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Critical thinking for 21st-century education: A cyber-tooth curriculum?

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Abstract

It is often assumed that the advent of digital technologies requires fundamental change to the curriculum and to the teaching and learning approaches used in schools around the world to educate this generation of "digital natives" or the "net generation". This article analyses the concepts of 21st-century skills and critical thinking to understand how these aspects of learning might contribute to a 21st-century education. The author argues that although both critical thinking and 21st-century skills are indeed necessary in a curriculum for a 21st-century education, they are not sufficient, even in combination. The role of knowledge, and an understanding of differing cultural perspectives and values, indicates that education should also fit local contexts in a global world and meet the specific needs of students in diverse cultures, as well as the particular technical and historical demands of the 21st century in relation to digital skills.

Keywords

Critical thinking, curriculum change, 21st-century technology, digital technologies, thinking skills

In 1939 Howard Benjamin published a short book on the challenge of curriculum change entitled *The Saber-Tooth Curriculum,* supposedly written by a Professor J. Abner Peddiwell. The book describes the three fundamentals taught to youngsters in a fictitious Palaeolithic curriculum. These were: 1) fish-grabbing-with-the-bare-hands; 2) horse-clubbing; and 3) saber-tooth-tiger-scaring-with-fire. However, climate change at the end of

the Pleistocene epoch led to the extinction of the saber-tooth tigers and the arrival of bears; rivers silted up, making the water too muddy to see the fish; and the horses migrated, to be replaced by swifter antelope. Accordingly, some of the younger and more inventive members of the tribe proposed that children should now be taught the skills of net-making (to catch fish), snare-setting (to trap antelope), and pit-digging to protect them from the bears (who were not so afraid of fire). The tale continues:

> However, the wise elders replied: "What have practical activities got to do with school and training? Anyway, the curriculum is too full to add any more…. Moreover, the things we teach our people are not for any direct practical purposes. We don't teach fish-grabbing to catch fish. We teach it to develop a generalised agility which can never be developed by mere training. Education is timeless. It is something that endures through changing conditions like a solid rock, standing firmly in the middle of a raging torrent."

> All the radicals were silenced by this statement, all except the one who was most radical of all. He felt abashed, it is true, but he was so radical that he made one last protest. "But—but anyway," he suggested, "you will have to admit that times have changed. Couldn't you please try these other more up-to-date activities? Maybe they have some educational value after all?"

> The wise old men were indignant. Their kindly smiles faded. "If you had any education yourself," they said severely, "you would know that the essence of true education is timelessness. It is something that endures through changing conditions like a solid rock ,standing squarely and firmly in the middle of a raging torrent.

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You must know that there are some eternal verities, and the saber-tooth curriculum is one of them!" (Benjamin 1939, p. 20)

Although written 75 years ago, this satire is particularly relevant today, as we face the challenges of a rapidly developing world and as we address the changes entailed by globalisation and by the proliferation and permeation of digital technologies in our diverse cultures. Underlying the parable is the message that much of what is pursued in the name of "education" may be of little long-term use to individual learners and may sometimes even be counterproductive in terms of the skills needed to equip them for employment and changing work patterns in later life. Certainly today we hear calls from business and industry for young people who can work together, and who are more analytic and more creative in the way that they tackle problems; yet these are rarely explicit curriculum goals, or the focus of our competitive summative assessments. The satire also suggests that some of the views held by the wise old men that Benjamin was gently mocking may have merit, though perhaps the right views held for the wrong reasons. They believed that formal education should focus on teaching higher-level principles, because the specific details— "mere training"— may be too context-dependent. In this article I provide an overview of the key concept of 21st-century skills and a more detailed analysis of critical thinking so as to consider the role of knowledge and the importance of values in order to unpack what curriculum reform and an education for the 21st century might require.

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What is a 21st-century education?

21st-century skills

The late 20th century and the beginnings of the 21st century have seen significant changes in the skills needed in today's world, for both work and leisure (Rotherham and Willingham 2010). These are associated with the emergence of new forms of technology, and particularly information and communications technologies (ICTs). These are now more commonly known as "digital technologies", where information is more easily moved, presented, manipulated, and re-presented. Technology has changed both how we can learn, and what we need to learn. It affects how we identify the final goals for learning, and how we can support how a student reaches these goals (Colwill and Gallagher 2007). There is some consensus between educators and those outside education that we must establish certain core skills, which should be taught in schools and should be included in the curriculum (Binkley et al. 2012). In this introductory section I try to respond to these questions: What are these new 21st-century skills, and how should we teach them?

The term "21st-century skills" is widely used, but there is no single framework for what is included under this umbrella heading nor an analysis of what knowledge is required for
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these skills (Ananiadou and Claro 2009); what is essential for some people or particular organisations is not so important for others. In his review, Dede (2010) compares a range of frameworks about what students should learn to become fully prepared to live in the 21st century. He adopted the Partnership for 21st Century Skills framework as a baseline to compare and contrast other perspectives, and concludes that within the overall skill-set, each group brings out a different emphasis. He then categorises these skills into two broad groups. The first are "perennial": retained from the previous century, but still of value in this century. This includes areas such as communication, creativity, and critical thinking, which were identified previously but which now have increased emphasis. The second group is "contextual" skills, unique to this century, such as the capability to manage large quantities of digital information that appears relevant for decision making.

In contrast, Silva (2009) states that these 21st-century skills are not new; they just represent a shift in emphasis. For example, he says, when people started to interact with other cultures they needed to translate knowledge into their own language and context; the result was a massive body of knowledge they needed to write, evaluate, and use in their lives. So they had to start using more complex skills that we would today call "higher-order" thinking (after Bloom, Engelhart, Furst, Hill, and Krathwohl 1956) or "productive thinking", rather than reproductive (after Romiszowski 1981; see also Moseley, Baumfield, et al. 2005). In other words, people have used 21st-century skills in previous centuries but

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in a different context and for slightly different purposes. Silva points out that many of today's teachers are familiar with these skills as they were trained to use Bloom's taxonomy, which has organized the objectives of learning according to the level of cognitive demand or complexity (Jerald 2009). Overall, there is some agreement on how students might apply their learning authentically in various situations and contexts (Voogt, Erstad, Dede, and Mishra 2013). Arne Duncan (2009), the United States Secretary of Education, emphasises that 21st-century skills increasingly demand creativity, perseverance, problem solving, and teamwork. (For a detailed analysis of a number of these frameworks, see Voogt et al. 2013.)

What are these skills?

As noted above, there is no single definition of what constitutes these skills. Trilling and Fadel (2009; see also http://www.p21.org) outlined a framework for 21st-century learning, defining the skills they thought essential for students' learning. They specify that these are not to be taught instead of core subjects but embedded into them, though they do not develop the relationship between these skills and content knowledge. They present four broad categories: Core Subjects and 21st Century Themes, Learning and Innovation Skills, ICT Literacy, and Life and Career Skills. The Metiri Group and the North Central Regional Education Laboratory (NCREL) have also developed the 21st Century Skills Framework

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(Burkhardt et al. 2003), again with four key groupings of skills: Digital Age Literacies, Inventive Thinking, Effective Communication, and High Productivity.

Again, the focus is on the economic imperative for productivity (Dede 2010)—on students learning to access, interpret, and communicate information represented digitally—and on creative thinking and communication. (Belshaw (2012) discusses and critiques the concept of digital literacy and the value of preserving some ambiguity.) These capabilities are similar to the six skills identified as vital for inclusion as part of the US National Educational Technology Standards for Students prepared by ISTE (2007): Creativity and Innovation; Communication and Collaboration; Research and Information Fluency; Critical Thinking, Problem Solving, and Decision Making; Digital Citizenship; and Technology Operations and Concepts.

Considering the change of focus, the emphasis is now on innovation and the changes that technology has supported in terms of the "information revolution" and "knowledge economy" (Webster 2002). In addition, some authors (e.g. Ananiadou & Claro, 2009). argue that the digital world and the interactive nature of technology require more participatory education and engaged citizenship, as acknowledged in the European competences model, discussed below. Learning is about developing the quality of one's

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judgement and the facility to use one's skills, knowledge, or understanding in order to resolve a challenge or problematic situation, above all through taking action (Dewey 1933). Such judgements are refined through experience and can be supported with the guidance of a teacher or mentor but are dependent upon undertaking inquiry (the use of knowledge to answer a problem or question) and then taking action (to test the utility of the solution). The nature and availability of information may change the skills and judgements required, but this does not alter the challenge of interpreting and translating information into active and useable knowledge, except perhaps that the increasing scope and scale of available information in today's digital age may have both advantages and disadvantages. On the one hand, access to information is undoubtedly easier, but we face more information, and often of questionable quality. This increases the complexity of the challenge but indicates the importance of more complex and more productive thinking in an effective education for today's learners. "Productive thinking" can be defined as what Bloom et al. (1956) referred to as analysis, synthesis, and evaluation and various combinations of these and other processes, when they lead to deeper understanding on the part of the learner, a defensible judgement, or a valued product. The phrase is intended to capture the idea that this kind of thinking "is also concerned with generating ideas and has consequences for action" (Moseley, Baumfield, et al. 2005, p. 119).

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It is also true that the range and forms of available information are changing with the advent of new digital literacies, but we need to be aware that these are not replacing other literacies. Rather they are overlaying them and increasing the complexity of what can and must be learned with the demands of multi-layered meanings and more complex semiotic systems (Kress 2003). This reinforces the importance of more complex or productive thinking including both critical and creative thinking, as well as the importance of digital and technological skills, communication skills, and the acquisition and application of knowledge to problems and real-life contexts, similar to the European "competences" framework. In all of the various 21st-century skills frameworks, the importance of critical thinking is acknowledged, so I turn to this theme next.

What is critical thinking?

Critical thinking is often thought of as the capability to think clearly and rationally. The concept tends to imply reflective and independent thinking. Indeed, as Fisher (2011) observes, many contemporary definitions of critical thinking owe much to Dewey's (1933) definition of reflective thinking, with its emphasis on knowledge and belief: "[A]ctive, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusions to which it tends"; it

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includes "a conscious and voluntary effort to establish belief upon a firm basis of evidence and rationality" (p. 9).

Critical thinking has been an important movement in the education system in the United States for several decades; in fact, in 1987 the American Philosophical Association convened an expert panel to undertake a systematic inquiry into the contemporary situation in education and assessment. Its report includes a consensus statement regarding critical thinking and the ideal critical thinker, which begins:

> We understand critical thinking to be purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based. CT (critical thinking) is essential as a tool of inquiry. As such, CT is a liberating force in education and a powerful resource in one's personal and civic life. Whilst not synonymous with good thinking, CT is a pervasive and self-rectifying human phenomenon. (Facione 1990, p. 2)

This definition reflects the concern with identifying rigorous and appropriate criteria for formulating judgements and the need to achieve a sound basis for belief and action as a key principle, though it does not specify the role of knowledge and values. Ennis (1985), a leading figure in critical thinking, encapsulates this more succinctly when he describes critical thinking as "reasonable, reflective thinking that is focused on deciding what to

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believe or do" (p. 45).   In the United Kingdom, critical thinking has been gaining more attention since the introduction of the AS Level in Critical Thinking (Fisher 2011); it has long played a role in international programmes such as the International Baccalaureate (Hill 2002, 2012).

Critical thinking is therefore not simply a matter of accumulating information and content knowledge. It is perhaps no surprise that in the final decades of the last century critical thinking and developing thinking skills became more prominent in education as people recognised the changes that technology was enabling and requiring in terms of information and knowledge (Pithers and Soden 2000). Some perspectives on critical thinking take an inclusive view of the skills involved, such as Halpern (1997), encompassing thinking from memory to creativity; others, such as Ennis (1987), focus more on argumentation and logic. Moseley and his colleagues (Moseley, Baumfield, et al. 2005; Moseley, Elliott, Gregson, and Higgins 2005) also examined the definitions and classifying principles used in 55 thinking frameworks or taxonomies, 38 of these described *critical* thinking; two of the key distinguishing features they found were the presence or absence of reflective and metacognitive processes, and the importance of dispositions or attitudes with conative and affective features, such as those in the frameworks of Ennis (1985, 1987), Paul (1982, 1987) and Lipman (2003). However, they found that some frameworks were limited to the cognitive/metacognitive domain (Moseley, Baumfield, et al 2005a).
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Another key feature of critical thinking frameworks is that few authors specify different kinds of objectives for thinking (e.g., global or specific, short-term or long-term) which might influence the appropriateness of the thinking involved. So, for example, if someone falls into the river right in front of you, your decision about what to do does not require a full and reflective analysis of possible options and their advantages and disadvantages, or even generating a series of hypotheses for testing. It requires quick thinking about the options, and then prompt action. The value of critical thinking is always in relation to the focus of that thinking. In Dewey's terminology, the more problematic the issue, the more valuable critical thinking is likely to be in finding an effective solution or action leading to a solution.

Critical thinking or critical thinking skills?

Of course the philosophical perspective itself has difficulties. There is no clear consensus among philosophers about a definition of critical thinking. McPeck (1981, p. 7) defines it as "the appropriate use of reflective skepticism within the problem area under consideration" and closely identifies these problem areas with subject disciplines. He argues that developing expertise in a subject discipline requires more knowledge of that discipline, because thinking critically about something is thinking about that specific subject content. However, without going in detail into the debate about subject specificity

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and general thinking skills, this seems too extreme a position. Some aspects of critical thinking may well be useful across academic domains, and even with experiences outside of a learning or educational context. These skills (or attitudes and dispositions) may be particularly useful as learners develop their expertise.

In addition, from a teaching and learning perspective, making connections for learners to see similarities across their learning might usefully take a "thinking" perspective (Higgins and Baumfield 1998). However, the use of the term "thinking skills" is problematic. Though practitioners and policy-makers often use it, those actually involved in research and development rarely do because "skills" can have negative connotations and it is hard to teach thinking skills without also developing critical and reflective attitudes and dispositions and including specific subject content knowledge as part of students' development. Another limitation is the focus on the individual, rather than the context and culture. Skilful thinking also requires one to understand the nature of expectations in a particular context and what a successful outcome might look like.

Ennis (1987, p. 45) understands critical thinking as "reasonable reflective thinking that is focused on deciding what to believe and do". Although he develops a taxonomy, he states strongly that the components cannot be "criterionised so that judgments can be made mechanically" (p. 45). Paul (1982) takes up this crucial point about how critical thinking

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relates to teaching, learning, and assessment, and distinguishes two senses of critical thinking. In the weak sense, a range of skills can be used to detect mistaken reasoning and in the strong sense, the complexity of most situations is acknowledged and "precise identification and definition depends upon some arguable choice among alternative frames of reference" (p. 3). This means that for Paul effective critical thinking involves judgement which is context-dependent. Ennis further argues that one purpose of critical thinking is to develop learners' perspectives; he argues for dialogue or "dialectical experience" as an essential ingredient in helping to develop judgement about how and where particular skills can best be used.

A wider view is provided by Matthew Lipman (2003) and the Philosophy for Children movement in school education. One key feature of the programme is that it cuts across subject boundaries, arguing for a position where learners develop connections between their areas of learning in order to draw on their experience and knowledge more broadly by actively engaging in dialogue with their peers.

Each of these perspectives on critical thinking entails differences in a critical thinking curriculum. If we accept McPeck's position, then each disciplinary area would need to identify its own distinctive rules to be observed within that specific subject area. Students would learn about a subject and this subject knowledge would be emphasised. Teaching

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critical thinking would be part of developing expertise in specific aspects of the subject. On the other hand, Lipman's approach is distinguished by using a separate timetable slot where students inquire into issues and apply their thinking in identified sessions with a pedagogic structure described as a "community of inquiry". McPeck, Paul, and Ennis do not have published curricula that can be developed for different educational settings. Lipman has such material (Lipman, Sharp, and Oscanyan 1980), and his work has been adapted internationally (Splitter and Sharp 1995) for learners of different ages, from nursery children (Murris and Haynes 2001), to school pupils, to higher education, and to online learning, in the form of the "Community of Inquiry" (Garrison, Anderson, and Archer 2010).

More can be said from the psychological perspective, too. Current understanding of the social nature of cognition and the important effect of context on an individual's thinking, its "situated" nature, resonates with some of the philosophical concerns. Though I cannot summarise all the arguments here, the implications of this debate are at the heart of the relationship between critical thinking, learning, and appropriate assessment. From both philosophical and situated psychological perspectives, assessing critical thinking is challenging. Assessing single aspects of critical thinking or discrete skills risks failing to capture either the quality of that thinking or the relationship between the identified thinking skill and the task which aims to assess it. For example, consider learning to drive.
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It is possible to learn aspects of driving in a classroom or in a practice environment and to become skilful at these separate tasks, but the assessment by a qualified tester takes place in a real environment. The tester has criteria but also needs to judge how well the learner has fitted together his observational and physical skills and must then evaluate whether or not his driving is good enough for him to be competent on public roads. Critical thinking is similar in that the appropriateness of the criticality in a specific case depends on the context and the purpose of that thinking. Assessing this appropriateness is often complex.

Descriptive or normative?

Another way of looking at this issue involves the values implicit in what counts as good thinking. Bailin (1998) identifies descriptive and normative versions of critical thinking. Descriptive definitions tend to be psychological in origin. They specify cognitive skills and the mental processes or procedures involved in different aspects of thinking. Implicit in this model is the belief that being good at critical thinking means being proficient at particular mental processes such as classifying, inferring, analysing, and evaluating. This broad, procedural view of critical thinking is similar to problem solving in that it can be undertaken as a series of steps or procedures. This approach can be used to identify the development of thinking in a curriculum, and to plan and teach based on the key ideas in

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these classifications. It can also help identify where these different aspects of thinking can be taught or where students may need more practice.

By contrast, philosophers argue for a normative definition. By this they mean that critical thinking is inextricably connected with values and essentially means "good thinking", which reflects cultural or community values about what counts as "good". From this perspective, a purely descriptive account omits the central issue of the *quality* of that thinking. For example, imagine a family jointly making a decision about engaging in a local recycling scheme. From a descriptive perspective, critical thinking would involve analysing the issue, generating and then evaluating possible solutions, and together synthesising the information to reach a decision. They could, however, analyse the issue from superficial perspectives, such as concern about enough space for bins or confusion about bins for different kinds of waste. It would also be possible to evaluate some options from a biased perspective, but still be systematic: the local factory might make recycling bins and therefore argue that households need more types of bins. A checklist of thinking skills can easily identify the presence, frequency, or absence of different kinds of thinking, but not their quality or relevance.

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A way forward: Descriptive and normative

I propose a synthesis of these two positions that builds on the strengths of each. A descriptive analysis is useful in identifying how particular aspects of critical thinking are valuable for a particular subject or in a curriculum in order to ensure that the teaching or elements of the course cover a range of critical thinking "skills", though these will still need to be taught in appropriate contexts. To assess such skills from the normative perspective, one must consider not just whether a student showed such thinking, but whether it was appropriate in the context or met particular requirements to ensure its quality. This requires some judgement by an assessor. Support for a combined perspective can be found in the empirical evidence from meta-analysis (Abrami et al. 2008): they emphatically answer "both" to the long-standing debate about whether the teaching of critical thinking should be embedded in curriculum subjects or taught discretely in separate lessons. They found that the most effective approach is a combined one where skills are taught explicitly as critical thinking lessons, but mixed with curriculum teaching which is infused with these skills (an effect size of 0.94). Learners do improve if taught general critical thinking skills separately (an effect size of 0.38), but perhaps do not know how and when to orchestrate and employ these skills. If they are taught the skills embedded or infused into a curriculum, that is slightly more effective than teaching them separately (with an effect size of 0.54), but learners may be less aware of them or of how they might need to adapt them to a different context or subject (see also Higgins et al. 2004).
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A European perspective

In the European Union, critical thinking is one of the key or "transversal" competences agreed on in 2000 as part of the Lisbon framework for international progress towards shared goals; these developed into the European Reference framework of key competences (Fredriksson and Hoskins 2007; Hoskins and Fredriksson 2008). Competences have emerged as a significant educational outcome because policymakers have demanded to know what individual learning outcomes a citizen needs to contribute to a modern globalised society, both economically and democratically. The idea of learning outcomes as competences is a blend of the usually separate components of knowledge, skills, attitudes, and values (Rychen 2004; see also Illeris 2007 for a broader conception of learning). Competences are usually assessed in relation to real-life tasks: being able to do things effectively rather than reproduce knowledge passed from one generation to the next (Hoskins and Deakin Crick 2010). This emphasises the importance of an active and first-person perspective. The rationale is again based on a conviction that this conception of knowledge will be the most useful for a rapidly changing technological and globalised world, where no one can predict what knowledge people will need or the form it will take in the next five or ten years, let alone for a lifetime.

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At the heart of the European framework of transversal competence is the belief in three key facts of education: knowledge will change, new technology will provide access to valuable information, and students must become economically competitive. Critical thinking (along with creativity, initiative, problem-solving, risk assessment, decision-taking, and constructive management of feelings) runs across or is embedded in all of the competences, but particularly communication, digital competence, and civic competence. Moreno and Martin (2007) analyse developments of this idea across Europe and Fredriksson and Hoskins (2007) offer a broader view.

A further dimension to the European competences approach lies in the development of indicators or assessments to track progress towards these objectives. Whilst this may be understandable from a political or accountability perspective, from an educational viewpoint it raises the possibility of high-stakes assessments (Nichols, Glass, and Berliner 2006) and a scenario of tests involving critical thinking items and performance monitoring of pupils' progress. We are already starting to see the effects of including problem-solving in the PISA framework (Dohn 2007). Assessing such competences at the national and international levels is likely to influence the development of critical thinking in practice, and the greater the stakes, the more profound the impact, though the wider impact is likely to be complex and unpredictable (Au 2007). The challenge is to decouple the specificity of the assessments from the nature of the accountability in a way which does not produce
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negative feedback for practice. Lingard and Sellar (2013), in their account of "catalyst data" and its detrimental "washback" on local policy and practice in Australia, offer a salutary lesson here.

Cultural limits of critical thinking?

Critical thinking has been censured as based on masculine and Western values. Thayer-Bacon (1998) notes that until the end of the 20th century, critical thinking, which values reason over other qualities, has had few detractors in the literature. She claims:

> This valuing of reason over other tools is not new with current critical thinking philosophers, it reflects a Euro-western cultural bias that can be traced all the way back to ancient Greece. The valuing of reasoning over all other abilities is also a gender bias, as reasoning (the ability to think logically) has been considered predominantly a male ability in the Euro-western world, while intuition, imagination, and emotional feelings have been associated with women's abilities. (p. 125)

Whilst these objections clearly have some validity, the key issue is in the phrase "over all other abilities". So long as critical thinking is regarded as *one* of the ingredients of a 21st-century education, the criticism is mitigated. Paul (1987) is one of several philosophers whom Thayer-Bacon criticises for their belief in rational thought as the dominant mode of thinking, which she sees as evident in his definition of critical thinking and his

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development of a taxonomy of Socratic questioning. For Paul, the spirit of critical thinking lies in the confidence that one can figure out the logic of anything. He acknowledges that critical thinking has been criticised as being too Western in its orientation, not dealing with creativity, ignoring the role of emotion in thought, and failing to address feminist or sociological insights. However, he claims that previous attempts to widen the scope of critical thinking to accommodate these concerns meant sacrificing some of the rigour and precision found in formal and informal logic courses. The key issue for a 21st-century education is therefore to help students understand when critical thinking is an appropriate tool, and when other kinds of thinking and feeling may be needed, instead or in combination.

Critical thinking and values in education

Another common assumption is that religious or moral values are in conflict with critical thinking—but this is not necessarily the case. Islam, for example, encourages reflective and critical thinking (Kazmi 2000). The Qur'an frequently challenges the reader to reflect, to think, and to contemplate to develop understanding. The destiny of human beings is not to be passive but to be reflective, critical and creative; we have been provided with minds to do this. A creative mind is also critical mind and in Islam a dynamic relationship exists between faith and reflective thought (Kraince 2007).

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Understood from this perspective, critical thinking is framed by limits set by its underlying purpose. In Islam, reading the Qur'an as an intellectual challenge is justified because of the value placed on accepting religious truth based on understanding and examination. Knowledge has no value in and of itself; its value lies in bringing humankind closer to Allah. Reason and intellect may be the only way of understanding this world, but understanding achieved only through reasoning and intellect does not offer a sufficient basis for religious precepts without a basis in faith. Of course, these values need not necessarily be religious. A humanist perspective (BHA 2014) encourages people to think for themselves about what is right and wrong, based on reason but also on respect for others (Norman 2012). The value put on life's experiences means that using reason alone will not allow one to find meaning, beauty, or joy in human experiences. These are experiences which critical thinking can help us understand and act out. Without an explicit underpinning framework of values, critical thinking can all too easily descend either into sophistry or into logically valid arguments, but based on unreasonable or unethical premises.

If we accept and respect the importance of underlying values, then these indications of the limits of critical thinking imply the need for an overall epistemological framing of critical

thinking and belief. Arguably, the best candidate for this is William Perry's (1970) Development Scheme, shown in Table 1 (see Moseley, Baumfield, et al. 2005), which he developed from studying "the variety of ways in which the students responded to the relativism which permeates the intellectual and social atmosphere of a pluralistic university" (p. 4). He expected that students would purposively move away from authoritarianism (Adorno, Frenkel-Brunswik, Levinson, and Sanford 1950) towards a synthesis of contextual pragmatism and existential commitment (Polanyi 1958). For some students, this involved rejecting a literal interpretation of religious truth, but ending up with a renewed and more tolerant religious faith. He portrayed this ideal as achieving a courageous and creative balance between dialectically opposed intellectual and ethical influences, and specified 20 of them in his research. Acknowledging a debt to Piaget, he saw his framework as going beyond Piaget's with its added "period of responsibility" in which people make "structural changes" in their "assumptions about the origins of knowledge and value" (p. 229). He saw the process as a cyclical one in which people are driven by an "aesthetic yearning to apprehend a certain kind of truth: the truth of the limits of man's certainty" (p. 63). Perry also acknowledged a philosophical debt to both Dewey and Polanyi and his scheme is compatible with an unusually broad range of both Eastern and Western philosophical and psychological positions, from Piaget to postmodernism, and with Goffman's (1959) sociological analysis of the self in interaction and performance and Kohlberg's (1981) ideas about moral development (Moseley, Baumfield, et al. 2005).

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Table 1 Perry's (1970) Development Scheme

Position 1 Strict dualism	The student sees the world in polar terms of we-right-good vs. other-wrong-bad. Right Answers for everything exist in the Absolute, known to Authority whose role is to mediate (teach) them. Knowledge and goodness are perceived as quantitative accretions of discrete rightnesses to be collected by hard work and obedience (paradigm: a spelling test).
Position 2 Dualism with multiplicity perceived	The student perceives diversity of opinion, and uncertainty, and accounts for them as unwarranted confusion in poorly qualified Authorities or as mere exercises set by Authority "so we can learn to find The Answer for ourselves."
Position 3 Early multiplicity	The student accepts diversity and uncertainty as legitimate but still *temporary* in areas where Authority "hasn't found The Answer yet?" He [or she] supposes Authority grades him [or her] in these areas on "good expression" but remains puzzled as to standards.
Position 4 Late multiplicity	(a) The student perceives legitimate uncertainty (and therefore diversity of opinion) to be extensive and raises it to the status of an unstructured epistemological realm of its own in which "anyone has a right to his own opinion," a realm which he sets over against Authority's realm where right-wrong still prevails, or (b) the student discovers qualitative contextual relativistic reasoning as a special case of "what They want" within Authority's realm.
Position 5 Relational knowing	The student perceives all knowledge and values (including Authority's) as contextual and relativistic and subordinates dualistic right-wrong functions to the status of a special case, in context.

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Position 6 Anticipation of commitment	The student apprehends the necessity of orienting himself [or herself] in a relativistic world through some form of personal Commitment (as distinct from unquestioned or unconsidered commitment to simple belief in certainty).
Position 7 Initial commitment	The student makes an initial Commitment in some area.
Position 8: Multiple commitments	The student experiences the implications of Commitment, and explores the subjective and stylistic issues of responsibility.
Position 9 Resolve	The student experiences the affirmation of identity among multiple responsibilities and realizes Commitment as an ongoing, unfolding activity through which he expresses his [or her] life style.

Source: Perry 1970, p. 9-11

Though he developed the scheme based on phenomenological research, thereby grounding its theory in lived experience, Perry (1968) did not approach his task without prior assumptions. He undertook the student interviews because he believed that thinking about thinking is a uniquely human capacity and would reveal generalisations at a high level of abstraction. What he found was a fundamental distinction between reflective and non-reflective approaches, or the meta-cognitive dimension to critical thinking identified by Moseley, Baumfield and their colleagues (2005). The borderline is between dualistic and

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relativistic thinking and the student makes the step to Position 5 only through reflective awareness (see also the levels of epistemological understanding developed by Kuhn and Dean 2004). This borderline can be equated with Bloom's distinction between lower- and higher-order thinking, or the distinction Moseley and his colleagues make between productive and reproductive thought, and it provides a threshold for "critical thinking". Moving from "relational knowing" to "commitment", in Perry's scheme, is analogous to the strengthening that occurs in the "key dispositions" of Perkins, Jay, and Tishman (1993), or the "habits of mind" described by Costa and Kallick (2000). It allows the individual to synthesise belief and rationality and forms the basis of critical thinking, relative to a set of values which are themselves open to scrutiny.

Knowledge and critical thinking

Embedding critical thinking in a curriculum has epistemological implications, and some further tensions in the application of the term relate to different understandings of the nature of knowledge and learning. Critical thinking emphasises the learner's process of reflecting and analysis in the process of learning or coming to know (Higgins and Baumfield 1998), and implies a difference in the quality of knowledge the learner achieves through purposeful activity. It aligns closely with the philosophies of thinkers such as Dewey, Merleau-Ponty, and Freire regarding the relationship between the learner and what

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is learned. It emphasises that this relationship is integrated in the same way that dancing creates both the dancer and the nature of the dance (Gill 1993): knowing is an interaction or transaction between the knower and the known (Dewey and Bentley 1949). Much of what is discussed as learning in education in fact equates to how the learner retains information assessed by applying specific academic skills, with a fallacious separation between who the knower is and what they know. Conceptually, this is a challenging position to take, as I believe we can only describe acquired information as knowledge once we apply it actively. An important facet of this relational quality of knowing is dialogue and interaction, or learners applying these ideas creatively in expressing their understanding through discussion with others. Dewey (1933) would argue that even this is an incomplete conception of knowledge, as such activity could still be somewhat artificial and it is only valid once such information is applied in some purposeful inquiry to resolve an issue which is in doubt.

This intrinsically evolutionary and pragmatic stance towards knowledge conceives it as neither ideal or pre-packaged but discovered in purposeful action. From this perspective, "knowing" is always a productive or creative act. Creativity in this sense includes how a child learns to crawl as well as how a musician composes a song. It can be understood as creative for the individual, if not original for the culture. For Dewey, effective learning through expressive or purposeful action was not a gradual approximation to some ideal

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concept or form or any abstract proposition. It is knowledge because, like effective science, it opens up creative possibilities for new ways of perceiving the world and for taking action within and upon it. This approach is also consistent with the definition of more complex forms of thinking as "productive thinking", as Moseley and his colleagues synthesised the 55 thinking frameworks they analysed. These frameworks map closely onto the categories of higher order in Bloom's (1956) terminology; Anderson and Krathwohl (2001) have revised it with an emphasis on the meta-cognitive dimension. However, Moseley et al. (Moseley, Baumfield, et al 2005; Moseley, Elliott, et al. 2005) see a qualitative change between *reproductive* knowledge, which is developed or acquired through recognition, recall, and basic understanding, and *productive* knowledge, which creates new knowledge for the knower, through analysis, synthesis, evaluation, and creative or reflective thinking. This conception of knowing and learning seems more appropriate for a rapidly changing technological world where information is widely available. It is learning and, through practical reflective and critical thinking, working out what information to apply and how to apply it purposefully becomes the distinguishing educational feature of knowledge that the individual sees as "productive". Of course a task remains here: to research the relationship between skills and knowledge more closely, particularly in the context of the digital world. Access to information is clearly different, but what about the way information is represented and communicated in terms of the relationship between an individual's knowledge and the wider community?

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From Gutenberg to Google: Plus ça change?

History is full of calls to reform education; the contemporary debate about 21st-century skills is hardly new. The so-called "progressive education" movement of the early 20th century, of which Dewey was a part, can be seen as a reaction to the profound social and cultural changes in North America and the challenge of urbanisation and industrialisation (Ryan 1997). Contemporaries of Dewey also saw technology (and multimedia) as the future of education. The *New York Dramatic Mirror,* presented Thomas Edison's vision for schooling in 1913:

> "Books," declared the inventor with decision, "will soon be obsolete in the public schools. Scholars will be instructed through the eye. It is possible to teach every branch of human knowledge with the motion picture. Our school system will be completely changed inside of ten years". [9th July, 1913, p 24)

What we need to decide, in the first quarter of the 21st century, is how much the current pace and scale of change should be reflected in the detail of the curriculum and the pedagogy for our time. Certainly the way we can interact with information is different in terms of the quality, and especially the quantity, of information now easily accessible. Information on its own is not the same as knowledge (Hayes 1969), however, as the latter has a personal quality involving interpretation and meaning (Dewey 1933). This, in turn,

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presupposes a purpose in acquiring and using the information. Do we need a curriculum with *less* specified knowledge, allowing a greater emphasis on skills, based on the argument that information (and therefore knowledge) is more readily accessible? Or do we need *more* knowledge, as the basis for developing greater expertise and the ability to make informed and complex judgements, based on a deeper understanding of a topic or field?

If we accept the arguments presented above, then critical thinking and digital skills (or 21st-century skills) are indeed essential today. As the world changes, schools and the curriculum must reflect these changes to prepare young people for the world they will inherit once they leave school and enter the world of employment, and as citizens responsible for the democratic choices in their societies (Grossman 2008). It seems reasonable to argue that, as the availability of information increases and the status of that information may be more questionable (think of Wikipedia, for example), critical thinking must take a more significant place in the curriculum. Digital skills are certainly important in allowing children and young people access to information and the ability to participate in the digital world and this may help to engage the learner in a contemporary curriculum (Colwill and Gallagher 2007). But how much of this we need to include in the curriculum is a different question. Is opening an e-mail today like opening an envelope in the 19th century? Do pupils really need lessons in this "skill"?

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Critical thinking and digital skills are both clearly necessary for a 21st-century education, but it is also clear that even together they are not sufficient. What is needed is an increased emphasis on the broader concept of productive thinking which helps the individual to surmount challenges and find solutions to problems. This certainly includes critical thinking and reasoning, but also involves creative and inventive thinking and the capability to synthesise information (Higgins, Baumfield, and Hall 2007) in light of one's values. What we don't want to do is create our own "cyber-tooth curriculum" which will need to be changed as technology evolves throughout the 21st century. We need a balance between the "wise" elders' view that the "essence of true education is timelessness", and the perspective of the younger and more inventive members of the tribe on practical and applicable skills for the contemporary world. That was the challenge Benjamin (1939) outlined in his fable.

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