When did you last predict a good idea?

Exploring the case of assessing creativity through learning outcomes

Kathryn Penaluna, Andrew Penaluna, Colin Jones and Harry Matlay

Abstract: *It has been noted elsewhere that an idea is acknowledged to be creative if it is novel, or surprising and adaptive. So how does that fit with education's desire to measure student performance against fixed, consistent and predicted learning outcomes? This study explores practical measures and theoretical constructs that address the dearth of teaching, learning and assessment strategies to enhance creative capacity in enterprise and entrepreneurship education. It is argued that inappropriate assessment strategies can be significant inhibitors of the creativity of students and teachers. Referring to the broader discipline of 'design', as defined by Bruce and Besant (2002) – the application of human creativity to a purpose – both broad employer satisfaction with education and fast growing economic success are found (DCMS, 2014). As predictable assessment outcomes equal predictable students, these understandings can inform educators who wish to map and develop enhanced creative endeavours such as opportunity recognition, communication and innovation.*

Keywords: *assessment; creativity; design; enterprise; entrepreneurship education;*

Kathryn Penaluna (corresponding author) is Enterprise Manager at the Centre for Creative Entrepreneurship, University of Wales Trinity Saint David, Mount Pleasant, Swansea SA1 6ED, UK. E-mail: kathryn.penaluna@smu.ac.uk. Andrew Penaluna is with the Pro Vice Chancellor's Office (Enterprise) at the University of Wales Trinity St David. Harry Matlay is with the Faculty of Business and Creative Industries, Business School, University of the West of Scotland, Hamilton Campus, Almada Street, Hamilton ML3 0JB, UK. Colin Jones is with the Australian Innovation Research Centre, University of Tasmania, Private Bag 108, Hobart, Tasmania, Australia.

Creativity and innovation are often cited as being important to enterprise and entrepreneurship, with many definitions making explicit the need for some kind of creative thinking. For example,

> '. . . learning to use the skills, knowledge and personal attributes needed to apply creative ideas and innovations to practical situations. These include initiative, independence, creativity, problem solving, identifying and working on opportunities.' (Rae *et al*, 2010, p 3).

'Embed in schools and higher education elements of entrepreneurial behaviour (curiosity, creativity,

> autonomy, initiative, team spirit) already in primary school education.' (Oslo Agenda for Entrepreneurship Education in Europe, 2006, p 3)
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> 'Now more than ever we need innovation, new solutions, creative approaches and new ways of operating. We are in unchartered territory and need people in all sectors and at all ages who can ''think out of the box'' to identify and pursue opportunities in new and paradigm–changing ways . . . Entrepreneurship is a process that results in creativity, innovation and growth.' (World Economic Forum, 2009, pp 5–8).

In contrast to these calls, there is evidence to suggest that the introduction of standardized tests has led to a decline in creativity in schooling (Kim, 2011; Parker, 2012) and that, in turn, a lack of engagement with creativity in schools means that higher education is obliged to make up the shortfall, with a role 'of moving students coming from a limited testing framework to one in which creativity is valued and nurtured' (Patterson and Loomis, 2007, p 125):

> 'There are numerous barriers to risk taking in activities involving children and young people. Many of these stem from a tendency of teachers and other professionals to prefer activities with planned outcomes and from an aversion to failure.' (Rolfe, 2010, p 21).

The Oslo Agenda (2006) refers explicitly to curiosity alongside creativity, and therefore has particular resonance with our discussion. Knowledge and curiosity, when viewed through the lens of a creative thinker, may have some unwanted and perhaps poorly considered repercussions. For example, this extract from the European Commission's Leonardo Da Vinci project's curriculum for teacher training pilot – Acknowledging and Developing Entrepreneurial Teacher Training (ADEPTT, 2013) – illustrates the potential for knowledge to inhibit curiosity:

> 'Knowledge=less curiosity (because you make assumptions based on ''knowns'')
> Less curious=accepts norms
> Acceptance of norms=sees fewer challenges
> Fewer challenges=less deep thinking about alternatives.'

Therefore, in something of a strange twist, we may inadvertently be educating out curiosity and associated creative thought. The premise is that the more knowledge we have, the less likely we are to challenge our own thinking through alternative perspectives. In neurological terms, we rely on old neural networks and trusted responses, and do not look beyond the obvious. Conversely, curiosity can be the trigger to seek out new links and connections, often because known knowledge no longer makes sense, or because a gap in our knowledge becomes evident. Alternatively, through 'naïve enquiry', in which things are seen differently through lack of experience, individuals can challenge norms and offer potential new ways forward.

This alternative view is espoused by the discipline of design, which not only has 'uniquely effective pedagogical methods for the teaching of innovative action and entrepreneurship' (Levick-Parkin, 2014, 168), but is also aligned well to business and economic success.

For example, a statistical report on the UK creative industries suggested that the Gross Value Added of these industries was £71.4 billion in 2012 (DCMS, 2014) and, with 10% growth in 2012, that these industries constitute one of the fastest growing areas of economic development. Furthermore, design thinking skills are regarded as an essential attribute (DCMS, 2014). If, further, we consider recruitment, in a 2013 survey 73% of design employers questioned based their decisions on the applicant's ability to be creative, 58% required a Bachelor's degree and only 19% did not look for a formal qualification. Importantly, and in the context of our discourse, 76% expressed satisfaction with the current dominant routes into the industry – through education (Creative and Cultural Skills, 2013).

These high levels of employer satisfaction with educational provision suggest that the teaching, learning and especially assessment strategies used in design education merit further investigation and may align well with the aforementioned demands of enterprise education (Pittaway and Edwards, 2012). The emergent term 'Design thinking' (Brown, 2009; Martin, 2009) encompasses this pedagogical stance and can be aligned with the requirements of the UK's Quality Assurance Agency's Benchmark Statement for Art and Design Programmes (QAA, 2008) with which all new degree level programmes of study must comply.

Conceptually, therefore, this paper considers the evidence that enterprise and entrepreneurship education could learn from a discipline that appears to be successfully addressing the need for creative ability, using assessment strategies that respond to creativity-based industry requirements.

Methodology

Because the purpose of this conceptual research is to respond to observations from the enterprise and

entrepreneurship research community that developing and enhancing students' cognitive ability for creativity through developed skills in divergent thinking and abductive reasoning is important, we must consider perspectives that may lie beyond more traditional enterprise and entrepreneurship education discourses.

Past calls to consider creative design (Cox, 2005; Penaluna and Penaluna, 2008; 2009; Neck and Greene, 2011; Levick-Parkin, 2014) have in turn led to further calls that those who are experienced in developing innovative assessment strategies 'need to continue their efforts' (Pittaway and Edwards, 2012, p 793). This discourse thus moves away from the perception that disciplines 'tend to be considered discretely with the other either ignored or presumed' (Tunstall *et al*, 2012).

Key aspects of learning through entrepreneurship education (Pittaway and Cope, 2007) appear to mirror the approach to learning of design education through an educational experience that encompasses failure, accepts ambiguity and risk and is built upon problem solving strategies in which theory follows practice (QAA, 2008). It acknowledges that

> 'The paradigm shift that is currently taking place follows the experience of a century of efficiencies gained through mechanistic and reductionist techniques . . . [and that] business leaders need to develop their creative capacity and to deepen their knowledge and understanding of themselves and others.' (Liotas, 2014, 175)

Thus in this paper we consider a learning environment which, when further underpinned by neuroscience (Damasio, 1994; Draganski, *et al*, 2004; Blakemore and Frith, 2005; Dijksteruis and Meurs, 2006; Kounios *et al*, 2006; Kounios and Jung-Beeman, 2009; Penaluna *et al*, 2010; Immordino-Yang and Damasio, 2011), develops in its learners broad and diverse neural connections, ones that lead to new understandings and visioning skills – creativity. It is an approach that 'recognises the importance of the mind and the dynamic approach to learning how to think entrepreneurially' (Neck and Greene, 2011, p 61), all of which draws upon constructively aligned assessment (Biggs, 2003).

The authors regularly work across disciplines to develop enterprise abilities in their learners. They are further informed by their own experiences and empirical evidence from extended international networks (Jones, 2011; Penaluna *et al*, 2012; Global Summit of Entrepreneurial Educators, 2014). As in this paper, their work draws significantly on the discipline of 'design', defined by Bruce and Besant (2002) as the application of human creativity for a purpose. This is developed as an integrated approach to the business process as opposed to a peripheral or specialist activity, based on the many parallels that have emerged with enterprise education.

We are overt therefore in clarifying that this research paper is led and underpinned by thinking from the discipline of design; it responds to the observations of Chaston and Sadler-Smith (2012, p 415) who note that 'creativity is seen by many researchers and policy makers as a driver for economic change', yet that thinking from the creative industries has 'received comparatively little attention from mainstream business and management researchers'.

Given that the primary aim is to support curriculum developers and educators in the HE sector, the literature that supports the arguments is drawn from many associated areas and disciplines. This in turn mirrors the discipline of design, where broad and wide understandings are brought into play to illuminate new and potentially useful links and connections – which may otherwise go unnoticed within a single discipline focus.

Our methodological stance is therefore a pedagogical one – if students can be taught to develop their creativity in the manner illustrated, and the creative endeavours that result bring about economic value and success (DCMS, 2014), how can these understandings inform entrepreneurship and enterprise education?

The art and science of entrepreneurship education and of creativity

Henry *et al* (2005a; 2005b) noted a general consensus amongst the education community in identifying differences between the art and science of entrepreneurship. The 'art' refers to the creative and innovative attributes; the 'science' to the business and management functional skills. They observed that the science elements were considered teachable, using what they referred to as a conventional pedagogical approach. However, when discussing the arts, they referred to elements that they did not consider to be teachable and which, by implication, could not be embedded (Henry *et al,* 2005b). Yet in education for music, theatre, dance and art and design, the unspoken premise is that creativity can be enhanced in contextualized learning environments. The national quality guidance that benchmarks these disciplines recognizes this, and specifically states that 'learning in Art and Design develops the capacity to be creative' (QAA, 2008, p 3), and that 'More divergent forms of thinking, which involve generating alternatives, and in which the notion of being ''correct'' gives way to broader issues of value, are characteristic of the creative process'. (QAA, 2008, p 3).

The observations by Henry *et al* (2005a; 2005b) illustrate the lack of interdisciplinary understanding that this present paper seeks to address. Moreover, Pittaway and Edwards (2012), in their international review of entrepreneurship education, focused on collated evidence of current assessment practice. Their findings revealed that – despite the desire to develop innovative approaches for entrepreneurship education – most educational practice was still fairly traditional and reliant on the notion of being consistently correct. The majority of courses taught 'about' styles of practice with learning outcomes that were 'knowledge based'. Those that focused on developing skills 'for entrepreneurship' predominantly used 'business planning' formats and assumed innovative capacity, whilst those categorized as learning 'through' the practice of entrepreneurship were less frequently encountered in the data. In other words, most of the assessment collated in the study by Pittaway and Edwards (2012) was based on knowledge retention, as opposed to the ability to act creatively through 'knowledge harvesting' in response to shifting demands and ambiguous situations, as is the case we shall describe in design-based studies.

The sample in Pittaway and Edwards' study (2012) also revealed the continued dominance of business schools in entrepreneurship education. They noted that over 50% of business schools 'focused on helping students understand the phenomenon rather than preparing them for genuine entrepreneurial activity' (*ibid*, p 793). In their conclusions they advocated a need to explore assessment practice in entrepreneurship education in disciplines beyond business schools. This extends the debate that assessment methods and associated value metrics, when applied to enterprise and entrepreneurship courses, do not always match (Gibb, 2002; Ollila and Williams-Middleton, 2011), especially where creativity, innovation and opportunity recognition are required.

Evidence such as this presents a dichotomy, with business and creativity being viewed as two distinct educational offerings (Scott *et al*, 2012) that traditionally sit in different silos. Rationalizing the disparate nature of the two approaches helps us to outline the pedagogical problems educators face as they attempt to deliver the 'art' as well as the 'science' of entrepreneurship education. Specifically, few specialists from business school environments are likely to have been exposed to the learning, teaching and assessment strategies used in the creative industries, with even fewer creative industries educationalists becoming actively engaged in the enterprise and entrepreneurship research agenda. As a result there is a paucity of relevant interdisciplinary research (Carey and Matlay, 2010, 2011; Penaluna and Penaluna, 2009, 2011).

Our discussion on the 'art' and the 'science' of entrepreneurship education also mirrors longstanding works such as *The Art and Science of Creativity* (Kneller, 1965, p 77) which asserted that 'one of the most justifiable charges against our education system is that it has neglected, all too often suppressed, the natural creativity of the young'. Almost 50 years later Parker (2012, p 1) questions '. . . whether there is a central contradiction between the development of creativity in young people and the way that schools are currently configured'.

Kneller's (1965) recommendation was that rather than introducing creativity as a new subject or skill the curriculum should be modified so that all subjects enhanced creative potential in context. Thus we see more synergies with the recommendations that entrepreneurship and enterprise are enhanced and developed in all disciplines: the argument is not new, but may have yet to be fully considered in business related pedagogies.

It is beyond the confines of the paper to extend this debate and any apparent impasses that may result. However, our pedagogic stance is that students can be taught to think more creatively – or, to be more precise, that they can learn to be more creative when working in carefully designed learning environments (Runco, 2007; Sawyer, 2011; Sternberg, 2006).

Definitional stances and situating the ability to act creatively

It is important at this juncture to consider the definitions used in this research, because the many existing variants can lead to different meanings being assumed. The definitions are taken from one of the more recent collaborative initiatives, the QAA *Enterprise and Entrepreneurship: Guidance for UK Education Providers* (QAA, 2012). Creativity and innovation, as a thematic approach, are viewed as follows.

> 'Ideas led by enterprise and entrepreneurship are founded on the ability to think and act creatively. Students should be able to:
>
> - Generate multiple ideas, concepts, proposals, solutions, or arguments independently and/or collaboratively in response to identified problems and opportunities
> - Think speculatively, employing both convergent and divergent approaches to arrive at appropriate solutions.
>
> Delivery should include opportunities for:
> - Creative thinking
> - Conceptualisation

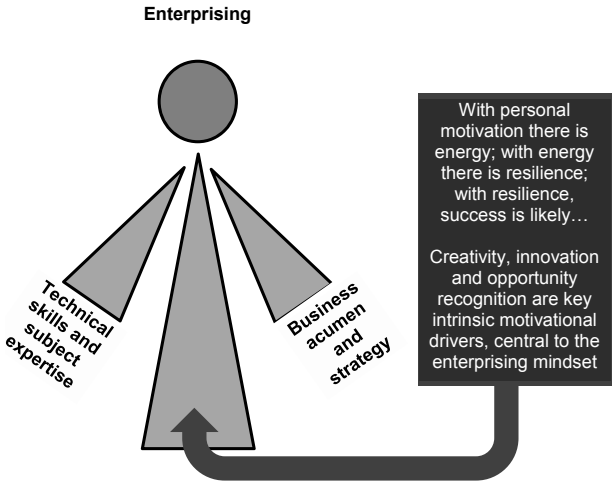

Figure 1. The Enterprise Angel.
Source: APPG Micro Businesses, 2014.

- Innovation
- Problem solving
- Understanding the value of intellectual property.' (QAA, 2012, p 18)

The document further defines enterprise as the development of a broader mindset and entrepreneurship as leading to venture creation and enhancement.

> 'Enterprise education aims to produce graduates with the mindset and skills to come up with original ideas in response to identified needs and shortfalls, and the ability to act on them. In short, having an idea and making it happen. Enterprise skills include taking the initiative, intuitive decision making, making things happen, networking, identifying opportunities, creative problem solving, innovating, strategic thinking, and personal effectiveness. Enterprise education extends beyond knowledge acquisition to a wide range of emotional, intellectual, social, and practical skills.'
>
> 'Entrepreneurship education focuses on the development and application of an enterprising mindset and skills in the specific contexts of setting up a new venture, developing and growing an existing business, or designing an entrepreneurial organisation.' (QAA, 2012, p 8)

These distinctions locate our discussion within mindset development. Thus we posit the model of the 'Enterprise Angel' from the Fifth Report of the UK's All Party Parliamentary Group for Micro Businesses (Figure 1). The accompanying text states, 'If we agree that enterprising people need to be creative and innovative in order to spot opportunities to act upon, and that they need to have an understanding of business as well as well as to have knowledge in one or more specific areas of study, then a picture emerges'. (APPG Micro Businesses, 2014, p 17).

This illustration was evaluated, reviewed and approved by a consortium of representatives from over 100 micro businesses who came together to lobby the UK Parliament on what they thought was lacking in current educational practice. It reflects the high standing in which the businesses consulted placed creative capacity. Business skills and subject skills are perceived as supporting the creative thinker because in the ever-changing environments in which they work specialist knowledge and skills can quickly become outdated and irrelevant.

> 'At the heart of enterprise is creativity, being able to think innovatively, and without the opportunity to develop this within the curriculum, there is little hope.' (Zoe Jackson, entrepreneur's evidence: APPG Micro Businesses, 2014, p 107).

Based on these insights, we suggest that intrinsic motivation is a key factor and that perseverance and resilience are linked to the motivation to succeed. Spotting opportunities and creatively solving problems are known to be key drivers of motivation and, therefore, when supported by subject specific knowledge and business acumen, can help to develop the enterprising mindset. Thus we see a shift in focus away from teaching the business process towards a more integrated approach driven by the combination of creativity, innovation and opportunity recognition.

Creativity, evaluation and assessment

This section draws from the design disciplines, the pedagogic approaches of which align well with those advocated for enterprise education.

Design thinking acknowledges that creative outputs are dependent on the development of divergent thinking strategies; ways of assisting enlightenment through the production of as many alternative solutions as possible (Gardener, 1982; Gomez, 2007; Torrance, 1972, 1981). Singular/correct answers, such as those commonly found in examinations, are believed to limit the opportunity to develop alternative creative solutions, whereas the development of multiple alternatives can help the learner to see wider-ranging perspectives and to make links between concepts and situations: opportunity spotting. Moreover, if an aim is to ensure that recent trends, and as a consequence contextual decision making, is integrated within the solutions proffered by

the student – so that they are immediate, relevant and up to date – then the learners' interpretations of the moment within which they are being assessed and evaluated need to be an integral component of their decision making and evaluation.

However, solutions-focused assessment (the 'science' of enterprise), as opposed to process orientation (the 'art' of enterprise) has been the main vehicle for evaluation (Pittaway and Edwards, 2012), with minimal distinction or recognition of the significantly different learning and assessment approaches that are required (Scott, *et al*, 2012). As a result, teaching, learning and, specifically, assessment strategies, may not be constructively aligned (Biggs, 2003) or fully fit for purpose, because they address only one of two aspects.

Assessments such as examinations and time-constrained exercises and their appropriateness for developing the learner and evaluating the outcomes thus become suspect when considering creative capacity. For example, when an examination was set by the primary author to assess an enterprise class, her mentor asked her what time constrained, memory testing activity she wished to examine. It was subsequently proposed that testing a learner's ability to harvest and explore a breadth of information, all within the context of responding to a set challenge, might be a more appropriately aligned learning and assessment vehicle. However, as will become evident, this is only the surface of the argument and there is much more to consider.

Learning and assessing like a designer

Loosely based on Torrance (1972) and supported by psychology driven literature (Amabile *et al*, 2002), design educators have established a pragmatic assessment strategy that integrates three key components. First, and perhaps best recognized, is 'ideational fluency', with learners challenged to devise as many alternative solutions to a problem as possible. Typically, and in more commonly employed exercises, this could be a task such as 'How many ideas can you come up with for a paper clip'. The intention is to prepare the mind for multiple and diverse solutions. However, if this is only a short term and 'once in a while' exercise, it will not be built upon and repeated to enhance capacity and levels of confidence. Furthermore, in situations that are time constrained, where the learner has not practised this technique, nor had the approach validated through assessment, they may disregard what at first seem faint or distant connections to the problem and play safe – something the authors describe as 'premature articulation'; a rush to the first ideas generated as opposed to seeking out distant and potentially tenuous unconnected situations, circumstances or physical components that as yet have not come to mind.

Second, we introduce 'expressional fluency', a form of reflection that requires a grid or framework to be drawn up which provides evidence of the range and variance of connections that formed in the mind. More than a simple mind-mapping exercise, the aim is to illustrate and connect trigger information and interim solutions through their developmental stages in a visually clear way. Conscious and, where possible, subconscious connections are drawn out to clarify these triggers and connections, so that the full range of ideas that are being developed can be pitched and communicated to peers and stakeholders with clarity and a high level of confidence. It should be noted that singular solutions are not acceptable, and multiple solutions grow in number as the learner enhances their abilities. Also, much like a good chess player, learners are expected to plan ahead and second-guess potential issues, thus delivering a range of solutions that can match different future scenarios. Usually presented in the expressional fluency chart, the approach also avoids the potential pitfall of developing multiple forms of what is effectively a single idea.

The term 'divergent production' encompasses all of the above, as the educator or evaluator can now consider how broad and diverse the range of solutions is. The greater the variance of the range of solutions offered, the more creative the individual or learning group becomes.

To summarize, using the example of a metal coat hanger:

- Ideational fluency – *How many ideas can you think of (inspired by and linked to the coat hanger)?*
- Expressional fluency – *How many connections can you make and how many triggers can you articulate through reflecting and linking the coat hanger to the way you discovered your solutions?*
- Divergent production – *How broad and diverse can your connections be? (Ideational and expressional fluency combined to prove disparity and breath of thought – the less similarities and greater variance the range of solutions exhibit, the more successful the learner.)*

Through frequent evaluations and when combined with increasingly more complex problem-solving scenarios and an iterative process of prototyping, learners become accustomed to extending their number of ideas and the variances among them. Through regular 'crits', in which their pitches are critiqued by lecturers, peers and other stakeholders, students become accustomed to managing

the risks inherent in the approach, and with time become less stressed when dealing with situations of ambiguity and risk. In addition, the level of intellectual enquiry is enhanced through the curiosity that the pedagogy develops. As defined by the Quality Assurance Agency's Subject Benchmark Statement for Art and Design, this 'develops a range of cognitive abilities related to the aesthetic, the moral, ethical and social contexts of human experience. The capacity to visualize the world from different perspectives is not only intrinsically worthwhile as a personal life skill, but also is an essential part of the human condition' (QAA, 2008, p 2). It also develops 'more divergent forms of thinking, which involve generating alternatives' (QAA, 2008, p 3).

Predictability in the classroom=predictable and non-creative students

Anyone, whether or not engaged in the teaching and education environment described above, might envisage that pupils' and students' responses can themselves create a changing dynamic, offering both challenges and opportunities for the educator that are clearly unpredictable or 'prescribe-able' (John, 2006; Ben-Peretz, 2001). The educator's role is to stimulate curiosity in a supportive learning environment in which student participation is encouraged. This will take a discussion in various tangential directions, but the educator retains control and manages the context. The outcomes may be set, but the journey and process take on an added resonance when a specific yet changing context drives it. The teacher manages a sense of direction, even though they or their students have still to develop the ultimate outcome.

It has been observed that as novice teachers become more experienced they move from a position of viewing planning and preparation as a prescriptive activity to seeing it as a 'concept associated with unpredictability, flexibility and creativity' (John, 2006, p 489). In addition, they recognize that 'Enterprise skills require responsiveness to unexpected pressures and tasks; they require reaction to changing circumstances and disruptive interventions. These attributes are contrary to the established framework of assessment processes.' (Wilson, 2012, p50.) Making the learning experience unpredictable, at least in part, becomes an integral part of the learning evaluation strategy.

Thus we suggest that if those delivering enterprise and entrepreneurship education could similarly create learning environments that are iteratively developed through multiple solutions, that take account of changing contexts and the views of others without a finite and exactly determinable solution, the kind of learning normally ascribed to entrepreneurship would benefit substantially.

Introducing 'curiosity-based learning'

Curiosity-based learning (Penaluna and Penaluna, 2008) is a strategy in design education that extends the pedagogy of problem-based learning (Schmidt, 1983; Savery, 2006). It provides opportunities for learners to recognize new problems for themselves – as situations and information changes, they are required constantly to identofy new problems and their associated opportunities. Reflecting the inquisitive entrepreneur, learners become aware of their shortfall in knowledge through their own experience, rather than simply being told it. They also learn to look around a problem and not just to see it at face value, or are encouraged to find problems within scenarios presented to them as a project assignment brief. Finding these problems is a necessity – failure to do so results in learners not being able to engage with the scenario.

We use Loewenstein's (1994, p 75) interpretation of curiosity as a 'form of cognitively induced deprivation that arises from the perception of a gap in knowledge or understanding'. The technique aims to enhance intrinsic motivation: the learners wish to know more, in order to solve a problem constructed in their own minds; it is something that they have to take ownership of. It is also believed that such curiosity also enhances memory (Kang *et al*, 2009).

It is acknowledged that the psychological and neural underpinnings that relate to this type of teaching and learning may be poorly understood (Kang *et al*, 2009). However Loewenstein (1994) asserts that an educator who stimulates curiosity in learners induces a drive of similar strength to hunger and thirst. Such educators are viewed by Kang *et al* (2009) as 'the wick in the candle of learning'.

As noted above, a barrier to divergent thinking has been described by the present authors as 'premature articulation' – that is, bringing a solution to bear before it has been fully researched in the broadest possible way; by, for example, exploring problems that sit beneath the surface problems and not merely taking these latter at face value. We know that extended curiosity-based research takes time to assimilate in the brain, especially so given that extremely divergent perspectives may be represented. Much of this thinking takes place subconsciously and comes to light in a moment of realization; not rationally developed, but more a sudden insight (Kounios *et al*, 2006; Kounios and Jung-Beeman, 2009; Penaluna *et al*, 2010). These are important aspects of learning that do not conform to more traditional linear strategies, where conclusions are reached through step-by-step logical determinations.

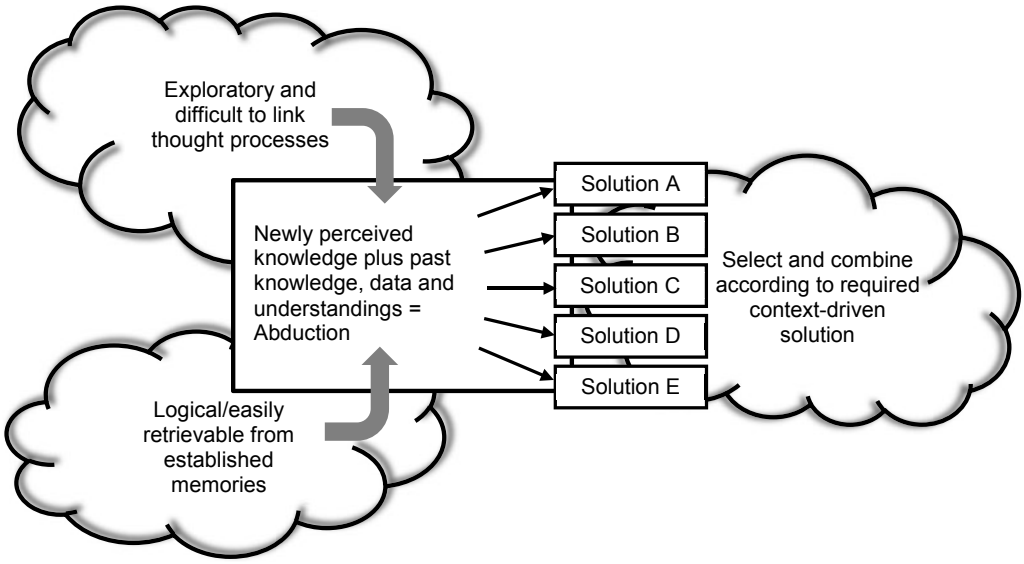

Figure 2. Bilateral multi solution finding model.
Source: Penaluna et al, 2014, 373.

Sudden insights typically do arrive unexpectedly and simply 'pop into the mind'. This is because the neural pathways required are developed subconsciously and only 'appear' in the mind during periods of relaxed cognition; when having a shower, for example, or walking the dog. These thoughts are often fleeting and temporary and need to be written down or otherwise recorded in some way in order to fix the memory. We assert that any assessment based purely on logical and linear thinking strategies misses this important aspect, because any logic is retrospective – it attempts to fit the discovery to a subliminal level of thinking of which the learner was previously unaware; it is dependent on reflective capacity, such as that described earlier through the making of charts and diagrams that identify the trigger elements of ideas.

In order to visualize future scenarios in which they may operate, learners are also required to second-guess what might happen in a specified period. Once again, divergent perspectives become essential, because seeking appropriate known facts and then combining these in a thinking process that considers future possibilities means that limiting the possibilities limits the opportunities for potential success.

Flexibility, adaptability, visualization and the mental constructs that define them

How can learners be flexible and adaptable to changing situations if they have visualized only a singular future dimension and do not take into account moments of lucidity when new neural connections are formed that bring new discoveries to mind? This has been a topic of discussion for many years in the specialist area of artificial intelligence (Bylander *et al*, 1991; Boden, 1998) and the solution that has been reached involves both emotional engagement and what is termed 'abductive reasoning'. While it is beyond the scope of this paper to articulate these understandings fully, mind state and emotional responses combined with an ability to see multiple solutions are leading factors in the race to develop artificial intelligence. What we might call tacit knowledge, or perhaps a 'gut feeling', has now been recognized to be the product of subliminal learning that takes place somewhere below conscious thought. The fact that we are unaware of it until an idea 'pops into mind' does not mean that it is not happening, and the moment when the brain responds in its right anterior superior temporal gyrus needs to be incorporated into the learning process (see Kounios and Jung-Beeman, 2009).

Figure 2, the 'Bilateral Multi Solution Finding Model' (Penaluna *et al*, 2014), indicates how these levels of understanding can be incorporated into learning environments. This model illustrates not only the fact that some solutions may be the result of non-algorithmic mental processing – the moments of 'aha' when thoughts spring into mind – but also the multiple solution-finding aspects associated with this type of creative thinking.

Convergent and divergent expression pedagogic framework

As we have discussed, the requirement to discover problems by means of an assignment brief leads the

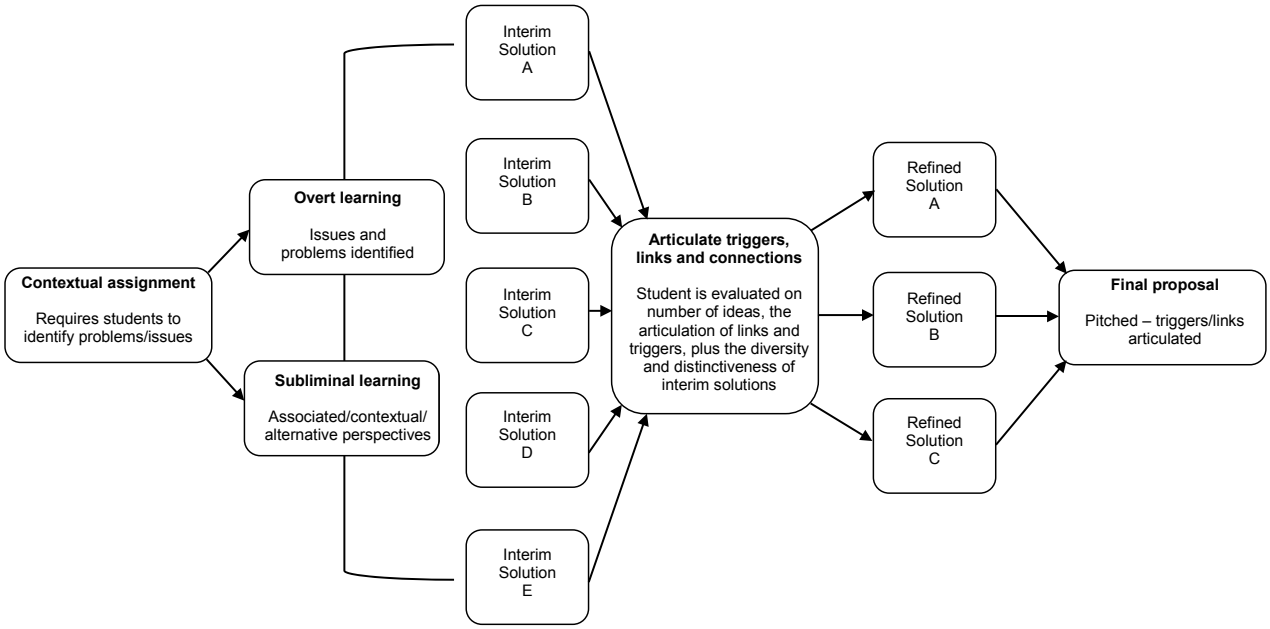

Figure 3. Convergent and divergent expression pedagogic framework.

thinking process in design-based and curiosity-led learning. During the exploratory process learners will also engage with their own emotional constraints and, if encouraged, will attempt to empathize with human-centric and contextually driven emotional constructs that the problem(s) they discover will elucidate.

In the model depicted in Figure 3, only two staged layers are illustrated where multiple solutions are generated and evaluated. However, more can be designed into the learning process by changing scenarios and offering new information – thus ensuring that flexible and adaptable response-developing skills are fostered. Because nothing stays the same, predictable responses generated early in the process no longer have validity and assessment and evaluation address more the process of idea generation than the final outcome. This approach also helps to fix memory through positive emotional responses that are directly related to the process which in turn has an effect on an individual's future approaches to the decision-making process (Bliss and Collingridge, 1993).

Once again the key factors of divergent production become evident. How many ideas can the learner generate? How well can they link these ideas to triggers and information elicited? How diverse and different are the ideas generated?

In this primarily formative assessment process, which once again has been developed from common and widespread practices in design education, similar incarnations of the same idea are avoided and the individual learner constructs their own learning pathways. In effect, learners are creating new neural connections and cementing this new knowledge through practical application. The approach can also be employed in teamworking scenarios, though the authors advocate that contribution audits (see Penaluna and Penaluna, 2009) or some kind of individual self-evaluation strategy is used in conjunction with the team's assessment and evaluation. This multiple solution model also enables the development of 'glorious failures', because solutions that no longer fit a context that has changed can be adapted, shifted and modified according to need and as a student's assignment develops.

Adoption and dissemination/future work

Teacher training using these approaches began in Wales in 2010 and the approaches have been incorporated into the Leonardo Da Vinci project, Acknowledging and Developing Entrepreneurial Practice in Teacher Training (ADEPTT, 2013). Both these projects have been formally recognized as emerging best practice by the European Commission (European Commission, 2013). At the time of writing (late 2013), new pilot projects are being developed for eight countries in the South East Europe Centre for Entrepreneurial Learning (SEECEL, 2014) to start in September 2014. The UNCTAD (United Nations Conference on Trade and Development) Empretec Programme is undertaking a project based on this research, with the aim of

employing the new pedagogic approaches that emerge from it in 34 developing countries.

At present therefore it is difficult to provide any exact evaluation of the proposals made, although initial responses from Wales are encouraging and the approaches are now being incorporated into a National Continuous Professional Development Hub, funded by the Welsh Assembly and hosted by the University of South Wales. However, as educator education develops in these countries and pilot projects are used to evaluate the success or otherwise of adopting a design-based approach to entrepreneurial teaching and learning strategies, more research will be needed, not only to evaluate the approaches described but also to consider the contexts in which these pilots will operate.

Conclusions

We have shown that:

- Curiosity, innovation and creative endeavour are central to entrepreneurial learning;
- The design industry has experienced considerable economic success;
- Design education is well perceived by those employing design students, especially in terms of its ability to develop creative capacity in its learners;
- Design education can be dissected, analysed and theorized in order to better inform other disciplines, especially enterprise and entrepreneurship; and
- Recent developments in cognitive and brain-related understandings support and triangulate the findings and learning proposals described.

The research adds to the body of evidence asserting that much of the literature for enterprise and entrepreneurship (and by implication the development of creativity in such education environments) has been limited because it has evolved from intrinsically limited silos of expertise, especially that of the business school. As demonstrated in this paper, the development of creativity and innovation necessitates skills that enhance opportunity recognition by means of strategies for the generation of multiple solutions. From an educator's perspective this requires similar breadth of understanding – by seeing beyond one's immediate silo of expertise and engaging with other specialists and knowledge. This discourse has engaged with specialist literature in design education and those who are extending the fields of neuroscience and thus in itself is an example of design thinking.

We assert that pedagogies that employ design-based understandings align with the requirements of enterprise and entrepreneurship education, providing frameworks for 'constructively aligned' assessment and interdisciplinary endeavour. The cognitive approaches include avoidance of 'premature articulation' when an idea has not been wholly formed, and encourages 'glorious failures' where the use of appropriate cognitive processes in situational contexts informs the assessment – not merely singular final outcomes. It is a lesson and evaluation of prototypes, not a lesson and evaluation of final conclusions.

Learning environments that support the development of curiosity and the ability to challenge norms enhance creative capacity. Turning ideas into action, progressively evaluating them in an iterative process of prototyping, emulates both the design thinker and enterprising individual.

While these approaches are theorized and discussed here in the context of enterprise and entrepreneurship education, it should be emphasized again that they are derived from long-standing approaches which have been in use over many years in an industry that has proved successful in an entrepreneurial context. The adoption and or adaption of such processes may well require the retraining and professional development of entrepreneurial educators, a process which, although not described here, has already started in Wales, in the European Commission and in the eight-country South East Europe Centre for Entrepreneurial Learning. Further research and evaluation is being undertaken by UNCTAD; further longitudinal studies will be required to validate the concepts and proposals made here.

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