Colloquium on Neuroscience in Education

Synthesis of Session

The goal of the meeting was to explore whether Neuroscience could inform not just the How, but the What, of education, in response to the CCR’s question “What should students learn in the 21st century?”

Preliminary Conclusions

I. **Physical activity** and exercise must be embedded elements of curriculum to produce the dynamics in the brain for effective learning.

II. **Perceived relevance** is critical to engagement for learning to occur; while internal and intrinsic motivation is optimal for deep learning over time, a preliminary level of relevance can be achieved through frequent explanation and situation of the content in the larger context for the learner. The difficulty is in determining relevance or saliency.

III. **Literacy/Language**

   a. is both functional and structural. It is an extension of our values and our culture—the learning of a second language beyond the structural acquisition creates an opportunity to gain prowess in social perspective-taking (“stereoscopic vision” analogy)—this is particularly true when the learner approaches the acquisition of a third language (triangulation).

   b. Learning a foreign language can force the brain to observe the differences and parallels between the two, and in particular force meta-thinking about the primary one. Also, since language is a tool—a literacy so you can perform in all the other disciplines, it may be the most neutral mechanism for developing “meta-learning” and “observer” abilities.

   c. Given the sensitive period of language acquisition, we can easily set the foundation for multiple language acquisition through basic exposure to multiple languages. It was believed that two languages of close linguistic distance could be mastered early, and that maximum gains would come from a third that is very distant linguistically (for example, English + Spanish or French, then Mandarin or Japanese).

   d. There is an intersection but no complete overlap between language and culture—culture has to be taught more deliberately. Three cultures seems to be a maximum for deep understanding, if only for time reasons. And while language acquisition starts early, cultural acquisition matures later

   e. The affordances of technology need to be explored further – in an age of automatic speech translation, the focus would be shifted on cultural and metacognitive benefits of foreign language acquisition.

IV. **Math**

   a. can be considered a ‘language’ just like spoken languages. The curriculum must be structured in a way that helps the learner not only learn the ‘phonetics’ and ‘vocabulary’ but also the culture, semantics, and language structures.
b. Traditional language/literacy has two sides of the coin: practices (spelling and phonics) as well as process (semantics and application through literature, cultural exchange, etc.). We traditionally have largely focused on the practices of math and ensuring the learner memorizes and understands these practices but less so on the processes. One of the foundations for acquiring the processes of math is through understanding non-linearity and system dynamics. As such, exposure and instruction to this must begin earlier (from statics to dynamics as an analogy), allowing for experimentation in Mathematics, as in Science.

V. Technology

a. has clear affordances, such as enabling us to experience phenomena that would otherwise impossible, or is vastly improved, through the technology (vizualizations, simulations, personalization, collaboration, etc). Given the influx and impact of technology, it makes an emphasized case for increasing the “meta” capacities of the mind, to be able to better regulate ourselves and our minds as we interact with technology.

b. Self-control of constant stimulations (email, SMS, etc.) and delayed gratification are two key areas related to this.

c. Of critical importance is enabling learners who can leverage technology, and just as critically, are able to also think without it—we must avoid “cyberphobia and cyberhelplessness”

VI. Meta-Learning

a. A key aim of any discipline is helping our students develop a feeling of the context of the field.

b. Developing an individual better capable of multiple perspective-taking. Frame the parameters in terms of the things we should NOT do, rather than what is optimal → this will allow us to go beyond completely useless ideological debates – we can not say what outcomes are ‘right’.
Elements for Further Research and Analysis

I. Physical Activity & the Learning Brain
   a. How much activity/exercise should we advocate for?
   b. Does the learner need to choose as to when/how this activity takes place?
   c. Does this activity differ from ‘play’? Do we have evidence to advocate for both, separately?

II. Relevance
   a. How can perceived relevance be increased? (i.e. what methods are effective for supporting this?)

III. Literacy/Language
   a. What does learning a language other than what is native for me derive? What are the secondary and tertiary benefits of learning a language?
   b. Is there evidence of skepticism through bi-lingualism?
   c. Does it matter which types of languages (structurally) the individual studies?
   d. Is there a studied connection between multiple language acquisition and social perspective taking (and therefore moral development?)
   e. Can computer languages ‘count’ as one of the possible languages to acquire if we seek triangulation?
   f. Number Sense is the conceptual foundation of the language’ of numbers that affects how well, and to what extent, all other math skills are built upon it; is there a comparable foundation in language literacy? If so, what is it?

IV. Math
   a. In light of the changes in the 21st century, what is the new “core” math for everyone?
   b. What ‘fault lines’ in the disciplines inform what we should teach? (for example, the demand of certain math concepts needing to be taught earlier to inform physics)
   c. Should some math and engineering be fused? (for instance, high school robotics)
   d. How might curricula begin as discrete disciplines and fuse/integrate over time?
   e. What is the value of teaching about complex systems?

V. Technology

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a. What cognitive elements are most critical in an age of the “digitally augmented brain”?

b. What are the negative impacts of technology and how do we design around them?

VI. General

a. Can you gain breadth more quickly if you learn something deeply first, does that expertise give you a mental model which you can generalize?

b. What are the key developmental learning pathways that need to be mapped?

c. How do we structure into the redesigned curriculum, multimodality (i.e. advocating for visualizations early on)?

d. At what level does it make most sense to move from linear to non-linear?

e. Do we have to construct the ‘meta curriculum’ in an abstract way? Or can we make a generic pathway where any content can be plugged in?

f. How does neuroscience promote a “dimensional” view of the learner, rather than a deficit or ‘labeling’ paradigm?

g. What type of learner operates best in a constructivist setting? What best serves their needs?

h. How do you maximize time through layering in elements in interdisciplinary study? It can empower things (by allowing students to more easily communicate) or slow things down significantly depending on how the teachers are able to use it.