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# Education 4.0: Is characterising and harmonising intelligences a way of thinking about a pedagogy 4.0 for higher education?

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**Abstract**

This chapter will provide an original perspective of current thinking around what is being called Education 4.0. Through making certain connections, we aim to stimulate debate and give some guidelines towards a conceptual platform for Education 4.0, providing a conceptual and pedagogical roadmap. These conceptual foundations are developed through focusing on a consideration of how human intelligence is different from artificial intelligence, and suggesting a distinction, as a metaphor to assist our learning design, between *'cognitive intelligence'* (cognitive and knowledge/data based) and *'holistic intelligence'* (emotional, ethical, agentive and cognitive). Through considering what human intelligence 'does best', we then consider the importance of emotional intelligence and how mindfulness is important and can play a role in promoting mental well-being and be treated as part of the pedagogical picture, a picture that also needs to consider the cultivation of psychosocial dimensions such as self-efficacy and agency. We provide some initial pedagogical principles derived from this developing thought into Education 4.0, before briefly considering the future of learning and work. We conclude by considering the necessity for radical extension of our pedagogical practices, if we are to embrace this need for a changing pedagogy for a changing and increasingly digital world.

**Keywords:** Education 4.0, Industry 4.0, Learning Design, Artificial Intelligence, Emotional Intelligence, Psychosocial Dimensions, 21C Skills, Digital Skills.

## 1. What is Education 4.0 and why do we need it?

Since Klaus Schwab introduced the notion of the fourth industrial revolution (IR4.0) in 2016 there has been intense dialogue, particularly in Higher Education, about what an implied *Education 4.0* should look like and be operationalised in teaching and learning practice. This debate is centred on the notion that the intersection of Artificial Intelligence (hereafter AI, and see next Section), Big Data, constant – and often de-localised - connectivity, and robotics (Industry 4.0) establishes a fast-emerging need for an educational paradigm shift, through which teaching, learning and assessment could be completely transformed. Although according to the UK Jisc[1], at the time of writing, these developments are

[1]Jisc is an established United Kingdom not-for-profit company whose role is to support post-16 and higher education, and research, by providing relevant and useful advice, digital resources and network and technology services, while researching and developing new technologies and ways of working.

currently 5-10 years in the future, we argue that there are a number of conceptual strands that can be considered to present an important broad-brush picture that illustrates the current state of play in a useful way. These can help to guide our thinking about developing a Pedagogy 4.0.

However, before considering Education '4.0', it is worth considering previous 'iterations' (and numbering) of previously reported Education paradigm shifts, to put this thinking into a historical context. Kay and Goldspink (2018), identify three iterations or extant paradigms of the 'education industry', in which Ed1.0 is hierarchical, knowledge-based and content-driven, focusing on 'academic achievement'; Ed2.0 focuses more on *engaging* learners in the process of learning through 'development towards design'; whereas Ed3.0 places greater emphasis upon self-regulation and reflective capacity in students. Each iteration or paradigm sees increasing levels of learner agency in education, which, according to Leadbeater (2017), consists of multiple aspects and exists at multiple levels, from personal (student / teacher) to systemic (e.g. school, infrastructure etc.).

We argue that *harmonising* what we call *cognitive (cognitive and knowledge/data based) and holistic (emotional, ethical, agentive and cognitive) intelligences,* can inform the currently emergent and dynamic educational paradigm: Education 4.0 for Industry 4.0 (hereafter I4.0). *However, at the outset we should also flag that our position is deliberately more progressive than a common position, of emphasising how we can 'skill up' students for responding to I4.0. On the contrary, our stance is that Education 4.0 should shape, question and challenge, and ultimately develop Industry 4.0, and not simply respond to it.* We use these terms, *cognitive* and *holistic* deliberately, to denote the different characteristics of each type of intelligence from a learning design perspective and avoid broader and more sophisticated debates about the differences between *artificial* and *human* intelligence.

In other words, whereas Education 3.0 could be viewed as a response to Industry 3.0, within an emergent Industry 4.0, Education 4.0 anticipates the emergent dimensions, parameters, values and principles of Industry 4.0, which has both established and emergent features.

Although, as implied by the discussion above, there is not a clear and consensual definition of Education 4.0, it is more of an important rallying call to re-think Education, and particularly Higher Education, to map to the needs of a developing understanding of Industry 4.0, and the rapidly evolving digital landscape in which we live and work more generally.

Importantly, this call has taken on a new dimension due to the *globally disruptive influence of COVID-19 and resulting 'lockdowns'*, prevalent at the time of writing. This has seen radical and immediate shifts in both the world of work and education, with significant impact upon the health and wellbeing, social, technological, and economic realities of people across the world. Industry and education are now both likely to see, amongst many other things, a rapid acceleration in digitisation generally, automation and AI, to account for economic loss, impacting the lives of many. Concurrently, technology has facilitated the continuation of social connectivity, online learning and professional practice, where *physical distancing* and travel restrictions have limited routines, practices and behaviours based on face-to-face contact and co-presence. Generally, the adoption of more digital forms of communication and collaboration has already happened virtually 'overnight', and it is now most likely that these more digital practices will become embedded in everyday learning and working going forward. Similarly, learning has been re-contextualised from physical to digital contexts, and more located in, and distributed through, homes, instead of educational institutions. Arguably, one the most significant and specific impacts is likely to be on young people's and students' mental health and how this relates to learning, particularly in response to the COVID-19 pandemic. This is elaborated upon below, however not fully as this is a substantive and complex issue that cannot be addressed in this Chapter.

Before launching into unrestrained near-futurism, it is worth being cautious about the use of numbers to signify a step-change like the ones above. Around ten years ago one of the authors (Ravenscroft, 2009; Ravenscroft et al., 2012) wrote enthusiastically about the impact on teaching and learning of

social computing and Web 2.0, yet these articles, whilst received respectably, seem somewhat dated when set against current debates. Nevertheless, the "4.0" signification is useful, because it encourages us to consider the alignment of Education with an Industrial landscape that has undergone revolutionary change in a relatively short time, and perhaps more importantly, is likely to continue changing at an accelerating pace. Whether or not Education 4.0 becomes version 5, 6 or whatever, there is an urgent need to re-conceptualise and revise what we consider contemporary Education should be, and particularly in HE, what pedagogies can operationalise revised learning ideas and approaches relevant to our current and near-future digital world.

To focus our critique and propositions, we consider and extend the idea that one of the most important contemporary skills, that is popularly stated as a growing educational necessity, is the ability to *solve complex problems in often uncertain and changing conditions.* We hold that this goal should be extended to *finding and solving complex problems in often uncertain and changing conditions.* This difference is important because identifying new opportunities, solving new problems, and essentially, 'problematising' the world in digital terms is the cornerstone of digital approaches that realise innovative solutions or present new ways of experiencing and understanding the world. Another, more detailed way to focus on this debate, is to consider 'what AI can't do', and how we need to work with AI, in a harmonised way, going forward. In considering this, it is not just employment and Industry that matter, as our everyday lives now involve attempting to make sense of numerous channels of digital communication from sources of varying quality and with varying agendas. Making sense of the world as an individual person and citizen, amidst 'fake news' and biased, emotive persuasion, in ways that allow us to have agency in it, is arguably a primary challenge for every citizen on the planet, so, we argue that an Education 4.0 should also help with this.

In considering these issues, it is important to point out that we are aiming to provide 'one way of thinking about' Education 4.0 and developing Pedagogy 4.0. Although a consideration of the broader practical implications for adopting new learning design approaches, staff development and what exactly the future skills for future jobs will be is beyond the scope of this chapter, we provide some thoughts on the latter that follow from the line of argument we have pursued. Similarly, we have given some developing examples elsewhere (Ravenscroft, Richards and Bunce, 2019). These include using participatory internet radio to develop employability and 21C skills with socially excluded young people (Ravenscroft, 2019) and on an international scale (Ravenscroft et al., 2018), and implementing the approach of 'Meta-Praxis' across a whole Performing Arts course cluster at University of East London (UEL).

In this chapter, we are proposing a platform for thinking about and debating prescient issues and applications, for learning for the future, to make a conceptual bridge between the development of Industry 4.0 and the practice of a potential Education 4.0.

## 2. Is it useful to think how human intelligence differs from artificial intelligence?

A number of researchers, and Rose Luckin (2018) in particular, have argued that understanding and harmonising the way that human intelligence will relate to, interact with, and generally work with artificial intelligence (AI), will be pivotal for future learning. One direct perspective arising from this point of view is to consider what do humans need to be able to do that AI can't do (and is unlikely to be able to do in the near future). It is important to qualify this comparison in our discussion. Recently, with the rise of the pervasiveness of machine learning, there has been a tendency to equate machine learning with AI, whereas AI is a broader set of approaches and techniques for modelling human intelligence (e.g. Russel & Norvig, 2016). Put simply, machine learning is a subset of AI that uses algorithms and statistical models, which work like neural networks to learn as a 'simple brain', to then perform tasks at an almost infinite scale (e.g. recommender systems). Whereas AI is a broader initiative,

including an array of other approaches including models of logic, reasoning, distributed cognition, probabilistic and rule-based systems. We will be deliberately broad in considering, generally, what AI is currently doing, or going to do in the near future, without restricting ourselves to specific AI techniques[2].

For example, Paul Feldman (2018) of Jisc has said that:

"95% of accounting tasks, 94% paralegal jobs, for example, are predicted to be impacted by technology"

Feldman, Jisc Blog, (2018)

Although Luckin's (2018) work was articulated towards intelligence and learning generally, in formal and informal contexts, it holds significant importance for debates about HE pedagogy. She provides a sophisticated way of conceptualising what she calls *interwoven intelligence*, that consists of *academic, social* and *meta-intelligence.* Building on this she offers two key concepts that are pedagogically useful, which are beyond AI but natural for humans, namely *perceived self-efficacy* and *social interaction*.

We argue, that taking this point further, with a view to developing practical pedagogy, it is useful to characterise what AI 'does best' and what humans 'do best' to concentrate our attention on the Education 4.0, and implied Pedagogy 4.0 debate.

In taking into account the work of Bialik & Fadel (2018), about 'what machines do best' vs 'what humans do best', we have articulated this in terms of comparative intelligence, and not comparative behaviour more broadly (as Bialik and Fadel do). Currently, AI is excellent for:

1. Solving well-defined problems regardless of their scale and complexity, usually based on concrete rules (e.g. chess and route-planning);
2. Generating knowledge and data driven diagnosis, predictions and questions (e.g. medical diagnosis and tax compliance);
3. Language processing and communication (e.g. speech recognition and chatbots);
4. Adapting to human behaviour (e.g. recommender systems using machine learning); and,
5. Doing all these things (1 – 4) repetitively and at a scale and speed that is impossible for humans.

The key characteristics of this current form of AI is that it is predominantly *cognitive and based on knowledge or data* (if we assume that knowledge and data are different for the moment), so we could paraphrase this, from a learning design perspective, as *'Cognitive Intelligence'.*

In contrast, the key characteristics of human intelligence that are different from this, are that it is more *emotional, ethical, creative and agentive,* which we could paraphrase, also from a learning design perspective, as *'Holistic Intelligence'.* Therefore, human intelligence is currently better at:

1. Adopting an abstract and ambitious or idealistic outlook on life and problems in general;
2. Identifying what problem or opportunity to focus on, through applying ethics and having agency and a sense of purpose;
3. Deciding and performing resource allocations strategically based on purpose (esp. as resources are nearly always finite), such as what the AI should do and what other humans should do;
4. Engaging in rich social interaction and participating in collaborative 'inter-thinking' (Mercer, 2002) to foster critical and creative thinking;
5. Participating in nuanced and inter-linked dialogue and communication genres and modes, such as brainstorming, persuading and negotiating;

[2] We accept that a detailed examination of "What AI does best" would benefit from a detailed examination of all commonly adopted techniques. But in this Chapter, which focuses on broad ideas for learning design, we have had to sacrifice this in-depth examination for a deliberately higher-level view.

6. Individual and group reflection;
7. "Thinking on your feet" and "thinking outside the box" when conditions may be uncertain and solutions may be unclear or involve a number of options, that might also be conceived as making "creative leaps" and/or "taking calculated risks";
8. Applying, developing and reflecting upon emotional aspects of intelligence;
9. Considering combinations of clear and precise knowledge or data along with less defined knowledge, data and ideas to make socially or ethically informed decisions; and,
10. Developing and using 'social capital' to influence others and make things happen, that will include forming and developing relationships and being active in networks in ways that have influence.

We are aware that our characterisation of intelligence, as *Cognitive* or *Holistic,* may seem somewhat simplistic, especially when compared to Luckin's (2018) more sophisticated *interwoven intelligence* model. But our motivation is different, whereas Luckin was investigating the sophistication and nuance of intelligence, instead, we are proposing tangible pedagogical design 'levers', or heuristics, that could help us in moving towards a Pedagogy 4.0. In other words, the cognitive and holistic distinction is a design metaphor, not an evidenced psychological distinction, although it may have some value in this respect and be worthy of further thought and empirical investigation.

Another important aspect of today's, and future human intelligence, is that human beings increasingly need to be resilient and apply measured thought and action in changing, or sometimes volatile and ambiguous situations, or the VUCA[3] world as it's called (standing for high levels of volatility, uncertainty, complexity and ambiguity). These situations may involve continuous monitoring, reflection, contingency planning, and working under pressure whilst also being 'mindful' and ethical alongside being goal-oriented.

Another way of thinking about this is that humans have a greater capacity for metacognition (Flavell, 1979; Metcalfe and Shimamura, 1994), where this may also involve understanding and managing emotions. Put simply, metacognition involves reflecting upon and monitoring our own thinking, or 'thinking about our own and others thinking'. Similarly, this links to a febrile debate in AI that goes back to the 1980's, and John Seale's famous "Chinese Room Argument", which is that AI cannot have 'consciousness' or be 'self-aware' and therefore cannot process information with the same rich understanding that humans can. The opposite of which, 'AI becoming conscious', has been the premise for many famous science fiction films, such as "2001 a Space Odyssey", "Demon Seed", the "Terminator" films and the recent UK Channel 4 series "Humans". Below we investigate this currently (just) human characteristic of emotions linked to emotional intelligence and mindfulness.

## 3. Emotional intelligence and mindfulness

Expanding on Luckin's (2018) emphasis on the importance of self-efficacy, which in a sense is a rational form of confidence (Ravenscroft et al., 2018), we need to embrace the importance of psychosocial dimensions more generally and arguably extend this consideration to also recognise that emotional intelligence is also crucial. According to Psychology Today (2020):

Emotional intelligence refers to the ability to identify and manage one's own emotions, as well as the emotions of others. (psychologytoday.com/gb/basics/emotional-intelligence, 27/8/2020)

[3] It should be noted that the authors have some scepticism about the "VUCA" term, that is derived from the US Military response during the 'Cold War' period, and it has also been criticised as being over simplistic. But, for the purposes of this Chapter it is used as 'short-hand' for summarising a common characterisation of the context for I4.0.

A useful definition extended by the American Psychological Association (APA) dictionary states that emotional intelligence is:

"a type of intelligence that involves the ability to process emotional information and use it in reasoning and other cognitive activities, proposed by U.S. psychologists Peter Salovey and John D. Mayer. According to Mayer and Salovey's 1997 model, it comprises four abilities: to perceive and appraise emotions accurately; to access and evoke emotions when they facilitate cognition; to comprehend emotional language and make use of emotional information; and to regulate one's own and others' emotions to promote growth and well-being." (dictionary.apa.org/emotional intelligence, 26/8/2020)

This point is developed further below, particularly because the world and work have far more complexity, uncertainty and 'stress' in general, and arguably, most of us will need to understand emotions, and apply emotional intelligence, especially in ways that support positive mental health as part of our overall learning experience. Pioneering work in this area is being performed by Seldon and Martin (2017), with their concept of the "Mindful University", that is proactive rather than reactive about mental health.

Jon Kabat-Zinn, considered a pioneer of the contemporary application of mindfulness to improve our mental health and general well-being, notes that:

"Mindfulness means paying attention in a particular way: on purpose, in the present moment, and nonjudgmentally." And (he also says) then I sometimes add, "in the service of self-understanding and wisdom."

Although this is perhaps the most widely adopted definition of mindfulness, it is arguably not the complete story, given its somewhat instrumental and individualistic flavour. Other definitions of mindfulness can also incorporate a more collective and ethical dimension, emphasising mutual understanding and how a more collective consciousness is important. Psychology Today (2020) offer 3 definitions, along with one that they consider a more 'scientific' one:

"Mindfulness is the **self-regulation** of attention with an attitude of **curiosity**, openness, and acceptance."

(psychologytoday.com/us/blog/what-matters-most/201711/3-definitions-mindfulness-might-surprise-you, 27/8/2020)

We would argue that this definition, referring also to openness and acceptance, implying a more collectivised approach may provide a platform for understanding the world and others more broadly and therefore be helpful in identifying potential problems and proposing or designing solutions. It is particularly useful to consider this definition in relation to working together in teams, where understanding and accepting or negotiating with the views of others is an important collaborative skill. Another way of expanding upon this would be to consider how to develop mindfulness that is skilful in the way we understand ourselves, our role in society and how we have agency within our environment.

There is a parallel here with our earlier discussion on "What AI can't do", which is, AI cannot yet be mindful and make decisions that are guided by emotional intelligence, creativity, imagination and an ethical frame. The human mind has these capacities and can also apply them in a 'gestalt way' to understand and solve problems, similar to the way Boyle and Ravenscroft (2012) describe in their approach to learning design called "Deep Learning Design". Put simply, this means predicating learning design on the full human experience in context, rather than considering knowledge, cognition and curricula as something separate from their application. A corollary of this is, more fully embracing the human experience means that we should also more carefully consider the importance of positive mental health as an underpinning condition for successful learning. This is briefly discussed below, particularly

in the context of responding to the COVID-19 pandemic, accepting that it is a complex and substantive issue.

### 3.1. The importance of positive mental health

In a sense, there is also a flipside to considering what humans do better than AI, because, in order to outperform AI and learn and flourish, we need to also consider the barriers to this happening, such as the negative influence of mental health conditions and related psychosocial aspects of learning, such as low self-esteem and confidence, that if unaddressed, can significantly reduce learning activity, educational performance and life-chances in general. Another dimension to this position is that people in general, and particularly young people and students in HE, seem to be suffering from unprecedented levels of mental health issues (e.g. Seldon and Martin, 2017; YouGov, 2016). This is an issue for further research, especially in response to the COVID-19 pandemic and the resulting 'lockdowns'.

Although it is too early to expect comprehensive evidence, research is showing responses to COVID-19 include increases in student anxiety and depression (Huckins et al., 2020), which is in line with similar responses across a number of countries (Rajkumar, 2020). However, these studies only report relatively immediate responses to COVID-19, and in the longer term, young people and students are likely to be facing greater anxieties, uncertainties and traumatic events, related to their own health and the health of others, dealing with the greater incidence of deaths in populations, uncertainties and negative predictions about economic and career opportunities, and, adjustments to the education process and methods of assessment. Linked to this, is accepting that human social relations and psychology will change permanently in a relatively short time. Put bluntly, approaches to future learning will need to take on board that we are likely to see the biggest global recession in history combined with a radical readjustment in human social relations and psychology, as we become more digitally connected and less physically connected. And linked to this, if we also consider positive mental health and being more mindful as potential foundations for learning, it is now useful to consider what specific skills are required for working and living in the rapidly changing 21C.

## 4. The 21C skills debate

Based on the current literature, debate about 21 C skills is occurring on two levels that are following different timelines. There is an ongoing debate about the need for 21C skills for the 21C workplace, with its particular emphasis on digital skills (e.g. Dede, 2009; Ravenscroft et al., 2012; NEA 2016). There is another ongoing debate, led by the OECD, about the "The Future of Education and Skills 2030". Although these debates have some similarities, in this paper we will focus on work in the near future. We also acknowledge that there is another position that 21C skills and generic skills do not exist (Neelen and Kirschner, 2016; 2018). In relation to this last point, our position is more nuanced than 'for' or 'against' 21C skills, and domain knowledge vs generic skills. Instead, we adopt the specific element of Bialik and Fadel's (2018) work, which is the notion that it is the *transfer* of meta-competences that is important, such as communication, collaboration, problem-solving, critical thinking and creativity. And further, that we can pattern-match and adapt problem-solving approaches in order to solve new problems based on our experience with earlier problems, where domain knowledge will also always be essential. The point being that sometimes, without having complete domain knowledge on which to make our decisions, we will still need to act, and it is this sort of experience that we are arguing is becoming more common in the contemporary workplace, especially as technological advances seem to be putting us in a constant state of change.

This is one of the reasons why researchers and practitioners in the contemporary learning landscape are considering the need to review our conceptualisations of competences that are suitable for the 21C, and

particularly in the context of current and future employment. Although there is some debate about what exactly these new skills are, and their relationship to more traditional 'knowledge focused' learning (Dede, 2009; Forum for Youth Investment, 2009; Sardone and Devlin-Scherer, 2010), there is some consensus that *"21st Century skills"* represent a commitment to more process oriented 'real-world' learning, such as the development of the '4 C's'- Collaboration, Communication, Critical-Thinking and Creativity (NEA, 2016). Also, in considering the importance of these new skills, researchers have pointed out (Dede, 2009; Conneely et al., 2013) that we also need to consider ongoing advances in communication technology, that is also linked to the consideration of changing forms of working practices that are becoming less based on material goods and services, and more focused on knowledge and information.

Another dimension to this debate has been provided by Collins (2010) who argued for a move away from subject-based learning to a more meta-cognitive and problem solving approach that also considered the development of the 'whole person'. Considering these sort of ideas a number of researchers have moved to a less extreme, and arguably more pragmatic position, proposing a new balancing of pedagogical approaches (Voogt and Pelgrun, 2005), which accepts that we should include more learner centred activities and working in teams cultivating these "4C's", rather than an over reliance on the delivery of knowledge, that is typically performed by the teacher. Conneely et al., (2013) argue that this is particularly important for developing creativity, which requires students to seek out new problems and develop new solutions.

Given this ongoing debate about 21C skills, we do not seek to deliberately favour one stance or conceptualisation of 21C skills over another, but instead adopt a position at a higher level, based on where there seems a consensus. This accepts that we needed to consider the move towards conceiving learning as having a greater emphasis on the 4C's and meta-competences given above (Collaboration, Communication, Critical Thinking and Creativity) and needs to consider the 'whole person' dealing with real-world situations. We are also seeking to further investigate this debate, and add to it, rather than seeking to provide definitive support, or not, to particular conceptualisations or stances. So, in taking on board this debate, we also considered in particular the importance of the *transfer* of 21C skills.

### 4.1. The importance of transfer

Bialik and Fadel (2018) also recognise the particular impact of technological development and AI upon the shaping of modern curricula to meet the demands of the changing conditions students will encounter, proposing that the relationship between *transfer, expertise* and *content* in education and the workplace must be *flipped* so that the *holistic intelligences* that may enable *transfer* are foregrounded in place of *cognitive intelligences* focused on content processing – a role now better suited to technology as collaborator in the classroom and workplace. Such a reconfiguration of the pedagogy establishes a demand for holistic and integrated approaches to learning that focus on developing *holistic intelligences* and transfer 21st C skills across a portfolio of potentially unpredictable employment contexts.

While traditional educational models focus on the quasi-sequential development of *expertise* before *transfer*, contemporary and future approaches may instead see the integrated development of both, so that students and teachers become *experts* in *transfer*, as content (knowledge and information) is leveraged for different contexts.

## 5. Implications for Pedagogy 4.0

In summarising our argument so far, one way to approach a Pedagogy 4.0 is to consider its foundations in terms of 'What humans can do better than AI'. To do this, it is important that we identify what is

essential to human learning, education and subsequent employment that is unlikely to be improved upon by AI. Another aspect to our argument, linked to this, is to consider the whole person, engaging with others and developing emotional intelligence and mindfulness alongside the psychosocial dimensions that can underpin successful learning. Luckin (2018) argues that *social interaction* and *self-efficacy* are two such characteristics, and we would argue that two other psychosocial dimensions, related to self-efficacy, are *locus of control* and *agency*. There is something that is uniquely engaging about the conditions of human social interaction, and also something similarly profound in the way that we can be more critically acute and creatively stimulated when communicating with, and in the presence of, others. Below we consider the role of arguably core psychosocial dimensions we should aim to cultivate – self-efficacy, locus of control and agency.

### 5.1. Can we cultivate core psychosocial dimensions such as self-efficacy, locus of control and agency?

The importance of *self-efficacy* in learning, and its links to agency have been thoroughly defined by the seminal work of Albert Bandura (1982) and his broader notion of "social learning theory (1977), and its definition in the Cambridge dictionary (2019) is honest to this and easily understood:

"a person's belief that they can be successful when carrying out a particular task:

*Perceived self-efficacy refers to people's beliefs*

*about their capabilities to exercise control over their own activities."*

This is an elaborated version of Bandura's (1982) earlier definition that:

"Perceived self-efficacy is concerned with judgements of how well one can execute courses of action required to deal with prospective situations"

(Bandura, 1982, p 122)

Ravenscroft et al., (2018) have shown how young people successfully performing and completing a series of engaging and contextualised learning tasks (through co-producing a radio show or series of shows), linked to the authentic recognition of their performance (people listening to and feeding back on the radio shows and receiving badges/micro-credentials) can lead to perceived developments in self-efficacy, where this is typically referred to in terms of "confidence" and "confidence to communicate". In other words, certain learning tasks can cultivate the development of a 'rational' form of confidence that is similar to self-efficacy.

Another concept in the psychological literature known as *locus of control* provides a broader lens on to self-efficacy. Locus of control is an individual's belief system regarding the causes of his or her experiences and the factors to which that person attributes success or failure. This concept is usually divided into two categories: internal and external. If a person has an internal locus of control, that person attributes success to his or her own efforts and abilities. A person who expects to succeed will be more motivated and more likely to learn. A person with an external locus of control, who attributes his or her success to luck or fate, will be less likely to make the effort needed to learn. People with an external locus of control are also more likely to experience anxiety since they believe that they are not in control of their lives.

Putting these two dimensions together, if a person is confident that they can perform well, and also considers that they are in control of the factors that determine their success, then they are, arguably, also likely to have a greater sense of *agency*. It is important here to point out that, as a concept, agency has an everyday definition and a significantly more complex scholarly conceptualisation. Its everyday definition refers to an individual's ability to make free choices and act independently in the world in a

way that achieves a tangible effect, which is the way that we will consider *agency* for the purposes of this paper, as we want to stay within psychological rather than sociological boundaries. The latter moves us into the importance of the structures within which agency is exercised, but, when considering locus of control as part of the picture, we are suggesting that, for learning and choosing which problems to solve with an internal locus of control, that should allow for a greater chance of effective agency. This sophisticated integration of emotional, psychosocial and intentional dimensions is currently far beyond AI.

### 5.2. Initial Pedagogical Principles for Education 4.0

In this section, we draw together the previous strands of our argument and capture these in terms of a broadly interpreted pedagogy based on 6 principles. In drawing together a consideration of what humans need to do that AI can't, the importance of developing emotional intelligence mindfulness, and core psychosocial dimensions, and also the literature on 21C skills - we accept that a neat and definitive synthesis is ambitious at this stage. So the principles below are suggested as a useful starting point for a Pedagogy 4.0: and to achieve holistic intelligence.

1. Problem based Learning in real-world settings
2. Working independently and in teams
3. Teacher as expert, inspirer and facilitator
4. Ongoing assessment of process and outputs - combining traditional methods, micro-credentials and critical reflection
5. Developing digital skills in action
6. Developing psychosocial dimensions and mindfulness

We describe each of the pedagogical principles below, and then present examples of initial mapping and practice.

***P1. Problem based Learning in real-world settings***

Problem-based learning (or PBL) is not new, and its advantages and challenges have been discussed before (e.g. Boud and Feletti, 2013). However, what is different nowadays is that the Industry 4.0 workplace demands proportionately more complex problem solving, and more simple problem solving. Similarly, the pace of change of technology and related socio-technical practices means that increasingly graduates will need to be able to identify new problems, and solve other problems that don't yet exist, as part of their typical career path and everyday routine. So arguably, the adoption of problem based learning is moving from being optional to being essential. Another difference is that, ideally, the PBL approach will be located in real-world settings (rather than within the University), and identify and solve problems in context, through collaborating with relevant organisations that could be community organisations, government organisations, industry or third sector.

***P2. Working independently and in teams***

Another important characteristic will be the ability to work both independently and as part of a team. This will involve developing the 21C skills and competences, such as: having the social awareness to decide which team you want to be part of and what role you can play; collaborative learning and working skills; and, more specifically, communication and negotiation skills. All these skills are required for successful team-working. And similarly, related digital skills will need to be developed and applied, such as being literate and effective with collaborative working tools of various levels of sophistication, from WhatsApp and Google Docs to MS teams and WordPress.

***P3. Teacher as expert, inspirer and facilitator***

Any move towards more student-led, team-based and problem-based learning means that the role of the teacher also needs to be reconsidered. However, it's important to make the argument that the teacher becoming more of an inspirer and facilitator does not detract from their need to also be an expert. These three roles need to be synthesised for effective pedagogy. A subject expert, and ideally someone with a strong scholarly and professional profile will be perceived and empowered to act as a convincing source of inspiration and effective facilitation.

As student learning activity adapts to the new paradigm, from a concentration on extrinsically motivated disciplinary *cognitive intelligence* to progressively develop intrinsic interdisciplinary *holistic intelligence,* so a teacher's role will extend to focus on expertise in transfer and facilitation as well as disciplinary knowledge. Although self-directed learning and 'teacher as facilitator' isn't new as such, linking these processes to developing holistic intelligence and adapting to interdisciplinary problem solving is a broader and more integrated account.

***P4. Ongoing assessment of process and outputs - combining traditional methods, micro-credentials and critical reflection***

Ideally, assessment should also be similarly authentic and relevant to the expectations for a 21C worker and citizen. This could involve ongoing formative assessment of processes combined with ongoing peer-assessment of a 'live' collaborative project, followed by a critique of the completed project. Informal and formative assessment could be incorporated into the facilitation process *(P3).* Indeed, with peer-assessment becoming more prevalent, formal assessment processes may be modelled on a *holistic* (responsive and dynamic) moderation of peer assessment, rather than a *cognitive* (final and fixed) summative assessment process. Similarly, process and progress should be monitored and mapped through the development of a tangible digital artefact, such as an interactive portfolio and website linked to other active digital media activities (e.g. www.metapraxisproject.org) and specific activities such as collaboratively creating internet radio (Ravenscroft et, al 2018; Ravenscroft 2020, see radioactive101.org).

Crucial here is to perform assessments that take into account the level of ambition, or difficulty, of a problem, so that taking calculated risks and exercising high levels of insight and imagination are encouraged, and not discouraged in order to do a 'safe' project. We could also combine traditional assessment approaches with micro-credentials; the students receive an assessment grade for a traditional type of essay or dissertation, digital asset or performance, whilst also receiving industry focused micro-credentials accrediting particular skills that they have developed along the way. These can range from standardised badges developed by Microsoft[4] to bespoke ones for non-formal learning (e.g. see Ravenscroft et al., 2018).

***P5. Developing digital skills in action***

Developing digital skills, including the capacity to continuously develop new digital skills, is becoming essential. This means that the pedagogy needs to weave in developing digital skills and broader digital literacy in action, and in particular - data literacy, sophisticated social media proficiency and design expertise.

***P6. Developing psychosocial dimensions and mindfulness***

Our previous research (e.g. Ravenscroft et al., 2018) and the earlier Section of this Chapter (5.1) have pointed out the importance of developing psychosocial dimensions such as self-efficacy and a sense of

[4] https://www.microsoft.com/en-us/learning/badges.aspx

agency. Related to these and particularly in the context of addressing student mental health and wellbeing, Seldon and Martin (2017) have proposed the notion of "The Positive and Mindful University" that is being realised at the University of Buckingham. The basic idea of this is to employ positive psychology (e.g. Seligman, 2011) and mindfulness through pedagogy and to embed it throughout a University.

## 6. Initial Examples of Education 4.0

Accepting that according to Jisc (2018)[5] the realisation of Education 4.0 in UK HE is arguably on a five to ten year timeline, a number of HE Institutions in the UK are already developing new approaches, pedagogy and curricula to realise some of the ideas we have proposed. Elsewhere (Ravenscroft, Richards and Bunce, 2019) we have given a range of early exemplars at the University and course level before reflecting on these developments. One of the examples (RadioActve101) maps to all of the principles, two (New Model in Technology and Engineering and Meta-Praxis) map to 5 *(P1 – P5),* and one (Positive and Mindful University) is deliberately focused on *P6*. These mappings are described in the accounts given elsewhere through the designation of the Pedagogical principles *(P1 – P6)* where appropriate, but these are broad-brush mappings showing that the principles are implemented to some degree, and not indicating the degree of implementation and any particular nuances. We have also pointed out the different scale of each example that range from University wide approaches (Positive and Mindful University), Pan-school level curriculum innovation (Meta-Praxis, see www.metapraxisproject.org) and module level implementation (RadioActive101, see radioactive101.org). Below are two examples that map to these principles.

### 6.1. RadioActive101: Participatory Internet Radio

If we take an existing example from RadioActive101, such as Music Performance students making a magazine style radio show called "Alternative Voices", we can demonstrate the operationalisation of these principles (P1 – P5), and this also cultivates, to varying degrees, the key points that characterise holistic intelligence (from Section 2), except points 3 and 9. They realise P1, through having the problem of making an internet radio show about the voices that you don't usually hear in the mainstream media. To realise P2 they self-organise into a team, agree roles, and then work independently (e.g. performing interviews) and as a team (e.g. co-editing the show). During this time, the teachers inspire and facilitate their activities, applying their knowledge to orchestrate the students' activities (P3). Weekly meetings are held to reflect on activities, assess the quality of the assets acquired and plan further activities (P4). Through performing interviews and sound recordings, and then editing and designing the sound, they are developing digital skills in action (P5). These types of learning processes are supported in a broader and more generalised approach through the developing model of Meta-Praxis (below).

### 6.2. Meta-Praxis

The Meta-Praxis Project establishes the conditions to cultivate holistic intelligence, (relevant to points 1-10 in Section 2), by placing emphasis on *transfer for* rather than *knowledge for* diverse, complex and changeable contexts. This nurtures learners as collaborative and social agents, who are able to leverage and allocate integrated cognitive and practical skills, and resources, dynamically, with critical awareness of self, others, and context. This supports teachers and education leaders in designing,

[5] https://www.jisc.ac.uk/blog/the-potential-of-education-4-is-huge-the-uk-must-take-the-lead-now-12-sep-2018

facilitating and inspiring (P3) reflexive interdisciplinary curriculum innovation projects within interconnected primary, secondary and tertiary contexts, and in particular as a design for a cluster of performing arts courses at UEL (P4). It models critically-reflexive practice at multiple levels: individual, social, organisational, and cultural (P4). The foundational concept of metadisciplinarity (P4) defines the integration, development and leveraging of knowledge, understanding, skills and reflexivity within interdisciplinary contexts for individuals and groups working in projects (P2), such as RadioActive101. This methodology embraces social learning as an integrative and dynamic process, proposing that the challenges and opportunities of collaborative, problem-based (P1) and creative learning promote the development of a broad range of competences emerging from and transcending the bounds of individual disciplines, thereby modelling the skills, knowledge, understanding, critical awareness and mindfulness required for individuals and organisations to thrive in complex environments (P6). The project uses interactive documentary and digital storytelling to develop reflective narration of project process and impact, hosted in an online repository (P5).

## 7. The Future of Learning and work

Here we develop our argument through thinking about what key trends, and pointers, might feature in the future of learning and work, or what might be core aspects of a more mature Education 4.0, accepting this arguably deserves a Chapter on its own.

Firstly, to re-iterate our central theme, Education 4.0 should be considered as the means to shape, develop and challenge Industry 4.0, and not simply respond to it. One example of this could be embracing digital performance to extend critical and creative communication. In other words, digital skills are not just about being able to successfully use digital technologies, but also about developing a consciousness around what it means to engage and respond to a distributed digital audience, for example. There are many emerging examples of new forms of creative interaction, from digital arts to distributed and real-time meditation classes, that are developing digital skills 'in vivo' in a way that are also creating a new and liberating human experience. These developments are often creative experiments, not instrumental activities, yet they can develop aspects of emotional intelligence such as empathy and ethical awareness in powerful and experiential ways.

Secondly, there will be new models for collaborative learning and working between humans, AI and robots. Although there is a vast and existing literature on Human-Computer Interaction (HCI) and Human-Computer Collaborative Learning, the pervasiveness of AI and possibilities of robotics takes this to a new dimension. Whereas HCI emerged as an important new discipline on the 1990s, we speculate that Human-Robotic Interaction (HRI) could become a vital new subset of this discipline for the 2020s. This successful development of this discipline will rely on the sort of successful harmonisation of intelligences that we explore in this Chapter.

Thirdly, there will be a more direct coupling of learning with work, such as NMiTE (New Model in Technology and Engineering), which, according to Hitt and Rogers (2020) in a paper available from their website (nmite.ac.uk) say:

"NMITE's team is united by an educational philosophy of increasing the potential of human beings—experimenting, failing and responding, learning how to learn, working with people from a variety of backgrounds, reflecting on work done and yet to do—these behaviours, rather than memorizing equations and sitting exams, can inculcate the habits of mind that result in engineers who consider communication, collaboration, and context as essential rather than tangential parts of engineering practice."

This is a bold educational experiment that will start with a "Pioneer Cohort" in 2021 studying a Masters in Integrated Engineering. It will emphasise industry and community links, applied projects and a trans-

disciplinary curriculum, foregrounding the integration of creative and innovative ways to address prescient engineering problems in industry or society in general.

Fourthly, there will be an emphasis on meta-skills that transfer, such as Collaboration, Communication, Critical-Thinking and Creativity.

Fifthly, there will be a greater emphasis on the possibilities for exploring human potential that builds upon and exploits emerging forms of human-computer and human-robotic interaction. Freed from most, if not all, data manipulation and knowledge-based problem solving, the human mind and character could be focussed more on the ethical, creative, critical and social practices during learning and within work.

Finally, the impact of COVID-19 and resulting 'lockdown' measures, combined with nations' re-emergence from it, will be an important factor whose consequences are difficult to accurately predict. Although what seems likely is that communications and team-working practices will be increasingly computer-mediated, and performed more from within non-formal contexts, such as homes, with a lesser need to attend physical classrooms and offices. This radical shift in communicative and team-working practices is likely to be operating within contexts that are also increasingly volatile and insecure in terms of their surrounding economic and political contexts. A situation that makes the importance of developing competences of critical thinking and creativity, linked to the development of emotional intelligence and resilience, even more prescient. We will need to be more creative, caring and generally more mindful to collectively innovate in ways that address totally new challenges.

## 8. Conclusions: Are we looking at radical extension for a Pedagogy 4.0?

If we were to extract the implications from the key general themes from our Chapter these would be that, in moving towards Education 4.0 and Pedagogy 4.0 in HE, you cannot have innovation without disruption linked to radical extension, so this disruption is necessary and should be positive. For example, during such innovation and disruption in Education we have the opportunity to reconsider arguably false dichotomies and instead embrace harmonising sometimes polar positions, such as the tensions between: learning knowledge or learning skills (surely we need to learn both?); normal and abnormal mental health (aren't we moving towards accepting differences and a continuum of dimensions?); and, subject-led or employment-led curricula (isn't a combination of both the ideal?). In other words, the development of Education 4.0 is an opportunity for positive disruption and radical extension in our pedagogical thinking, developments and applications. Another issue might be that not only is disruption and radical extension inevitable, it is likely to be ongoing, so a Pedagogy 4.0 will not just be different, it is likely to be constantly changing in line with the similarly changing employment landscape and developments of society in general. This means, broadly, that we need to pay more attention to understanding and modelling near-future psychological, social and cultural dimensions of 21st Century learning, in ways that harmonises intelligences and also recognises the full value of what is unique about being human.

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