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Empowering Multi-disciplinary Policymaking with Systems Dynamics: The Return on Investing in Early Childhood Education

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ABSTRACT

The human sciences are maturing rapidly. Education policymaking must also mature. One method of ensuring rigor in policymaking is evaluating the return on investment (ROI). A major discovery in the human sciences is the importance of the first thousand days of life in shaping an individual's life. This period is neglected in educational policymaking and funding. This research aims to build an ROI model to support educational policy in the first thousand days. The research was done in two stages. Firstly, the literature on early childhood was reviewed and integrated to derive equations that describe the life-long impacts of early childhood. Secondly, a systems dynamic (modeling of complex systems) is constructed using Vensim® software. We propose a three-phase model: (1) rigorous adolescent teaching of emotional and social skills; (2) an "it takes a village to raise a child" strategy; and (3)a "parents as first teachers" strategy. We found that (1) Australian government agencies lack a coordinated strategy; (2) Education funding is primarily directed at supporting educational professionals and institutions rather than empowering and skilling families and communities. (3) More research on forgetting and loss of skill post-course completion is needed, and (4) Research into and awareness of complex systems can be fostered with easy-to-use systems dynamics software platforms. This research applies four powerful tactics for empowered educational research: (1) empowering individuals and communities; (2) education as operating in multi-disciplinary complex systems; (3) championing recent transformational discoveries; and (4) exploring the ROI of policies.

Keywords: Early childhood education, Multi-disciplinary research, return on investment, Policy Research, Systems dynamics.

Background

A golden age in the human sciences

Educational science development can be broadly categorized into two streams: (1) those on individual behavior and how learning occurs and (2) those on cultural and institutional behavior.

Thomas Kuhn (1962, 1970), in his influential theory on the history of science, proposed that long periods of slow, incremental development were interspersed with periods of rapid, explosive growth. He coined the term "paradigm shift" to describe the cause of latter periods – when a fundamental scientific conceptual change opens the mind to new viewpoints. One such new perspective was the discovery by Nicolaus Copernicus (1543, 2008) that the earth was not the center of the universe (as was the then-dominant belief in Western civilization), and today, we recognize the earth as merely a speck in a multitude of galaxies. Copernicus's different perspective spurred further discoveries by other scientists. These discoveries were applied to develop inventions and gave us the unprecedented wealth of the Industrial Revolution.

While Copernicus's paradigm shift led to breakthroughs in the physical sciences, Kuhn also identified a later paradigm shift by Charles Darwin (Darwin, 1885): the discovery of evolution. This paradigm shift freed scientists in the human sciences to study humans and their behaviors more objectively and as merely another species in many animals. Disciplines such as neuroscience, biochemistry, and endocrinology provide knowledge of the underlying mechanisms, while evolutionary biology, primatology, cognitive psychology, anthropology, and sociology provide knowledge of observed behavior. Integrating these diverse sources delivers robust and holistic insights. These discoveries are being applied to fuel dramatic change in practical fields such as medicine, economics, and computer science. However, education has been slow to exploit these discoveries. This paper explores the practical implications of one of these discoveries: that human development is not uniform, and it contains *sensitive periods* that can be exploited for rapid development but can also cause damage if poorly managed.

Research Objectives and Contribution

The theme of this conference is "Empowering education through research". We take the position that education is a practical discipline and industry and must thus be guided by its costs and the subsequent benefits it delivers. Unfortunately, education funding is rarely motivated by analyzing costs and benefits but by the desire to continue and expand historical practices and industries. This paper describes the potential for refocusing education based on recent discoveries in sensitive human development periods that promise to deliver substantially superior benefits at significantly lower costs.

As such, this research has two objectives:

(1) Design a set of educational interventions to exploit early childhood's sensitive period better.

(2) Construct a software model of the above design that permits other researchers and policy designers to explore the return from investing in these interventions.

This research contributes to the growing body of research that envisions education as a rigorous science that delivers tangible economic and social benefits to the individual, their immediate community, and the wider society.

Research methods and the structure of this paper

This research explores the future of education and its implications for society in a holistic manner. It is, therefore, appropriate to use the methods from the field of Futures studies - a multi-disciplinary field whose goal is to identify and design preferred futures. Substantial effort has been made to develop a robust toolbox of methods (Bell, 1997, 2003; Inayatullah, 2008; Jerome & Gordon, 2009) for this field. The methods that we use come from this toolbox. In previous work, the authors (Somasundaram, 2017, 2018; Somasundaram et al., 2022) identified sensitive periods as one of several important and underappreciated discoveries in the science of learning that have the potential to transform education. In the next (second) section, we briefly describe the current literature on the most important of the sensitive periods - early childhood. The literature was identified using the future studies method of environmental scanning (Gordon & Glenn, 2009; Voros, 2003). In the third section, we summarise current government education policy and systems. In the fourth section, we use the literature to design a three-stage preferred intervention that builds on existing systems. In the fifth section, we model the interventions using software that supports a method for modeling complex systems known as systems dynamics. Descriptions of systems dynamics and the reasons for selecting the modeling software for this type of work have been described by the authors (Somasundaram et al., 2022) and are not replicated here. The final seventh section discusses our conclusions and the limitations of this work.

Literature on the importance of early childhood

We identified knowledge from three types of sources as providing important knowledge regarding the goals of this research, each applying a defining phrase: (1) the phrase 'sensitive periods' from psychology; (2) the phrase 'the first thousand days of life' from medicine; and (3) the phrase 'it takes a village to raise a child' from culture and sociology. Our delineation of these phrases as arising from distinct fields is arbitrary, as researchers working on these topics realize their work is multi-disciplinary.

Psychology – sensitive periods

The critical impact learning has in later life was scientifically popularised by Conrad Lorenz in another animal species (Lorenz, 1937) - geese. He observed that baby geese established an attachment bond with a nearby object within hours of their birth and would later follow that object around in preference to their mother. Lorenz coined the term *critical period* to describe that window of time in which appropriate attachments needed to be formed with geese.

A half-century later, a similar issue was observed in human infants who were reared in an environment of intense social deprivation and were not removed from it before they were six months old (Rutter, 1998). The research indicated that the damage's intensity was based on the timing and duration of the deprivation. However, this damage is partially reversible with intense therapy, and sensitive periods rather than critical periods more aptly reflect that in humans, the impact of these periods is not absolute.

Further research has linked both adult (1) mental and (2) physical illnesses to both (1) chronic deprivation and (2) acute mental trauma in childhood (Zarse et al., 2019). The National Scientific Council on the Developing Child (2007) compares the occurrence to building a home:

The brain's basic architecture is constructed through an ongoing process that begins before birth and continues into adulthood. Like the construction of a home, the building process begins with laying the foundation, framing the rooms, and wiring the electrical system in a predictable sequence. It continues by incorporating distinctive features that reflect increasing individuality over time. Brain architecture is built over a succession of "sensitive periods," each associated with forming specific circuits associated with specific abilities. Developing increasingly complex skills and their underlying circuits builds on the circuits and skills that were formed earlier. Through this process, early experiences create a foundation for lifelong learning, behavior, and physical and mental health. A strong foundation in the early years increases the probability of positive outcomes, and a weak foundation increases the odds of later difficulties. (p5)

Better instruments and techniques now allow us to relatively non-invasively monitor changes in brain architecture. Figure 1 shows how synaptic density – the number of connections between brain cells -rapidly increases, peaks, declines, and then flattens out. The density of the visual and auditory cortices (areas involved with vision and hearing) peaks before the prefrontal cortex (associated with complex behavior).

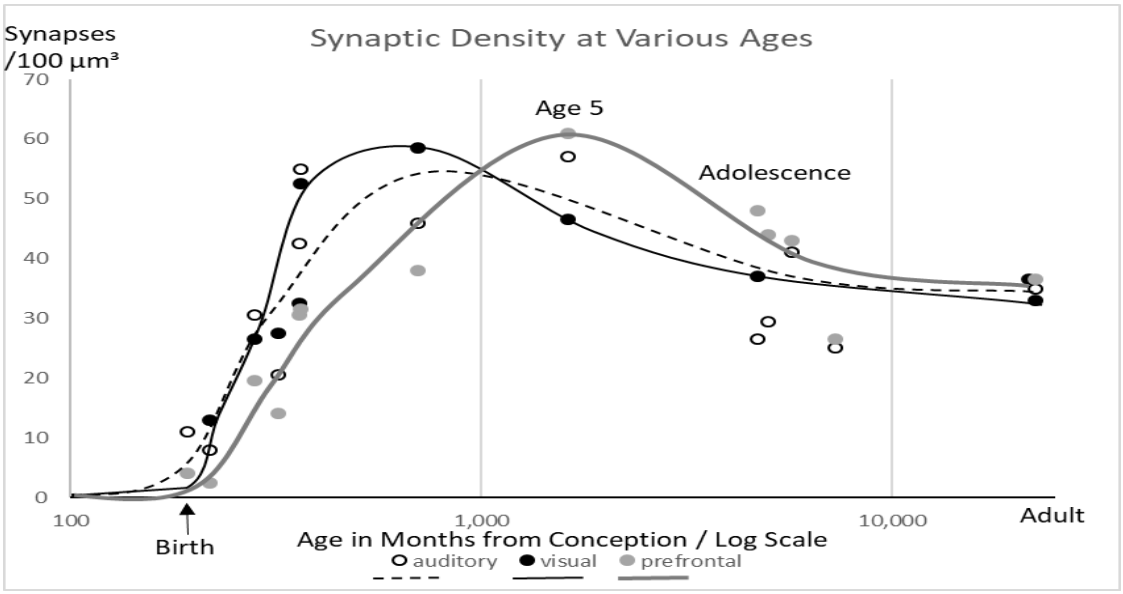

Figure 1. Synaptic density at various parts of the cortex at different ages. From Huttenlocher and Dabholker (1997).

The ability of brain cells to form, strengthen, and weaken connections between each other – called neuroplasticity - is life-long. Neuroplasticity is how we learn. Thinking results from a sequence of nerve cells firing in a meaningful pattern. When a chain of nerve cells fires, they grow stronger (due to neuroplasticity), and a reduced likelihood of firings diverting into less meaningful patterns. Thus, we can define a sensitive period as a biologically driven period of higher neuroplasticity substantially increasing learning impact.

Two issues should be noted. Firstly, a selective reduction in brain cell connections is also a form of learning since it reduces less meaningful patterns. Thus, efficient learning can occur when there is a biologically driven increase in synaptic formation and a biologically driven decrease in synaptic formation. Secondly, learning can also be harmful in the form of "learned helplessness".

Where a person learns to avoid seeking solutions to problems they could solve because they have been repeatedly placed in negative situations they have no control over ("a phenomenon in which repeated exposure to uncontrollable stressors results in individuals failing to use any control options that may later become available" ("Learned helplessness," 2023)). Three characteristics of learned helplessness are (a) a lack of motivation in tackling negative situations, (b) less learning from successful solutions, and (c) higher stress in negative situations. Educational interventions must be careful not to promote learned helplessness during sensitive periods.

The changes discussed so far can be described as nature building the brain for survival. Next to survival, nature's most important goal is reproduction, and two other sensitive periods, both targeting reproduction, are of interest to this paper: one occurs at puberty and the other during pregnancy. These periods are included in the interventions this paper proposes and are targeted in the policy design (section 4).

The First thousand days of life

The term 'the first thousand days of life is thought to originate from a US foreign aid strategy focusing on nutrition during the first thousand days:

Nutrition plays the most critical role in a person's life during a narrow window– the 1,000 days that begin at the start of a pregnancy and continue through the second year of life. The quality of nutrition during those 1,000 days can help determine whether a mother and child survive pregnancy and whether a child will contract a common childhood disease and experience enough brain development to go to school and work as an adult.

The science of nutrition points to a strategy. Suppose we target that brief critical period during which nutrition has the biggest impact and focus on improving nutrition for expectant mothers, new mothers, and young children. In that case, we can accomplish several things at once. We can save lives, help children start on a better path, and bolster economic development and learning.

US Secretary of State. Hillary Clinton (Clinton, 2010)

This insightful phrase caught on quickly in policy and research circles. It also expanded quickly, recognizing that the insight not only promoted adequate nutrition in developing countries but had a global relevance to parental drug use and other physical or mental trauma during maternal pregnancy. A report by the Royal Children's Hospital in Melbourne (Australia) entitled 'The First Thousand Days: An evidence paper' (Moore et al., 2017) and the article 'The First Thousand Days: early, integrated and evidence-based approaches to improving child health: coming to a population near you?' (Darling et al., 2020) in a British Medical Journal publishing group journal, reviews the field thoroughly.

It takes a village to raise a child.

The third insightful phrase is from a widespread African proverb ("It takes a village," February 13, 2023). Raising thriving children is extremely resource-intensive across multiple dimensions, such as nutrition, security, time, and skills. Social forces such as those driving mobility and a nuclear family disrupt traditional social support networks.

The article 'It Takes a Village to Raise a Child: Understanding and Expanding the Concept of the "Village"' (Reupert et al., 2022) in the journal Frontiers in Public Health provides a good review of current research and practice. The authors propose nine principles in a village approach.

Current policy and systems

Australia has two layers of government that deliver services of relevance: federal and state. Within each layer of government are three distinct areas: (1) education, (2) health, and (3) social services operated by distinct departments. Poor coherence and coordination across services often impact educational policy and systems. The descriptions provided below on the state-level systems are based on the Queensland system.

Education

The federal government's education department specifies its purpose as contributing "to Australia's economic prosperity and social wellbeing by creating opportunities and driving better outcomes through access to quality education" (Department of Education, 2023, p4). In contrast, Queensland's education department specifies a common national commitment to "equity and excellence in education – that all children and young people are confident, creative lifelong learners active in their community" (Queensland Government, 2022, p8).

Government funding of early education is primarily directed at supporting institutionalized services (at centers rather than in homes). The federal government calls the funding childcare (implying that a primary purpose of the funding is to provide babysitting services so that parents can work). In contrast, the state government system refers to it as early childhood. Both systems operate by providing funding if the center operates to certain standards. In Queensland, approximately 40% of children attend these centers.

Health

The federal government provides funding for primary care delivered by the private sector in a highly regulated environment. Primary care funding is delivered through a system called Medicare. The states provide hospital services. Health care is focused on the individual as a patient.

Social services

Social services are provided by state governments, with income support provided by the federal government. A principal focus of state social services is to respond to reports of children at high risk of harm.

Proposed design

We propose a three-stage strategy that builds on both current research and current systems: (1) Teach skills for achieving successful parenting delivered during adolescence (puberty); (2) Teach 'village-building' skills and support triggered by pregnancy; and (3) Teach 'parents as first teachers' skills delivered after birth. We base our strategy on the position that the purpose of education is to foster the skills for individual and community thriving (Cantor, 2021; Kristjánsson, 2017).

Adolescence is a sensitive period where the mind and body transform to achieve reproduction. Learning is enhanced due to neuroplasticity, and the relevant skills are immediately relevant and practicable to the adolescent. The specific skills we propose to teach during sensitive periods are summarised in Table 4.1.1 as outcomes: (1) building stable partnerships; (2) building strong social networks (villages); (3) maintaining optimal physical and mental health; (4) life planning and resource management. Adolescence is also a period during which harmful behaviors can be formed in both the individual and the offspring: (1) dysfunctional pair bonding, (2) substance abuse, (3) early and unwanted pregnancies, and (4) poor financial and resource management skills.

Village-building

Currently, pregnancy triggers only a health response – an assessment of the mother-to-be's physical health and treatment guidance for abnormal markers. We propose a substantive holistic assessment of the strength of the whole village and its capacity to support pregnant women and their children. We also propose a holistic plan integrating health, education, and social services.

Current Medicare strategies for (1) chronic disease management and (2) elder-care assessment and care delivery are examples of multi-disciplinary team-care approaches and are somewhat similar to what we propose. However, these Medicare strategies are (1) weak in applying educational techniques (instructional design and delivery methods) for skills development and (2) lack the authority to appropriate non-health resources.

Parents as first teachers

Childbirth represents a major transition in the skills and environment required for infants to thrive. While the previous period focuses on the mother's physical health and ensuring the village's building, the period after birth focuses on developing parenting skills and maintaining the village. The team-care systems can be continued throughout infancy and childhood as required to support and educate parents in their role as first and most important teachers.

Limitations

As George Box cautioned, "*All models are wrong, but some are useful*" (Box, 1979, p 2). Models are simplifications of a complex reality. It must be simplified to study reality, as there are far too many factors for them to be fully analyzed. The quality of a model is whether it captures and represents the most important elements. The model developed and described here explores the return on investment of different investment tactics for early childhood development. Our goal was to create a simple and easy model for others to understand, but sophisticated enough to represent some underlying principles and attract others to study further and contribute to the presented issues.

This paper draws data from the Australian education system. Other countries have different systems. While other countries have somewhat different systems and educational cultures, we believe that education systems have substantially similar structures, such that our model can be easily adapted for different countries.

Model description

System dynamics (behavior patterns over time) modeling and simulation are powerful tools for policy-making in learning science. It contributes to system thinking (approach) and analysis of a complex social system, its economic problems, and public policies concerning childhood education. Different policymaking approaches can be integrated through system dynamics that influence the development of technology and correct sciences and the application of computer simulation methods to analyze complex social science and systems.

The purpose of the model is to serve as an educational and research tool for developing the novel educational policies for early childhood discussed in section 4. It uses data from the current (2023 forecast) Australian economy. The model is shown in Figure 2. A user can increase the level of funding to each of the three strategies described in section 4 ((1) Adolescent Education (AE); (2) Village Building (VB); and (3) Parents as First Teachers (PAFT)) and observe the quantitative impact on an overall thriving outcome.

In the model, funding for these strategies will be taken from the national education funding and thus cause funding for traditional (existing) educational systems to fall (movement of the slider changes the percentage of educational funding allocated to that particular strategy). This would indirectly lead to a fall in traditional skills, and the lack of traditional skills can potentially reduce national earning capacity (Gross Domestic Product (GDP)). However, investment in the proposed strategies has the potential to improve traditional skills through improved learning skills and classroom behavior (and thus GDP) and improve national thriving.

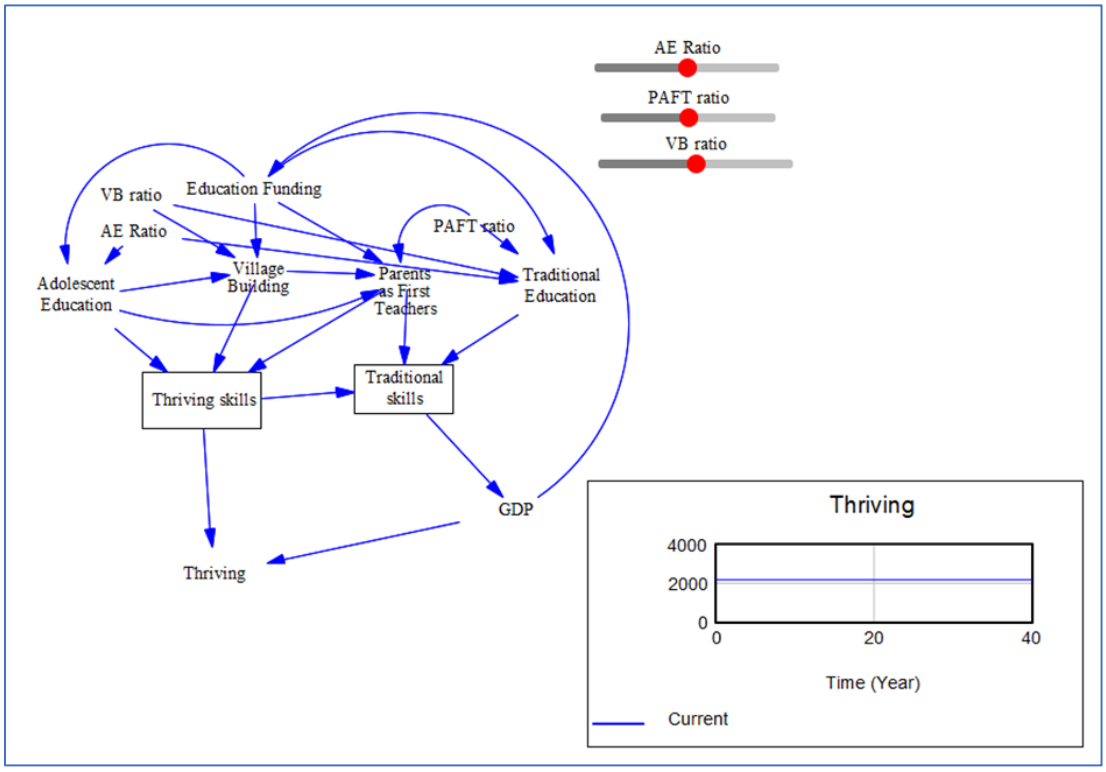

Figure 2. Graphical view of the systems dynamics model used to explore the Return on Investment of the proposed policies.

For those who wish to expand the model further, a copy that can be loaded onto a VENSIM platform is stored here:- https://drive.google.com/file/d/1jbE7sKa9YqcYy3IchDzX-oi1nAR_eF1i/view?usp=sharing and a table with the equations and constants are available here: - https://docs.google.com/spreadsheets/d/1kfOorCzGtVHvzjNm2uorDvCPkFhYitcA/edit?usp=sharing&ouid=104466710374660343241&rtpof=true&sd=true.

Discussion

Findings

From our exploration of the literature, in section 4, we propose a three-stage strategy of educational policy to target the severely under-funded area of sensitive periods in early childhood:

Rigorous adolescent teaching of emotional skills and social skills;

An "it takes a village to raise a child" strategy and

A "parents as first teachers" strategy.

Further, in undertaking this research, we found:

(1) Australian government agencies lack a coordinated strategy, which negatively impacts the education system. Federal and state educational departments have different goals for their educational policies. There is also fragmentation across the key services of education, health, and social services, as described in section 3. These services must be closely coordinated to be effective and economical. Robust public policy decision-making demands a robust return on investment analysis to justify public expenditure. Which strategy provides the better return? How much money should we invest in education? And is the money better spent on education or some other service? The purpose of this model is to explore these questions through quantified analysis.

(2) Education funding is primarily directed at supporting educational professionals and institutions rather than empowering families and communities with skills for autonomous learning (see also (Somasundaram et al., 2006)).

(3) More research on forgetting and loss of skill post-course completion is needed. We found very little educational literature on human forgetting. Understanding the gradual natural losses in skill that occur after course completion is essential if we are to achieve a better understanding of the value of educational programs.

(4) Teaching students easy-to-use tools such as systems dynamics models can enable research into and awareness of complex systems. This research found the software we used reasonably easy to learn and quite powerful. It is free for academic and research use.

Universities have crucial roles to play, influencing the next generation of parents and educators and fostering next-generation research methods for policymaking.

Implications

Scientific discoveries have the potential to revolutionize human thriving. However, we are discovering that our world is complex, and simple solutions based on reductionist methodologies

usually have limited success. Policies need to be both multi-pronged and consider life-cycle costs and benefits.

The first thousand days are the most impactful period in a person's life. But educational investment in this period is minimal. Reallocating educational resources to the first thousand days will mean reducing funding from other sources, which will be resisted by stakeholders negatively affected by such reductions. Therefore, significant effort must be invested in building a strong case and engaging stakeholders to embrace educational policies in the first thousand days of life.

Institutions evolve, shaped by the stakeholders with the most influence. Furthermore, as societies advance, their needs and capacities change. There is value in re-examining the purpose of education and whether existing institutions are meeting this purpose. In particular, if education aims to foster the skills for human thriving (including but not limited to the skills required to get good jobs), emotional and social skills are sorely missing from curricula and examinations.

Historically, research training and most research has been by individuals focusing on a narrowly defined research topic – what Ernst Boyer (1990) called the scholarship of discovery. Furthermore, as there is a global proliferation of universities, research students, researchers, and academic publications, narrowly scoped knowledge has expanded exponentially. This proliferation has caused greater sub-division and splitting of disciplines, often with their specialized technical terms. But complex, real-world problems are best solved by combining expertise from multiple disciplines, which Boyer (ibid) called the scholarship of integration. Modern researchers need the skills to use the methods of the scholarship of integration. Modern scholars also need the skills to work in multi-disciplinary teams. Current research training is not adequately addressing the skills needs of researchers investigating real-world complex problems.

Recommendations

Universities have the intellectual and structural capacity to influence and even lead society strongly, but we too often fail to live up to this capacity. Twenty-first-century leadership requires using twenty-first-century science to learn skills to find solutions to twenty-first-century problems.

This paper is a report on part of a broader research project on recent discoveries in the science of learning. In our previous papers (Somasundaram, 2017, 2018; Somasundaram et al., 2022; Somasundaram et al., 2019), we prioritize three major structural changes to education:

(1) Rigorously teaching the skills of self-regulated learning (which we suggest is more valuable than even learning maths);

(2) For post-secondary educational institutions to substantially reduce their costs by utilizing students' capacity for self-regulated learning and

(3) Designing and delivering educational models to better fit our neurobiological capacities and socio-economic skill needs.

The recommendations in this paper sit under the umbrella of the previous recommendations, and we focus on issues highlighted by the research this paper reports on:

(1) The purpose of education needs to be clarified and widely accepted. In this paper, we argue that the purpose of education is to foster the skills for thriving - that while the skills for economic success are necessary for thriving, our education system neglects other important skills (such as emotional and social) necessary for thriving. But neither we nor the educational industry has a right to decide the purpose of education – that is, the role of society as a whole. However, universities and education professionals can and should lead the discussion on the purpose of education.

The development of (a) emotional skills and (b) social skills are poorly taught by our educational systems even though they are essential, not only for personal thriving, but also success in most work-places, and most importantly, for building the skills and environment to raise our next generation successfully. While our paper argues for best fostering these skills from early life, higher education institutions should also mandate compulsory formal courses in emotional and social skills for all their students.

The contents of this paper can be used to develop a capstone course (a capstone course is a course near the end of a student's degree that builds on, integrates, and reinforces important earlier courses). Students from multiple disciplines, such as education, health, social work, economics, and information technology, could collaborate to build and extend the systems dynamics model described in this paper. Such a course has several major advantages: (a) it helps build the skill for cross-disciplinary teams; (b) it facilitates students' awareness of the complex, interactive nature of real-world issues; (c) students are the parents and community leaders of tomorrow, and this course will make them better aware of the skills and environment needed for successfully raising the next generation; and (d) students are a substantially underutilized resource and students' work on such a course can be used to extend and expand the contribution this paper makes to early childhood education.

Original contributions

This paper's principal original contribution is the explication of a three-pronged educational strategy that teaches adolescent children the emotional skills and social skills necessary for stable homes and integrates it with the strategies of 'it takes a village to raise a child' and 'parents as first teachers'. The paper also contributes to the literature on the whole-life modeling of the benefits and costs of education.

Conclusion

The theme of the 2023 SEAAIR conference was "Empowering Education Through Research" – a timely recognition of the value of research. This research applies four powerful tactics for empowered educational research: (1) empowering individuals and communities; (2) education as operating in multi-disciplinary complex systems; (3) championing recent transformational discoveries; and (4) exploring the ROI of policies. Both education and research are catalysts for a better society. Catalysts have the valuable property of enhancing activities without being consumed by the process. Once created, catalysts continue to contribute their benefits forever. Investments in both education and research multiply the effects of human efforts to thrive.

We conclude this article with a humorous drawing (Figure 3) of the first element of the proposed three-pronged strategy, one that draws from some of the elements of good teaching: that good

teaching engages multiple modalities, engages students' memory and attention, and is immediately applicable to their lived lives. Current research from the human sciences has the potential to empower and revolutionize education. We should not miss that opportunity.

Figure 3: Teaching students emotional skills and social skills. The best education engages students and is immediately relevant to and practicable in their lives. © (Kouwshigan & Somasundaram, 2020).

References

Bell, W. (1997, 2003). Foundations of Futures Studies, volume 1: history, purposes, and knowledge. *New Brunswick, NJ: Transaction Publishers*.

Box, G. (1979). Robustness in the strategy of scientific model building. In R. L. Launer & G. N. Wilkinson (Eds.), *Robustness in statistics* (pp. 201-236). Academic Press. https://doi.org/https://doi.org/10.1016/B978-0-12-438150-6.50018-2

Boyer, E. L. (1990). *Scholarship reconsidered: Priorities of the professoriate* The Carnegie Foundation for the Advancement of Teaching. https://files.eric.ed.gov/fulltext/ED326149.pdf
Cantor, P. (2021). All Children Thriving: A New Purpose for Education. *American Educator*, *45*(3), 14.

Clinton, H. (2010). *Remarks at CARE's 2010 National Conference and Celebration* https://2009-2017.state.gov/secretary/20092013clinton/rm/2010/05/141726.htm

Copernicus, N. (1543, 2008). *De revolutionibus (On the revolutions)* (E. Rosen, Trans.). Johannes Petreius. http://www.geo.utexas.edu/courses/302d/Fall_2011/Full%20text%20-%20Nicholas%20Copernicus,%20_De%20Revolutionibus%20(On%20the%20Revolutions),_%201.pdf (1543)

Darling, J. C., Bamidis, P. D., Burberry, J., & Rudolf, M. C. J. (2020). The First Thousand Days: early, integrated and evidence-based approaches to improving child health: coming to a population near you? *Archives of Disease in Childhood*, *105*(9), 837-841. https://doi.org/https://doi.org/10.1136/archdischild-2019-316929

Darwin, C. (1885). The origin of species by means of natural selection: or The preservation of favored races in the struggle for life.

Department of Education. (2023). *2022–23 Corporate Plan (varied) – Department of Education*. Canberra: Department of Education Retrieved from https://www.education.gov.au/about-department/resources/202223-varied-corporate-plan-department-education

Gordon, T. J., & Glenn, J. C. (2009). Environmental scanning. In J. C. Glenn & T. J. Gordon (Eds.), *Futures research methodology—version 3.0* (3rd ed.). The Millennium Project.
Inayatullah, S. (2008). Six pillars: futures thinking for transforming. *Foresight*.

It takes a village. (February 13, 2023). In *Wikipedia*. https://en.wikipedia.org/w/index.php?title=It_takes_a_village&oldid=1139104356

Jerome, C. G., & Gordon, T. J. (2009). *Futures research methodology Version 3.0* http://www.millennium-project.org/publications-2/futures-research-methodology-version-3-0/

Kouwshigan, R., & Somasundaram, J. (2020). *Transformative learning.* [Digital]. Colombo.

Kristjánsson, K. (2017). Recent work on flourishing as the aim of education: A critical review. *British Journal of Educational Studies*, *65*(1), 87-107.

Kuhn, T. S. (1962, 1970). *The structure of scientific revolutions* (2nd ed.). The University of Chicago Press.

Learned helplessness. (2023). In *APA Dictionary of Psychology*. American Psychological Association. https://dictionary.apa.org/learned-helplessness

Lorenz, K. Z. (1937). The companion in the bird's world. *The Auk*, *54*(3), 245-273.

Moore, T. G., Arefadib, N., Deery, A., West, S., & Keyes, M. (2017). *The first thousand days: An evidence paper*. The Royal Children's Hospital Melbourne. https://apo.org.au/sites/default/files/resource-files/2017-09/apo-nid108431_1.pdf

National Scientific Council on the Developing Child. (2007). *The Science of Early Childhood Development: Closing the Gap Between*

What We Know and What We Do. H. University. https://developingchild.harvard.edu/resources/the-science-of-early-childhood-development-closing-the-gap-between-what-we-know-and-what-we-do/

Queensland Government. (2022). *Equity and Excellence: Realising the potential of every student*. Brisbane: Queensland Government Retrieved from https://education.qld.gov.au/initiativesstrategies/equityexcellence/Documents/equity-excellence-booklet.pdf

Reupert, A., Straussner, S. L., Weimand, B., & Maybery, D. (2022). It Takes a Village to Raise a Child: Understanding and Expanding the Concept of the "Village" [Perspective]. *Frontiers in Public Health*, *10*. https://doi.org/10.3389/fpubh.2022.756066

Rutter, M. (1998). Developmental catch-up and deficit, following adoption after severe global early privation. *The Journal of Child Psychology and Psychiatry and Allied Disciplines*, *39*(4), 465-476.

Somasundaram, J. (2017, September 6-8). *A revolution in the science of learning: Higher education at the crossroads* 17th Annual conference of the South East Asian Association of Institutional Research, Singapore. http://www.seaairweb.info/conference/2017Proceedings.pdf#page=260

Somasundaram, J. (2018). Paradigms from the science of learning: An emerging revolution in education. *ASEAN Journal of Education*, *4*(2), 1-14. https://aje.dusit.ac.th/upload/file/Flie_journal_pdf_18-04-2019_090422.pdf

Somasundaram, J., Bowser, D., & Danaher, P. A. (2006). Pathways to lifelong learning: Transforming capitalist transactions into collaborative journeys. In *Lifelong Learning: Partners*,

Pathways and Pedagogies: Keynote and Refereed Papers from the 4th International Lifelong Learning Conference (pp. 291-296). Central Queensland University Press. https://research.usq.edu.au/item/9xzv8/pathways-to-lifelong-learning-transforming-capitalist-transactions-into-collaborative-journeys

Somasundaram, J., Danaher, P., & Rasul, M. G. (2022, Sept. 28-30, 2022). Applying recent discoveries to design a transformational new normal. 22nd annual SEAAIR conference: New Normal Education: Transitioning, Transforming, and Technologies Agenda, Seoul, South Korea.

Somasundaram, J., Rasul, M. G., & Danaher, P. A. (2019). Sustaining competencies and employability: A fishbone model for engineering education to fit the processes of life. *Journal of Institutional Research South East Asia*, *17*(1), 216-229. http://www.seaairweb.info/journal/JIRSEA_v17_n1_2019.pdf#page=227

Voros, J. (Ed.). (2003). *Reframing environmental scanning: A reader on the art of scanning the environment*. Australian Foresight Institute: Swinburne University. http://choo.ischool.utoronto.ca/FIS/respub/AFI.pdf.

Zarse, E. M., Neff, M. R., Yoder, R., Hulvershorn, L., Chambers, J. E., & Chambers, R. A. (2019). The adverse childhood experiences questionnaire: Two decades of research on childhood trauma as a primary cause of adult mental illness, addiction, and medical diseases. *Cogent Medicine*, *6*(1), 1581447.