Chapter 22. Does the science of learning matter?

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Society has changed. The change is fundamental, that young people are facing a VUCA future, volatile, uncertain, complex and ambiguous. The conventional role of education, which prepares people for lifelong credentials towards definitive jobs, is being challenged. Young people have to learn to learn, in order to adapt to ever changing circumstances, to survive and thrive, but then we have to know much more about learning, hence the Science of Learning. Meanwhile, the development of non-traditional modes of learning has also placed urgent demands on the understanding of learning. Nonetheless, principles established by Science of Learning have to be made simple and available to teachers and parents.

The foregoing chapters, written by scientists who specialise in the science of learning, have provided many ideas about the newest findings and their implications for policy. In this chapter, I write not as an expert on learning science, or the science of learning, but as a person focused on education policies and reforms. My goal is to fill the gap between macro policies and micro activities on the educational frontline.

Science of learning: Why now?

I regard learning as the core business of education. Yet educators know little about how human learning works. People often ask, "Do we need a science of learning? What difference would it make?"

I believe that learning is a human instinct, but education is not. Education is what adults design for the younger generation to produce systematic learning. As a human design, education inevitably bears with it the economic, social, cultural, political and/or religious inclinations of the time and place the design is made.

The education systems we have today, represented by contemporary schools, started only in the mid-19th Century. There is a common notion that schools as a national system started in 1870 at the enactment of the British Education Act.

It does not mean that there were no schools before that. I have seen Buddhist schools, with hundreds of years of history, in Myanmar, Laos and Cambodia, where children attended as novice monks, and could choose to stay in the monasteries after a certain period of study. The primary activity in the Buddhist schools was memorising and chanting Buddhist scripts. However, contemporary Buddhist schools also teach a full syllabus – Language, Mathematics, Science, English – not very different from any other school. However, one major difference from other schools is that their primary concern is the development of the child. People believe that Buddhist schools are where young people are purified, often seen as an essential stage of personal growth. Young people live under strict discipline and modest living conditions, as a way of training them to be a "good person".

I have also seen Madrasa by the side of Mosques in Central Asia and other Muslim countries, where students reside and study. Koran is basic to their study, but their curriculum includes Local Language, Arabic, Mathematics, Science and sometimes English. The curriculum is not very different from any other modern school, but the primary aim of the schools is to cultivate a close relationship between the students and Ala.

With different religious accents, in both the Buddhist schools and the Madrasa, the focus is on people. This is rather different from the modern schools. I was inspired by the school in Sturbridge, Massachusetts, in the United States, supposedly a tourist site, where people live the life of 1836. It was among the first schools in the United States. I played a student, attended the class and chatted with the teacher. "Why did young people come to the schools?" I asked. "Oh, they wanted to find a job in Boston. Therefore, they had to learn: to read and write and calculate" was the answer. This is perhaps how contemporary schools were established – for knowledge and skills to fit available jobs in the workforce.

Ever since, education policies in most countries, with only rare exceptions, are formulated as part of an economic discourse. Up until now, people related the development of education to GDP growth and global competitiveness at the national level, and employability at the individual level.

What is wrong with this? The economic discourse perhaps is a perfect match to an industrial society. A typical industrial society prospers on mass production. With the principles of

division of labour, by way of carefully designed systems of bureaucracy (i.e. layers and departments in the organisation), people work in departments and tiers. The lowest tier hires labourers where knowledge is not necessary, and they have to handle only very simple skills. Through meticulous designs, the production lines integrate all these simple skills and come up with a very sophisticated product, which then are produced in mass quantities. It is an efficient pyramidal structure of manpower.

The pyramidal model of the organisation also shapes society, which is also a pyramid, and forms a pyramid of knowledge. The army of frontline workers may have little knowledge, but over the tiers, the upper layers require more knowledge. The chief engineer, who designs whole systems, should be the most knowledgeable.

This idea has also shaped the education system. Classification, ranking, screening, selection, have become the social objective of the education system. In a way, the education system, with no shame, is a mechanism that turns human beings into human resources. A more cynical way to say this is: Students are tortured until they confess to the labour market!

It is therefore understandable that people often take schooling for education. In our parts of the world, where population density is high and school choices are plenty, people compete for admissions into the "best" kindergartens, then to the "best" primary schools, "best" secondary schools, then to "good" universities, until they secure a "good" job. Hence, the call for "school readiness" for kindergarten, "college readiness" for high school, all the way to regard colleges for "career readiness".

I have taken a long path of argument in order to delineate a picture of a typical industrial pyramid, but also to illustrate that this kind of pyramid approach is fading away.

In 1999, when Hong Kong launched an overhauling education reform, I decided to look at the workplace in which our students would end up. I did this with the overall belief that the primary aim of education is to prepare young people for their future. I was shocked to find that the workplace has changed so much that it is no longer recognisable. Further tracing the changes, I believe that the change is comprehensive, irreversible and global.

There is no intention to elaborate the changes here, but I will mention the dimensions. First, the economy has changed. Instead of producing for demands, industries now compete to create demands (or, more accurately, to create desire). Second, in doing that, and in the general context of oversupplying, production aims at "less of more" – less quantity, more variety – and produce customised, tailor-made, personalised products and services. Third, in that context, large bureaucracies are gradually giving way to "one-stop" small units; organisations are therefore becoming smaller, flatter, looser and more fragile. Fourth, Individuals are now working under very different conditions. Frontline workers have to face clients, make decisions, design products or solutions. They have to innovate, to shoulder personal responsibility, to run risks, to face ethical challenges, and so forth.

Education versus learning

In other words, people are no longer protected by the organisation. Unlike in a typical industrial society, credentials prepared a young person for a job, and he or she could be in that job for ever. Now, individuals are largely on their own. Credentials no longer give them lifelong guarantees. Overall, obtaining a credential, which is more or less what schools are about, is no longer sufficient preparation for life.

Meanwhile, individuals face all kinds of changes. They change jobs and occupations much more frequently. Even in the same job, the organisation can change or disappear. The product, the clients, the market, the technologies, can all change, and change very rapidly. With the challenge of rapid change, individuals have to survive, to succeed, if not to lead.

They have to learn! They have to learn continuously! And here comes learning!

This is how the overhauling reform in Hong Kong's education came about at the turn of the Century. This is also the line of thinking that underpins noticeable education developments in jurisdictions such as Singapore and Shanghai, and also in systems such as Ontario, Canada. Two elements are essential to make education reforms meaningful – awareness of the change in society and focused attention to learning.

Example 1 – Learning Chinese

I had the opportunity to encounter the Science of Learning, and tried to compare it with practices in education, and I was again shocked. I have come to understand that education, as we have traditionally known it, is not always conducive to learning. At times, what is practiced in education may even hinder learning.

Let me spend some time and explain an example of reform in Chinese language learning, attributable to my colleague Professor Brian Tse. It is not difficult to know that learning of Chinese characters, the rare species of ideographic script in the world, is not easy. One of the typical practices in teaching the Chinese characters is dictation – the teacher gives the students a passage of, say, 100 characters, students are asked to practice and memorise them, for example overnight, and dictate these characters the next day.

Tse queried such a practice in which students rote-learn the passage. The motivation for students is to get high scores from the teacher. This is not how people effectively learn. Instead, Tse used "creative dictation". Each student is given a large piece of white paper, with a theme written in the centre of the paper, such as the word "SPRING" for a second grader (7-8 year-olds). Students are asked to write, around the central theme, words relevant to "Spring". There is no limit to how many they write, but they are expected to produce at least six. Each word (often comprises two to three characters) will be given three marks, and there is no punishment for mistakes or errors. Students are encouraged to identify these words in whatever way they can – from books, from newspapers, from parents – as long as they are relevant, or even remotely associated.

In the end, a student may produce a few dozen words. The example shows a student's work of 53 words, involving over 100 characters. The work the student produces actually represents a mental lexicon, where the characters are mutually associated in meaning.

In the whole exercise, the students are active learners. They compete to do more, and find interest in their work. It is their creation. They own the learning. They learn the characters in context, with meaning. The lexicons are constructed by individual brains and they reflect individual undertaking. Diversity is not only allowed, but also cherished. All these features echo the principles of the Science of Learning described in this book.

Teachers may be sceptical of the method, because there is no control over what characters students will learn. However, clever teachers capitalise on the diversity and ask students to work in groups of five, for example, and select from the five papers, say 30 characters to be recommended to the whole class. The process gives the students the opportunity to examine the total number of characters in a group, and learn from additional numbers from other groups' recommendations, and so on.

The process takes much longer than just a few minutes in traditional dictation, but students are rewarded by their very fruitful learning of a large number of characters. More importantly, they are masters of such a learning process. The most important thing is that their attention is focused on the characters, rather than whether or not they fit the teacher's expectations, and get high scores.

This is an illustration of the power of the Science of Learning when compared with the traditional way of teaching Chinese. There has been basically an analytic paradigm. Students are taught to start with characters, which are building blocks of sentences. And in order to learn characters, they have to start with characters of fewer strokes. However, some of the characters with fewer strokes could be rather remote from children's lives. Yet, some of the characters with many strokes, which are difficult to write, are easy to recognise as a picture, which makes much more sense to the children. Hence the analytic approach goes against students' effective learning processes.

Brian Tse's "creative approach" to learning Chinese extends to reading (starting from stories rather than from simple words) and writing (starting with diaries), with small kids in their very early years of schooling. In the end, children under this approach can master about 2 500 characters, which is sufficient to read newspapers by the end of Grade 2. By Grade 5, they are ready to read thick novels in Chinese.

Tse's method was supported by the Education Bureau and was implemented fully. In the end, Hong Kong's performance in PIRLS – an international comparison of reading literacy – escalated from the world's 14th in 2001 to 2nd in 2005. This further reinforces the government support of the approach. Brian Tse has since become a consultant to governments such as Singapore, Taiwan and Korea.

Example 2 – Teaching of Tort Law

There is another example in higher education, the teaching of Tort Law. The conventional way of teaching a law course is to start with theories, followed by cases, overseas and local, which help to illustrate the theories. My colleague in law, Professor Rick Rofcheski, took a different approach. Rofcheski starts by introducing students to the basic concerns of Tort, and asks them, from the very beginning, to (a) scan newspaper stories, and to do a brief trial analysis of three such stories wherever they found them relevant to Tort, and (b) walk around the city and take photos of whatever they see as relevant to Tort.

This produces a fundamental difference in students' learning. First, they pay attention to local news and local society, which is basic to professionalism in law. Second, they start with a notion that knowledge of law does not start from the book or from the professor, but from social reality.

Rofcheski chooses some cases for illustrative analyses in class. As the course proceeds, students are asked to do more in-depth and elaborate analysis of cases, again on newspapers. Students select a few such analyses for submission as assignment at the end of the course.

People would think such practices are possible only with intensive resources in small classes. To everybody's amazement, the class is with 250 students. A typical scene is students, in groups of five, work together in an assembly hall. With the help of a digital platform, all students are exposed to hundreds of cases analyses, from their own experience, with the teacher's analysis as guidance.

Rofcheski is not keen to mark and correct each and every one of the students' work. He marks only the minimum required for scoring purposes. The final examination is again a real case. The real case may be open to diverse analyses, and there are cases where there is no perfect solution. "The students should always work in reality", Rofcheski emphasised.

The drama surrounding the examination, which is a traditional sit-down examination, as required, is that he opens up discussion of the cases immediately after the examination, right on the spot.

Students love the course. They learn in a lively way and they learn deeply. All the way, through the eight-month course, despite the workload and constant group work, students develop insights into Tort Law, creating views that are sometimes beyond Rofcheski's original thinking.

Again, here, students are the masters of their own learning. Based on their respective observations of social reality, they produce diverse cases for analyses. That way, the concepts (or theories) they learn transcend individual cases. They learn in groups. And, they are assessed not by what they know, but by what they can do.

Gist of learning

So, what is learning? Learning is often taken for granted. People often take education, learning, and even study as interchangeable synonyms. The above two cases refer to education or study in areas that are common in the education system. However, they depart from the teaching conventions in a number of ways.

First, these practices put students into the position of active learners. Second, students learn by creation, producing the mental lexicon and the case analyses. That is, they form concepts or knowledge during the process of creation. These are processes of knowledge construction. Third, they position student learning in real life applications, hence they provide students with fertile soil for self-motivated learning. Fourth, they trust students, tolerate and embrace diversity, and believe that nitty-gritty rights and wrongs are not the major concern. Fifth, they have therefore distracted students from scores and marks, and hence developed learning targets which is not due to teachers' expectations. Sixth, they all emphasise group work.

As I made clear from the outset, I am not a scientist of learning. However, I believe that if learning is the core business of education, then policy workers should also have a sound knowledge of learning. Until now, there are relatively few examples of study on the genuine outcomes of student learning. A large percentage of research on "teaching and learning" often lead to examination scores as proxies of learning. While the notion of "learning outcomes" looms high, measurements about learning outcomes are often based on very narrow concepts defined by formal examinations and scores. The actual learning process, about what goes on in the learner's brain remains a black-box.

There are often subtle assumptions which are not based on any scientific exploration, but are commonly believed. For example, there is still a belief that knowledge is transmitted, like a liquid, into students' heads. There are still TV advertisements where babies would "absorb knowledge like a sponge". There is still the belief that theories should precede practice. Hence, even science teachers may think lessons are for students to learn the theory, and experiments are just to verify theories.

There are also assumptions that go without challenge. For example, asking learners to follow analytical procedures in order to achieve, or, to believe that schools should be "pure"

institutions "clean" from social reality, with real experience in society coming after schooling. As a third example, even when group work is introduced in some of the learning sessions, assessments are still based on individual tests.

The foregoing observations do not fall into anyone's specific territory. It is not typical for scientists of learning to detect the deep paradigms that dictate educational practice. It is even more difficult for teachers to reveal what has become part of a culture in education, previously unchallenged and unquestioned.

This has led me to try to summarise what I understand, albeit constrained by my limited knowledge about the Science of Learning. Running the risk of over-simplification or distortion, I have settled on the following general principles:

1. The fundamental

    o Human brains are plastic.

    o Human activities shape the development of human brains.

2. Learning as sense-making and knowledge construction

    o Learning is making sense of the world external to human beings. A new-born girl sees all and hears all, but these impressions make no sense to her. Only after her interactions with others does she begin to form a concept of things she sees and hears. Thereby human beings construct their knowledge.

    Corollaries:

    o Learning happens in individuals' brains, not due to transmission of knowledge from outside.

    Implications for education:

    o Students have to be active learners. They do not learn as passive receivers.
    o Teaching is the act of inducing or facilitating learning.
    o Emphasis should always be on students' learning rather than teachers' teaching.

3. Learning is an individual undertaking.

    o Different people learn differently.

    o Even when facing the same environments and engaging in the same activities, different people learn differently.

    Corollaries:

    o Respect diversity in learning.
    o The same learning processes may yield different learning outcomes.

    Implications for education:

    o The same learning processes may yield different learning outcomes.
    o It is unreasonable to expect uniform learning outcomes from students.
    o Students should be at least given choices of learning paths.
    o Programmes should be so designed to allow maximal personalised learning.
    o Technologies should help create customised learning opportunities.
    o Assessment of learning should move from testing "what students know" to "what students can do".

4. Experience is of critical importance to learning.

o Experiences are activities in which human beings learn. Experiences allow human learning.

Corollaries:

o Human beings learn through diverse experiences.
o Human beings also learn from other people's experience, indirect learning.

Implications for education:

o Students experience should not be confined to listening, writing and responding.
o Students deserve the widest range of diverse experiences.
o Students deserve experiences in classrooms, outside classrooms, beyond schools, in nature, beyond geographic boundaries, and in the cyber space.
o Students deserve experiences in cognitive, affective as well as motor domains.

5. Understanding and application are intertwined.

o Understanding and application are two sides of the same coin. Knowledge is constructed during practice.

Corollaries:

o Understanding and application happen at the same time.
o Theory and practice are not separate stages of learning.
o The best learning occurs in context, i.e. with meaningful activities.

Implications for education:

o We learn by doing.

o Students learn not only by knowing, but also by using.

o Memorising and imitation are essential initial stages of learning, but they are lower levels of learning.

o Students should be expected to experience real life nature and society as early as possible during the school years.

6. Learning is a holistic process

o Learning happens as a comprehensive and integrated process. Learning takes place embracing multiple integrated dimensions all happen at the same time.

Corollaries:

o Learning does not take place as clear-cut segments of analytic pieces.
o Intended and unintended, planned and unplanned learning often come together.
o Implicit learning is commonplace in human life.

Implications for education:

o Exploit the wonders of implicit learning.
o Rigid programmes should be replaced by accommodating platforms of learning.
o Turn assessment into opportunities of holistic creation by students.
o Education should induce innovations which are often holistic in nature.

7. Learning is best in groups

o Learning is a matter of social cognition. Human brains echo one another and have multiplying effects on learning.

Corollaries:

o Challenging the basic assumption that the best learning happens among isolated individuals.

Implications for education:

o Discussion is essential at all stages of education.
o Classes should become learning communities, rather than "necessary evils".
o Create all possible opportunities for collaborative work.
o Use technology to enable more extensive and sophisticated collaborative learning.
o Create new ways of looking at "learning outcomes" and "assessments" in view of group work.

Concluding: Scaling up

The question typically facing policy-makers is: Can these practices at the grassroots and at the micro-level be extended to scale? In other words, can the Science of Learning be applied to change a whole system of education?

Hong Kong has tried. In the education reform that was launched in 1999, curriculum reform took centre stage. In a nutshell, the essence of the reform was to totally change the discourse about curriculum, from "subjects" to "Key Learning Areas". "Subjects" are infiltrations of university's academic disciplines, "Key Learning Areas" refer to learning experiences that students deserve. The net results compress the traditional subjects, and create room for new experiences, such as Liberal Studies (which involves broad discussions about society and life), Applied Learning (experience in the workplace) and Other Learning Experiences.

Such changes have to meet challenges from conventions about schooling, about university admissions, and sometimes even parents' expectations. The change in the curriculum touches upon fundamental assumptions about education. Nevertheless, the reform stays on, basically because teachers have undergone a movement from an industrial discourse to a learning discourse about education. However, for real change to mature, this is just the very beginning of a long journey.

Before I end this chapter, I cannot help mentioning the more urgent needs of understanding human learning. They come from many angles. Students learn much more outside the formal school curriculum, and of that we know little. Many emerging technologies meant for student learning are designed by technologists who are not informed by how students learn. Students develop their ideas, norms and beliefs often from the social media, from "consensus" within confined groups, i.e. group-think. Just to mention a few. There are enormous expectations on the Science of Learning.