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Learning: some metaphors and their consequences

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Abstract : I offer an assessment of the potential impact of cognitive science on learning policies. The main thesis is that there can be no frictionless discussion of the issue of impact. Societal context is key factor in determining which policies are to be implemented. Along the way, some suggestions are offered for redesigning some aspects of the learning situation.

Keywords: learning; modularity; cognitive science; teacher-pupil relation

Introduction

This text puts together ideas on learning that are based on a number of data and background hypotheses (possibly prejudices). Data from cognitive sciences, especially literature on conceptual change and modularity, play a major role. But societal aspects – inserting the learning situation in wider contexts will be appealed to as well.

The varieties of learning

'Learning' is a folk-theoretical umbrella term that covers a number of phenomena that may have little to do with each other. One is said to learn, or to have learned, one's native tongue, although there is reason to think that something else has occurred (that knowledge of one's native tongue has "developed" instead). One is said to have learned to draw; how to cut and paste from a digital text; the main elements of a nation's history – here too, different things are conflated. Let us try some first, rough classification.

At the very beginning there is a series of unlearned or innate endowments, without which, of course, there could be no learning at all [Gallistel 1993, Spelke 1990, Carey 1987]. The main subdivision then is between processes for which there is a 'learning' window, and processes for which there is none, or no clear one. You may not be able to 'develop' a native-like competence in a second language, if the second language is acquired after about age 12. Within each possibility, there are further subdivisions. Out-of-the-window learning can be subcategorized into rote learning (getting to know a city map if you are a cab driver, or a sequence of events if you are studying history) and procedural learning (learning to extract square roots, or to repair bicycles). Window-restricted learning is paradigmatically centered on the classical and well studied example of language, which intimates clear educational policies in a range of cases. In fact, unless the Broca area is activated, syntactically articulated language is not acquired [Moro 2006]. The policies are, at a minimum: expose children as soon as they are born and until at least 10 year of age to someone's speaking (not necessarily to them, but not only on TV!); expose deaf children to sign language; [Moro 2006] Outside the case of language, little is know. At one extreme [Gopnik, Meltzoff & Kuhl 1999], suggested that the huge plasticity of children's brains makes it reasonable to hypothesize that children could be better problem solvers than adults, provided they are fed appropriate instructions (and ethical issues are properly addressed); but

no specifics were offered. On less extreme views, there are clear cases of competences that are best acquired during childhood, hence signaling the presence of a window of learning (especially if sensorimotor loops are crucial, as in playing a musical instrument, or maybe in weaving a tapestry or shaping pottery), and less clear cases (playing chess?). The less clear cases are bound to become hot topics in educational policies, both private and public.

Indeed, the uncertainty about what is window-dependent and what is not is likely to generate some anxiety. Parents may feel that their children are missing out on some huge opportunities that will never present themselves as their children grow up. Although this statement is perfectly trivial for education in general, it is less so when it comes to allocating children's, parents' and the educational system's time and resources. Should we "expose" our children to "engineering settings" (complex Meccanos or Legos) so as to make them develop engineering capabilities which will give them a competitive edge as they grow up as sharp as the edge dividing native and non-native speakers of a language?

Hypotheses about possible policies

Under uncertainty, I assume one could make a few bets. Second-language acquisition is a relatively established field; we know that early exposure does the work; formal learning should be reserved – but here too current policies are in need of substantial revision – for late comers. [The EU policy makers acknowledged this bus somewhat oddly tried to create strange bilingual creatures, with English taught only in high school.] There is no such a thing as an advanced math module as there is a language module [Wynn 1998; Dehaene 1997 on *idiots savants*; Lakoff 2000]. Innate numerical competencies are minimal; going beyond them is a huge leap, requiring a lot of training up and down the scaffolding of non-trivial formal systems. Some have suggested that this may be requested only from children aged 10 and more, given the need for strong motivation in exercising, and given the necessity of surmounting math anxiety [Girelli 2006; Johnson 2003]. Likewise, turning your children into a poet may require you to wait a bit. On the other hand, successful managers may be those whose social skills are activated early on; this may require a lot of informal training, such as participation in games, choir singing, acting, simulation, etc., more than being taught from principles [Larkin 1997, p. 15, on between-wars French vs English educational system; Masuda and Nisbett 2001, for cultural diversity]. As to two of the foundations of civilization, reading and writing, much depends on historical factors such as the phonetics/orthography divide (wider in English and French than in Italian). [Jackendoff 2002, defending teaching of Ebonics as proposed by the Oakland School Board in California. "…the actual proposal was to recognize the children's own dialect in the classroom as a legitimate means

of expression, and to use it as a scaffolding for teaching literacy in Standard English. An important part of learning to read is appreciating how orthography reflects pronunciation. If one is teaching reading of Standard English to a child who does not speak it, it is difficult to establish this crucial link" (p. 5); which bespeaks gloom for much secondary teaching of second languages across the world.]. But here already a rough modular approach is bound to be left behind, as for instance reading calls for the interaction of pre-existing modules (shape recognition and language processing) to form a quasi-module (exhibiting mandatory activation, but with no possibility of adaptive selection).

You may begin to feel uneasy about the general project that seems to surface here: "making children successful by engineering their development in a cognitively apt way". We will reconsider this aspect later on.

The reality of conceptual change

If one detaches oneself from the rather crude modular image associated with the idea of windows of learning, one may study strategies that accompany conceptual change or development in general [Carey 1987; Karmiloff-Smith 1992]. How are we to improve on, or to replace the child's world view, given the rich and relatively stubborn innate endowment? Here the discussion becomes philosophically intricate because of a deep foundational issue. It is not well known what the mechanism of naïve theories is; but whatever it is, it is at a bare minimum structured upon conceptual representations which are mandatorily and directly activated upon encounter with some specific stimulation (an animal approaching rapidly will elicit a different conceptual representation than a stone rolling towards you, and this in turn will elicit different exit strategies).

However, non-naïve theories do not work like this. They are rather inferential machines that are useful to accommodate data sets in terms of hypotheses and principles; the inferential process being mediated by the mastery of some often rather sophisticated formalism, which in turns requires a lot of active exercise (and maintenance), mostly in order to upload in long-term memory (and refresh) useful tricks to be retrieved on demand during complex calculations, or patterns to be used for high-order cross-comparisons. On this account, conceptual change construed as replacement of a set of representations with another set is just a theoretical artifact, as there is no representation set to provide the replacing. (The headline here is: no scientific "intuition", no "bosse des maths". This bespeaks uselessness for some popular science writing, of course, where some existing representations are hopelessly twisted or rearranged in order to give a gist of what complex hidden structure are like.)

Hence the strategies to be deployed here are quite different from the ones to be expected in case conceptual change is admitted. And they may be quite deviant strategies, given the necessity of building up the scaffoldings of formalism: here a motivational aspect may be the key factor to be monitored (Ashcraft & Kirk 2001 on math anxiety and working memory, showing that pen-and-pencil mathematical ability being equal, math anxiety disrupts working memory; Girelli 2005). These strategies, modulated by age, are likely to be necessary in all those areas in which the core set of beliefs is resilient. Physics appears to be a case at hand. Naïve physical beliefs are resilient even to formal training [McCloskey 1983]. As to rote learning, it is obviously present in a number of other learning activities and practices as a functional component (music performance, play, historical research); in general whenever access to a long-term memory database makes it swifter to get solutions and results. Progress here can be made by redesigning the storage process: Chinese children learn only one half of the multiplication table (given its symmetry), which may account for higher performance in arithmetic (along with other factors) relative to children from cultures where rote learning of the multiplication table is a clumsier process (one, for instance, that nullifies the acquired knowledge that multiplication is commutative).

In view of the rather gerrymandered landscape that we have overviewed, what are the sensible steps in designing the learning situation?

The risks of frictionless discussion

Here is a cautionary tale. Social psychology suggests that stereotypes are more effective in situations in which they are easily applicable [Steele 1997]. Caucasian boys underperform in athletic activities when put in groups that include African-American boys (they underperform not only relative to the African-Americans, but also relative to a control group of Caucasian only, thereby indicating that they are prey to the stereotype of ‘white men don’t jump’). The opposite holds for intellectual performance (African-Americans underperform if they feel the comparison with Caucasian); the result is echoed in studies about women (whose scholastic performances are higher in mono-gender classes). But it would be a big leap to have any policy dictated by these results only. In particular, a crude policy would be to segregate so as to get better scholastic results in each group. The moral of the cautionary tale is that focus on the expected results should be counterweighted by attention paid to education as a social setting, one where people also learn to live with different people.

Pragmatism: Make do with existing policies

Making suggestions of policies is of course a risky move in contexts in which the factors at play are very large (among which one should count institutional inertia, and the still uncertain outcome of cognitive studies). A more promising attitude should be one of promoting small reforms or designing experimental tools to show the viability of new approaches. However, the necessity to do something in order to reform existing curricula should always be on the ideal horizon of the little pragmatic steps, given the oddities, non-optimalities and redundancies of the curricula. As [Pinker 2003] has stated, the issue is not whether learning trigonometry is important, but whether it is more important than learning statistics (arguably it is not; trigonometry may be a historical relic of a period in which land was the main item around to be measured). The main problem is that of the allocation of time and resources. Latin has been presented as useful for learning word meaning (in countries where enough words are of Latin ascent), for learning syntactical analysis, even for learning to think in general. All these (and other) alleged benefits have been questioned in empirical studies, but the main issue is not whether the study of Latin is or not useful to attain the goals indicated, but whether the cost of it makes it reasonable to use the study of Latin as a means towards those goals.

Given all this, here are some loose ideas on reconceptualizing the learning situation for those cases in which some formal learning is required; some warnings are issued on sensible points.

The conveyor belt

The first step consists in neutralizing a powerful but potentially harmful metaphor, the conveyor belt metaphor. According to the metaphor, the instructor is simply a belt which conveys pre-existing packages of knowledge to the pupil. The metaphor presupposes that such packages exist; that they can be delivered through a person's endeavors; and that once delivered, they'll make a difference in the pupil's mind and behavior. It is possible to question the metaphor on all three accounts. But as a means to contrast the conveyor belt metaphor, one can get inspiration from the organization of learning in a very advanced context. Graduate students and young researchers are typically in a two-way interaction with their supervisor, in the sense that the questions of the student are triggers for the director's own advancements. No belt can convey anything here, because there is nothing to convey in the first place. The director rather steers the strategies of the student so as to enable the student to express his or her ideas in a language that is the language of the community, to use existing problem-solving patterns, to take useful shortcuts and avoid dead ends. Now although it may be risky to immediately export the model to other learning

situations, this is what I propose to do for the sake of testing the limits of existing approaches.

The result of this discussion is that we can envision some ways to short-circuit existing limitations.

Enhancing the peer

In some cases, individual differences at intellectual or personality level appear to be explained by a mixture of factors. Among which formal teaching or family environment appears to play a relatively minimal role. Variance appears to be explained mostly by a combination of inheritance and exposure to peers in the same age class [Pinker 2003]. The recommendation here is to work on the design of instruments that steer peer pressure, amplifying the benefits and reducing (by teaching to manage them) its stressful aspects.

Empowering the teacher

The most tentative proposal I have to offer here is: redesign tools for learning by centering them on the teacher. Trying to bypass the teacher by creating instruments of self-teaching, one-to-one, machine-to-student instruments, may be short-term advantageous or attractive, but it risks upsetting the key role played by the teacher in the complex social context of the class; in particular it should be balanced against the risk of diminishing the teacher's authority (in the sense of the teacher's being authoritative). Any instrument should then put the teacher clearly in command, give him or her an edge that can be exploited in the relationship with the student, make routines automatic so as to free energy and resources for more direct interaction, provide tools for self-assessment, etc. *Trust in the teacher* and the teaching method is an obvious keyword here; another is the *construction of self-confidence* on the part of the pupil.

Stipulating (meta-)contracts

As an indication of an empowering tool for teachers I offer the 'teaching contract', based on acquaintance with some existing cases (sillabi in US universities). Not only general objectives of the course are laid down explicitly, but so are specifics, down to very small details. The idea is that this sets the interaction between teacher and pupil at a very high level, by providing a meta-label for each step in the learning process. The content of the meta-label is a specification of the contribution of each single step to the general process (what presupposes what, which role has a certain assignment, and so on). The pupil is given a roadmap to find his or her own way in the content taught. Conversely, the teacher acquires a reflective

understanding of his or her own work. The contract is a sort of metarepresentational tools for conscious learning. A practical proposal here is to create a tool that helps the teacher writing down their own contract. It would include questions such as “why is this important/done at this point/…”.

Learning by teaching

As learning by teaching is an effective way to induce learning, because it forces an in-depth treatment of information, students should be introduced to it whenever appropriate as soon as possible in their career. This requires teachers to teach students to teach. Which in turn has the secondary effect of forcing teachers to reflect on the teaching situation. The tool here will be instruments for designing micro-classes that are nested within the class taught by the teacher. Issues of responsibility loom large in this project. Learning to teach is learning to behave responsibly towards the pupil relative to the issue of knowledge (for instance, in order not to abuse of the teacher’s dominant position).

Conclusions

This very short review of the large picture of the learning mind makes three main points:

1. There is no general teaching model.

2. Optimizing teaching should not be anchored to maximizing learning: social factors should counterweigh the ideal target of the pupil's performance

3. There is a lot of room for improving existing policies step-by-step.

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