

Cognitive tools for epistemic engineering

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Abstract—Emerging technologies create new possibilities for learning, but their speed of introduction has overtaken our understanding of the cognitive tools that we need to develop in order to take the best advantage of these possibilities. To think and perform better, we must develop and tune thinking tools and build and develop frameworks within which others can learn and continuously re-tune these thinking skills. Learners need to be part of a scholarly knowledge cycle and to know that they are part of this process and that they have agency within it. In addition, learners and their teachers need *Perpetual Beta Skills*, to be able to appreciate the ways that the new forms of interaction can support conceptual growth; *Failure Appetite*, in order to appreciate the opportunities for experimentation; *Resource Synthesis*, so that the connections between their interactions can be brought together effectively to progress their learning, and *Technological Skills* that go beyond simple operational efficiency. A longer version of this paper can be found in my book *Re-Designing Learning Contexts*.

INTRODUCTION

Our understanding of the manner in which people learn with technology increasingly lags behind the advancements being made in the technologies themselves. If we look at what we know about current technology developments we can already see that the combination of cloud computing with ever cheaper and more powerful computer technology means that more and more people are able to access powerful computing, the capability of which does not necessarily need to be in their pocket or on their desk. Their interactions will increasingly be through more and different interfaces including touch, voice and physiology and through the multitude of artefacts, environments and people that they encounter, including themselves. Robust networks and web technology developments support complex interactions that can make connections between anything from individual data elements through multi-media resources to people, enabling mass collaboration between people and machine in a powerful distribution of intelligence.

These technological innovations enable communities of people to work together to build, shape and re-shape their communities and their artefacts using language as a means of organizing their activity and of passing on the results to future generations. Technology brings about collaboration on a massive and global scale, such as that seen through web 2.0 technology, and collaboration that involves human and machine enterprise, such as the crowd sourcing in Galaxy Zoo. This is significant, because this difference in the scale of information-sharing and collaboration has become a difference in kind and because 'anything that changes the way groups get things done will affect society as a whole' (Shirky 2008: 23). So what might this mean for learning and for learners? Clark (2008) refers to people as 'epistemic engineers' who 'self-engineer ourselves to think and perform better in the world we find ourselves in. We self-engineer worlds in which to build better worlds to think in. We build better tools to think with and use these very tools to discover still better tools to think with. We tune the ways we use these tools to discover still better tools to think with. We tune the way we use these tools by building educational practices to

train ourselves to use our best cognitive tools better. We even tune the way we tune the way we use our best cognitive tools by devising environments that help build better environments for educating ourselves in the use of our own cognitive tools.' (Clark 2008: 59-60)

But what cognitive tools are currently being tuned and what kind of tuning is going on?

THE SCHOLARLY PROCESS OF KNOWLEDGE CONSTRUCTION

If mass collaboration and the proliferation of new interactions enabled by technology are bringing about changes in kind, then perhaps one site where these changes might usefully shape our cognition is with respect to the collaborative and participatory construction of adapted, extended and new bodies of knowledge, changes that may enable more people to engage with the scholarly knowledge cycle. I would suggest that examples of mass collaboration are already displaying elegant examples of distributed intelligence, examples that are beginning to involve novices working with experts and humans working with machines. The classification of new galaxies in Galaxy Zoo may also be contributing to the body of knowledge about astronomy and this contribution will be the result of the efforts of many people who would not previously have considered themselves part of the scholarly knowledge production process. There is a step missing here, however, if these new 'knowledge body constructors' are to signal the step change in cognitive tuning that a change in kind ought to yield. This step concerns the need to develop people's understanding of what knowledge is, so that they can both tune and appreciate their own knowledge construction efforts.

Some candidates for consideration with respect to how we might help more people to understand what knowledge is, include:

1. What kind of knowledge concepts are the subject of the learning activity and how they are described in terms of the learner's context? This suggestion is consistent with the Curriculum-Based Ecosystems suggested by Barab & Roth (2006) who recognise that knowledge requires an understanding of the relationship between concepts and the accompanying resources and 'contexts-of-use'.
2. What it means for someone to know something, for example that they can specify the evidence that supports their knowing and justify the validity of this knowledge.
3. What role the learning process plays in helping the learner to know something. This entails identifying the process by which the learner used the resources available to them to specify the evidence and justify its validity.
4. What it would mean for the learner to be aware of the process through which they have come to know something.

Each of these elements contributes to increasing personal agency in the learner's conceptions about the nature of knowledge. This also offers a useful way of talking about the role of teaching. A learner's interactions with those who are helping them to learn will influence the way in which the elements identified above can be developed. Teachers, peers and others can engender a move to a more sophisticated appreciation of each of these elements if their interactions are grounded in such an approach.

Different specialist traditions will offer different methodologies and specifications about how knowledge of that specialism is generated and acquired (Young 2008). A second step that needs to happen for the desired step change in cognitive tuning is to open up the manner in which these bodies of knowledge are generated and recognized. This step can be extended beyond the well-defined bodies of formal knowledge to encompass new conceptions of vocational practice, for example, such as the multifaceted approach proposed by Guile (2009) in his re-thinking of the relationship between vocational practice, qualifications, and learners transitioning into employment. Some specialisms may be more suitable than others, and we need to take care here to ensure that the specialisms are operating as gatekeepers of this knowledge in a manner that is appropriate and not by dint of some embedded 'technology' as in the case of the early scribes who mastered the art of writing (Shirky 2008). This is important if we are to realize the power inherent in a more democratically distributed growth of knowledge.

LEARNER AGENCY AND THE RELATIONSHIP BETWEEN LEARNERS AND TEACHERS

The general law of cultural development (Vygotsky 1978) makes plain the responsibility incumbent on society to make available opportunities and tools for shared consciousness and understanding. This responsibility is dynamic and therefore requires that society updates its provision in line with development. To what extent then has the nature of the learning and teaching relationships, at least with respect to formal education, developed in line with the changes in kind I discussed above? In particular, has the balance of power between people playing different roles within a learner's context developed consistently with the new interactions made possible through technology and our changing relationships with it?

I suggest that we need to consider how we facilitate a learner to take greater agency in the creation of their learning context. For example, the technological innovations and resultant expansion in the forms of interaction available to a greater number of people mean that teachers may be faced increasingly with learners who know more about at least certain aspects of the technologies and interactions than they do. The interaction and negotiation between learner and teacher will need to recognize the value of the learner's technology expertise resources and also recognize that this does not diminish the teachers' know-

ledge and teaching expertise if the mutual growth envisaged in the term *obuchenie* is to ensue. It is also the case that these same technological and interactional innovations offer the opportunity for the generation of contexts for learning by learners. I describe this as a learner-generated context: 'a context created by people interacting together with a common, self-defined learning goal' (Luckin et al, 2010). The idea behind a learner-generated context is not that learners can necessarily work unaided by teachers, rather it is that learners can be more active in the construction of their own contexts for learning through appropriate technology and appropriate teacher interaction. Institutions such as schools have a key place within a learner's context, but this importance is as much about how they enable learners to build links between their experiences outside the school as it is with the way that they support learning experiences within the school.

THE NATURE OF THE COGNITIVE TOOLS THAT LEARNERS (AND TEACHERS) WILL NEED

I have stated elsewhere (Luckin et al 2009) that the current exploitation of new technology, such as web 2.0, is not taking most learners beyond the base level of superficial use that the technology naturally encourages. I have also expressed concern about the extent to which even relatively sophisticated learners are developing an understanding about how knowledge is justified. I build on these concerns here and suggest the kinds of cognitive tools that are needed for a capable population. My discussion of the first two questions has already suggested that learners (and teacher) will need improved and different knowledge working capabilities. There are other additional capabilities that will be needed if we are to take full advantage of the staggering array of interaction possibilities that has and will continue to come our way. These include:

Perpetual Beta Skills, to be able to see the ongoing process of technology development as a learning opportunity that involves looking beyond the specific instantiation of a technology to the interactions that it permits. This skill needs to take the learner beyond an operational ability to an appreciation of the ways that the new forms of interaction can support their conceptual growth.

Failure Appetite, in order to appreciate the opportunities for experimentation and learning that mass information-sharing and collaboration can offer. Shirky makes this point well when he discusses the web 2.0 group co-ordination application Meetup, which he suggests succeeded 'not in spite of the failed groups, but because of the failed groups' (Shirky 2008: 236).

Resource Synthesis, so that the connections between resource elements in the learner's Ecology of Resources (Luckin, 2010) can be brought together effectively to progress their learning. These resource syn-

thesis skills extend also to the skills that the learners themselves bring to their learning: their cognitive, affective, metacognitive and epistemic resources need to be brought together in an integrated fashion and in a manner that recognizes the important connections between the learner's resources and those of their Ecology of Resources.

Technological Skills, in order to ensure that particular technologies are not seen as unnecessary filters to the learner's progress and to enable more people to engage with the ongoing development of technologies and the refinement of our relationship to these technologies. As noted by the Foresight Wider Implications of Science and Technology report (WIST 2007), there is insufficient technological literacy to enable us to recognize and exploit the significant technological advances being made: we need a more technologically literate population, and therefore we need to develop technology-rich learning activities that support this development.

These capabilities are not suggested as an alternative to the media literacy and digital literacy skills proposed by others (Buckingham 2007, for example) but as a necessary extension that will strengthen these new literacies.

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