens.

In conclusion, recent studies have further demonstrated the influence of education in improving reasoning skills [13] and intelligence more broadly [14]. Thus, the education laws and policies we put in place have a significant impact on children's cognitive development. If policymakers provide teachers with additional training in interdisciplinary curricula and instruction, children should be better able to traverse islands of knowledge and see the 'bigger picture'. General intelligence organises knowledge into coherent networks, enabling further exploration. Classroom teaching, therefore, should be a main conduit in establishing such networks to promote curiosity and lifelong learning.

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About the Author

Ivan Simpson-Kent is a 3rd year PhD candidate in medical science (specialising in developmental cognitive neuroscience) at the University of Cambridge. His



research aims to understand how the brain and behaviour interact with each other during childhood and adolescence to produce intelligence. He plans to apply insights from his research to help guide education policy, especially for disadvantaged youth struggling to learn in school. In his spare time, he co-hosts a podcast called *Clever Ramblings* (available on YouTube), watches anime, and daydreams about his hometown of West Philadelphia.

Conflict of interest The Author declares no conflict of interest.