Teaching Artificial Intelligence (AI) and language

Carlo Lusuardi
Buckinghamshire New University
High Wycombe Campus
Queen Alexandra Road
High Wycombe
Buckinghamshire
HP11 2JZ
carlo.lusuardi@bucks.ac.uk

Abstract
The question of how to make good students has been couched in a number of different terms over the years. However, there seems to be general consensus that Reflective Learning (RL) and higher-order thinking (HT) have a role to play. In particular, it appears that it is exactly these critical-thinking skills that enable self-awareness vis-à-vis the learning process to take place. Furthermore, while there is also agreement that it is beneficial to learners, when it comes to the question of how to deliver it and what is even meant by these terms, there is much debate (which on reflection isn’t a bad thing). An examination of key properties reveals that the areas of HT and RL have elements in common with Artificial Intelligence (AI) and Intelligent Agents in particular, which is not surprising as ultimately we would like machines to display these skills. Interestingly, when we examine higher-order critical thinking in different disciplines, the results reveal the use of different terminology for each discipline and even a different perception of thinking critically. In other words, the role of language is seen to be instrumental not only in creating the perception of critical thinking but also in generating criticality itself. Therefore, what may be required is a clearer understanding of the potential role of language to determine the world as well as a more thorough application of syntactic-semantic analysis to subject content.

Keywords
higher-order thinking, reflective learning

1. How to make good students
In the past there has always been a strong bond between HT/RL and Higher Education (HE), indeed Barnett (1997) argued that it was the lifeblood of HE: “Critical being has to be the business of higher education”, “critical being” being an extension of critical thinking which
involves living and breathing HT/RL. However, today the (Post ’92) university sector is facing unprecedented pressure to deliver simultaneously ‘employability’, high levels of customer- (the new term for student) service and great value for money. In the current political and economic climate you might think that the question of how to make good students has had its heyday and that the fad no longer has any place in HE. Nonetheless, there are those who still seem to see some merit in it: “university education should equip graduates with mental skills and intellectual flexibility. It should develop the powers of the mind, enlarge knowledge and understanding, and enable graduates to lead fuller and more rewarding lives” and vitally this “intellectual activity [must] be freely conducted without regard to its immediate economic benefit” (CDBU, 2012). In fact, in the current political-economic climate the debate may be more important today than it ever was.

The question of how to help students learn effectively/intelligently is premised on the notion that they require not just the technical, subject-specific knowledge associated with their particular discipline but something more. Barnett’s (ibid) statement of the popularity of the subject: “almost everyone is in favour of critical thinking” belies the fact that there is much discussion over what it is, if it is allied to a respective discipline and not least how to teach it. Furthermore, the discussion has been couched in different discourses and terminologies. Teachers adopt expressions that focus on the concept of learning i.e. reflective learning, learning to learn or building learning, in which students evaluate their own learning literacy. Educationalists use terms such as: analysis, evaluation and synthesis, considered the higher-order thinking skills in Bloom’s (1956) taxonomy. When approaching from a cognitive psychological perspective, the talk is of metacognitive awareness and self-regulation, which are defined as the ability to evaluate the various cognitive processes humans employ when learning and to pursue those that are most successful (Schneider, 2010). Terms such as inference, deduction and induction feature heavily in the lexicon that derives from philosophy and formal logical. Neuro-scientific discourse may focus on the terminology of memory: short and long-term, episodic and declarative as well as neural plasticity (the process by which new neural pathways develop). However, while the language employed may differ, it does appear that we are dealing with the same thing in essence. Philosophers/logicians know that higher-order thinking skills require reflection and (self-)evaluation, i.e. metacognition. Learning to learn/building learning focuses on the deductive nature of human cognitive processes. Neural plasticity during learning is about the allocation of additional physical resources based on the analysis and evaluation of a new situation or experience.

2. Higher-order Thinking / Reflective Learning and Artificial Intelligence

There are numerous definitions of the kind of thinking and learning we might wish to foster in students. McPeck (1981) put forward a definition that coloured the subsequent debate: “the propensity and skill to engage in an activity with reflective scepticism”, emphasising the ability to be critical and evaluate any activity dispassionately. How this happens is by
engaging in “the kind of thinking involved in solving problems, formulating inferences, calculating likelihoods and the development of cohesive and logical reasoning patterns” (Halpern 1997). For Facione et al (2000), many of the same sorts of themes are relevant: “analysis, inference, evaluation, deductive reasoning, and inductive reasoning”. Floyd (2011) examines a number of these definitions and concludes that “common to most are the skills of reasoning, inferring, evaluating arguments and deduction”. Robinson (2011) believes it holds out the possibility of improving decision-making: “ideas are accepted or rejected based on the evidence used to back those claims and this is done with a view to helping make better decisions and arriving at the truth” (whatever that may mean). What emerges is the importance of evaluation, reasoning, reflection and regulation (i.e. acting on the reflection). This situation is replicated in courses on the subject. Pontzer Ehrhardt (2011) has chapters on argument, evidence gathering, inductive and deductive reasoning and synthesis as do Seay & Nuccetelli (2008). Similarly, Raine (2011) includes formal logic, inductive and deductive reasoning and so on. What is common to all is that the abilities to represent knowledge, to draw inferences and to evaluate those conclusions are be closely related to the notion of HT/RL. Some go so far as to say that they are necessary components: Siegel (1990) believes “exposure to formal logic is desirable for the critical thinking student [because] it illustrates well the fundamental property of ‘being a reason for’”. This view asserts the pivotal roles of analysis and reasoning as well as self-reflection in higher-order thinking.

Gibbs (2013) echoes the same ideas: “effective students … can tell you all about how they go about their task, have a sensible rationale for doing so and change what they do when they notice the context or task demands are different”. This “self-reflective improvement” of students, as Gibbs labels it, clearly focusses on the ability to reason about the strategies to employ and to evaluate choices in a changing environment. This suggestion is also present in Brockbank & McGill’s (1998) discussion of Reflective Learning in which “The learner is able to be critical in relation to the domains of knowledge, self and the world…[she] is effective within her discipline, as well as critical of her discipline from without, … She is able to be in a reflexive position about learning how she learns”. This definition makes it explicit that the reflection is directed at the material to be understood, the learner themselves and external influences (the world). As noted above, this approach to learning rests on the cognitive-psychological principle of metacognition. Metacognition, which Vockell (2013) defines as “learners’ automatic awareness of their own knowledge and their ability to understand, control, and manipulate their own cognitive processes” comprises three elements: metamemory, metacomprehension and self-regulation. These focus on the evaluation of and reflection on the cognitive process (rather than the process itself) by the students themselves who takes responsibility for reasoning about and assessing the most effective memory techniques, the most effective comprehension techniques etc.

---

1 It is only fair to say that this view is not without its critics. For some, the point of departure when making ‘good’ students must be knowledge of the subject itself but we shall return to this. Gibbs (2013)
Interestingly, it turns out that AI is interested in similar activities. A perusal of the literature reveals i.e. that Callan (2003), Ngenevisky (2005), Russell & Norvig (2009) and Schalkoff (2011) are all concerned with knowledge representation, logical inference, deductive/probabilistic reasoning, evaluation and decision-making because AI aims to provide machines with the rational, logical apparatus to make inferences, deductions and ultimately the ability to evaluate and make considered decisions. This is seen in the development of intelligent agents (IA): artificial systems that can, on our behalf, act and interact dynamically with other agents (either artificial or human) to achieve a specific purpose. The way an agent understands and negotiates the world is through computational logic (CL). “Computational Logic is the agent’s language of thought. Sentences expressed in this language represent the agent’s belief about the world [and allow it to] reason about the world for its own benefit” so that the IA is seen as “any entity that can … perform actions on the world to maintain itself in a harmonious relationship with the world” (Kowalski 2011). However, the value of CL is not just in enabling machines to evaluate their view of the world; CL also exists to help humans think critically and reflectively, its ultimate aim being to foster in “the student transferable thinking and communication skills”.

Significantly, the focus on autonomy and the self is mirrored in the metacognitive view of learning, which sees the student as a “self-aware agent who can construct his or her understanding of the world [as] successful students take charge of their own learning”. Furthermore, “As agents of our own thinking, we construct our understanding of ourselves and the world, we control our thoughts and behaviors, and we monitor the consequences of them” (Hacker et al., 2009). Effective students have an awareness of the self, of its role in the construction of the world and can question the accuracy of their understanding of it. Similarly, IAs should also model the world in order to infer knowledge which they can then use to make logic- or rule- (i.e. evidence-) based decisions. It is precisely the unique human ability to make informed and reflective decisions that we wish to replicate. RL and HT attempt to make explicit the mechanisms for acquiring a phenomenon that is, by definition, common to all humans. IAs, through knowledge representation, formal logic and decision-making techniques, also attempt to formalise the same, inherently-human ability (or attempt to replicate a replica of the ability). Therefore, given this shared purpose, could AI be a suitable vehicle for HT teaching? This raises the thorny question of whether CT skills can be taught subject-independently or need to be embedded in a discipline. The subject-dependency camp argues that without a high level of subject knowledge, the degree of HT/RL involved risks being little more than trivial. Gibbs (2013) reports that most attempts to teach learning skills out of context have met with very little success.  

---

2 As this debate has been widely rehearsed McPeck’s (1990) Ronald Reagan example is reproduced simply for its comic value. When Reagan boasted about the robustness of the American economy in the State-of-the-Nation address his claims were rebutted by the Democrats. McPeck did not know whom to believe not because either side had been illogical or reached fallacious conclusions but because he couldn’t validate the respective arguments: “what I needed to know was more economics, not more logic”. McPeck argues that CT is a higher-order brain function that operates on potentially novel and complex information, it isn’t simply making run-of-the-mill decisions within well-known scenarios. The comic value of this anecdote derives from the notion that someone would need any knowledge of economics at all to follow Reagan’s musings on Monetarism or Keynesianism. Reagan was accused of many things over the years, but being a brilliant economic theorist was not one of them.
3. Higher-order Thinking / Reflective Learning and Language

If RL/HT could be taught independently of a discipline, it would be reasonable to assume that the same material could be taught to all students. This assumption could be tested by examining differing concepts of HT in different disciplines. Moore (2001) carried out a linguistic analysis of the terminology used in the expression of criticality and the overall academic perceptions of HT in Philosophy, History and Literary Studies departments. The analysis revealed that in Philosophy criticality is associated with the language of dissecting and cutting down; critical philosophy students evaluate given propositions and discard what is invalid. In History, almost conversely, being critical is associated with terminology relating to building, because criticality constructs arguments by means of the combination of various appropriate elements of source material. In Literary studies, students are required to use theoretical or conceptual notions to justify interpretations. Therefore, a student’s criticality is not directed at source texts (whose validity is ‘unassailable’) but rather implies the ability to interpret literary masterpieces by means of various critical paradigms, e.g. Marxist, feminist, psychoanalytical etc. More accurately, criticality resides in the student’s ability to assess the validity or evaluate the power of the paradigm. The varying responses to the notion of CT suggest quite clearly for Moore that different disciplines have, at the very least, their own lexicons and potentially their own discourses as well. Therefore, the ability to apply higher-order reasoning has a clear bearing on the language used by students.

However, the relationship may well be bidirectional. Floyd (2011) examined how thinking and reasoning in a second language can affect performance specifically in a CT test. Non-native speakers (attending an Anglophone university) were split into two groups and given half the test in English (L2) and the other half in their native language (L1). The first group took the L2 half of the split-test first while the other group took the L1 half first. Efforts were made to obviate the common, language-based problems associated with taking a test in a foreign language. For instance, dictionaries were provided to the students. Floyd found that the students who took the English test first performed significantly better when they took the L1 test. In addition, the second group (L1 test first) performed significantly better than the group that took the English test first. Floyd concluded that the fact that these students are working in a second (at least) language did indeed have a major impact on perceived HT. Additionally, students were interviewed to gather qualitative data on the perceived difficulty of the respective papers. Students stated that the test administered in their non-native language was more difficult, supporting the statistical findings. i.e. that thinking critically or at least displaying CT is more difficult in L2 than in L1.

We could dismiss these result by saying that the students were simply unable to express higher-level thinking in a foreign language because they did not possess the requisite, general language skills or possibly the vocabulary of criticality in that language, which we can reasonably assume come later in the language-learning process. However, as Floyd points
out efforts were made to reduce the purely linguistic barriers during the experiment. The argument also ignores Moore’s examination of HT in multiple disciplines, which supports the existence of discipline-specific discourses and views of the world. In fact, Moore suggests that the lexicon is different precisely because students and lecturers presumably have a different perception of HT and of the world to which it is applied. He is quite clear that it is not just the vocabulary of the discipline that varies. Therefore, it would not be sufficient simply to learn the terminology associated with criticality in History to be a critical historian, the meanings of the respective discourses are substantively different. To paraphrase Moore, intellectually historians are builders while philosophers are cutters.

The explanation for this may derive from the naming and creative power of language. The way we perceive the world, our Weltanschauung, is inevitably shaped by language. “The categories and types that we isolate from the world of phenomena we do not find there because they stare every observer in the face. On the contrary the world is presented in a kaleidoscopic flux of impressions which have to be organized in our minds. This means, largely, by the linguistic system in our minds” Kay & Kempton (1984). In particular, language conceives of objects as displaying varying degrees of abstraction so their logical, ontological status varies accordingly. Lyons (1977) explains how language differentiates between: “first-order entities”, concrete events that occupy some time and three-dimensional space and “are publicly observable”, “second-order entities” that describe states-of-affairs or events that “occur or take place, rather than exist” but do not occupy a location in space, “third-order entities”, namely abstract notions or concepts that occupy neither time nor space. When this insight is applied to traditional disciplines, it becomes clear that the physical sciences are concerned with the study of entities that occupy a particular location in time and space, history and the social sciences generally examine second-order entities, i.e. state-of-affairs pertaining to an entity occurring at a particular time and disciplines such as philosophy dissect and evaluate propositions or arguments, which are third-order entities, to arrive at the truth. The conclusion that the logico-linguistic type of the object of study determines what is considered to be HT within that discipline is reiterated by Moore (ibid), who concludes that “the ‘critical thinking’ game would seem to be largely one of analysing the logico-semantic relationship of propositions”.

4. Conclusion

The discussion began by noting that the various approaches to making good students employ distinct terminologies and discourses while actually talking about the same thing. Furthermore, we saw that the artificial power-of-reasoning with which IAs are endowed, CL, is very much a language system, whose purpose is not just to provide students with thinking but language skills as well, the suggestion being that these are not separate. Also, as critical language differs across different disciplines and determines the way in which criticality is understood, it appears that the choice of lexical terms moulds and shapes

---

4 The concept of linguistic determinism, including the Sapir-Whorf Hypothesis, is not necessarily compatible with the Chomskyan notion of language universals nor with the non-verbal or pre-linguistic view of human thought described by Pinker (1994).
students within a particular field. Moreover, the difficulties faced by non-native speakers show that language plays a fundamental role when students (people in general) perform higher-order, reflective activities. Not only is language the physical medium for expressing thought but it also provides the cognitive framework for these reflective activities. Even more importantly perhaps, linguistic determinism reinforces the centrality of language to the thinking process. It proposes that the world as we perceive it is, at the very least, moulded by the language we use to describe it but potentially fundamentally a linguistic construct created by the language habits of a particular community. Under these circumstances, the importance of possessing and developing language skills becomes paramount. Of course, most learners will possess them passively so what is required is an active approach to language understanding. Specifically, the self-reflection and awareness that students are encouraged to apply to their subject matter or their own learning must also (or first) be applied to their language processing. All learners would benefit from becoming conscious of the syntactic and semantic processing they perform routinely so that it can be reproduced when embarking on any HT or RL. To conclude, language study (in this specific sense but also in its general sense) should be an, if not the, essential element of any attempt to enhance the thinking and learning of students.

References


Bloom, B (ed.) 1956 Taxonomy of educational objectives: The classification of educational goals handbook 1: Cognitive domain  New York: David McKay Co

Brown, R (1988) The Development of language and language researchers


Entwistle, N (2009) Teaching for Understanding at University  Eastbourne: Palgrave Macmillan


Gibbs, G (2013) Raising awareness of best-practice pedagogy

Hacker, D, Dunlosky, A & Graesser, A (eds.) 2009 Handbook of Metacognition in Education USA: Routledge


Kay, P & Kempton (1984) What is the Sapir-Whorf hypothesis


Pontzer Ehrhardt, V. (2011) Critical thinking and writing skills. UK: Anthem Press

Raine, D (2011) HEA Workshop: Critical Thinking (based on the work of John Hilsdon) University of Surrey


Seay, G & Nuccetelli, S 2008 How to think logically Pearson Higher Education

Schalkoff, R. (2011) Intelligent Systems USA: Jones and Bartlett Publishers

Schneider, W. 2010 Metacognition and Memory Development in Metacognition, Strategy Use and Instruction

Vockell, E. (2013)
http://education.purduecal.edu/Vockell/EdPsyBook/Edpsy7/edpsy7_meta.htm accessed 20/9/13
