4 The microfoundations of entrepreneurial learning and . . . education: the experiential essence of entrepreneurial cognition

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Experience is not what happens to you, experience is what you do with what happens to you.
Epictetus

Introduction

Knowing a lot about entrepreneurship is hardly sufficient to make one a successful entrepreneur, 'knowing a lot' can even be dangerous. Knowledge is not just an accumulation of data; knowledge requires both the information content *and* the structure by which we organize it. All too often in our haste to transfer large amounts of important content to students, we lose sight that the knowledge structures are even more important and our ability to influence how students' mental models evolve is the essence of education.

Perhaps nowhere is this as visible as in entrepreneurship education, where we must go beyond teaching facts and teach students how to think like an entrepreneur, to help them toward a more expert entrepreneurial mindset. One way to do that is to situate entrepreneurship education in settings where mental models are not shared, where there is cognitive diversity, that is, a significant diversity of knowledge structures. The success of cross-campus entrepreneurship programs may derive in large part from the inherent cognitive diversity of its students and teachers.

As entrepreneurship educators, we are not training memories, we are training *minds*. Education changes students; entrepreneurial education is no different. Here, more than anywhere, we can assess that change and we can use that assessment to nurture our students' education. Many of our best teaching and training methods visibly affect how students think about entrepreneurship. Of any business discipline, can one readily envision classes where experiential learning does not dominate in the way it typically does in entrepreneurship teaching?

The rise of cross-campus programs in entrepreneurship now offers a golden opportunity to explore this, given the greater cognitive diversity of students who come from different majors, different academic levels and even different physical locations. However, we first need to step back and look at the microfoundations of entrepreneurial learning. We offer here a primer of how the constructivistic paradigm of education applies to entrepreneurial learning; we also hope that it provokes significant discussion about what are, and how we might test, the drivers of cognitive change in entrepreneurship learners.

Constructivistic, not behavioristic

Genuine experiential education changes what learners know but even more importantly *how* they know it. Teaching content is often behaviorist in nature, but to change how we think requires a more constructivistic mode of education. Constructivistic approaches

change more than what students know, they change how they *structure* that knowledge. If entrepreneurial education often includes highly constructivistic methods, we can thus make the case that entrepreneurial education can have significant, positive impacts on learning.

However, this then requires us to consider some new questions as we design, implement and assess entrepreneurship education. What is the change we are attempting to induce? We argue here that it is logical to assume that we want to help learners move from a more novice mindset toward a more expert mindset as entrepreneurs. To be specific, we want to help learners move from being novice to expert thinkers!

Considerable research has explored how experts become expert (Ericsson and Charness, 1994), studying chess grandmasters to musicians to pole vaulters. What do all experts share? They may know different things, but what really differs is how they structure their knowledge. Also, there are consistent cognitive processes that develop those deep knowledge structures, processes that we need to take explicit advantage of in our teaching and training.

Thus, we need a better understanding of what course (and curricular) activities influence what cognitive changes. We must also understand what cognitive changes are most desired (and it would not hurt to have a better understanding of what cognitive mechanisms are involved in moving learners toward being more expert entrepreneurial thinkers).

Entrepreneurship education is inherently constructivistic

Entrepreneurship faculty members all want to believe that there is something 'special' about what they do in the entrepreneurship classroom (Fayolle and Servais, 2000). The expectation is that the applied, hands-on nature of class assignments helps students to think entrepreneurially, to see themselves truly as entrepreneurs. State-of-the-art educational theory suggests that the bias toward experiential, action learning found in entrepreneurship training reflects how humans actually learn complex, ill-structured knowledge (Krueger, 2007; Gustafson, Chapter 5, this volume). In fact, these methods reflect the cutting-edge educational theory of 'constructivism' – which is coming to dominate the more familiar and traditional behavioral methods.

Genuine education changes how we think

Perkins (1994) argues that education needs to be 'thinking-centered' – reflecting the reality that education truly involves changing how students think. Truly changing students' entrepreneurial thinking requires more than mere transfer and acquisition of information and skills – students need to move toward a more expert way of structuring that content. To do that, students must take ownership of these new skills and knowledge. This requires significant change in deeper cognitive structures, not just changes in knowledge content but also changes in how individuals structure knowledge.

Krueger (Krueger and Brazeal, 1994; Krueger, 2000) argues that an organization seeking a more entrepreneurial climate requires more entrepreneurial thinking in its members. Classrooms are no different. As with organizations, educators must seek to develop a fertile seedbed that supports entrepreneurial thinking. This cognitive infrastructure supports entrepreneurial thinking and the changes in cognitive structures such as intentions and attitudes, and even deeper cognitive structures such as students' personal mental models of 'what is an entrepreneur? Am *I* an entrepreneur?'.

We must care about these deeper structures. If we are to truly stimulate entrepreneurial thinking in a fundamental way, then it is likely that there will be important changes in students' thinking, including deeper cognitive structures that reflect how humans represent and process information. Mere transfer of information is insufficient to fundamentally alter behavior. This has important implications for *learning* how to think entrepreneurially.

Despite a very extensive – and largely descriptive – literature of entrepreneurship education, academics have been less successful at researching how entrepreneurs actually learn (for example, Alberti et al., 2004). The descriptive work done in entrepreneurship education has, of course, proven of great benefit. The next step for researchers is – as is now being done with intentions – to be much better grounded in educational theory.

Learning and constructivistic education

There are two dominant paradigms in education. The traditional 'behaviorist' approach focuses on fact-based learning (including rote memorization, repetitive drilling and similar mechanisms that focus on transferring content knowledge). Instructors typically provide the models and the framework for knowledge being transferred to students. In contrast, the constructivist approach argues for situated learning where students must develop their own ways of organizing the knowledge (building and changing their own mental models to represent knowledge) as they acquire it. The labels 'learning the answers' versus 'finding the questions' are one way to think about the difference; the author prefers the words of W.B. Yeats about learning. Entrepreneurship educators, it seems, much prefer 'lighting a fire' to 'filling a vessel'. And this makes perfect sense in terms of cutting-edge educational psychology.

Traditional methods provide greater control to the instructor and can appear as more efficient for large groups of students. Constructivistic methods tend to be much more student centered, but this reflects how humans actually learn in daily life: by trial and error in a social setting. Moreover, if one wishes to change deeper cognitive structures such as scripts, then more student-centered learning is imperative. Albert Bandura's social learning theory (for example, 1994) posits learning as an iterative change process by which deeply held beliefs and attitudes co-evolve as learners actively acquire, process and organize new knowledge. That is, students and teachers alike learn from each other – not just facts, but from each other's mental models. The more cognitive diversity, the more opportunities there are to learn from one another.

The number one objective of constructivistic education is deep understanding, the more surface-level skills will follow naturally. Obviously, the more complex the skills required, the more advantageous it is to be constructivistic. Constructivism thus appears essential to nurturing an expert. Moving toward becoming a more expert entrepreneurial thinker is not easy, nor is teaching this. How do we provide critical development experiences for students that accelerate change toward more expert deep knowledge structures?

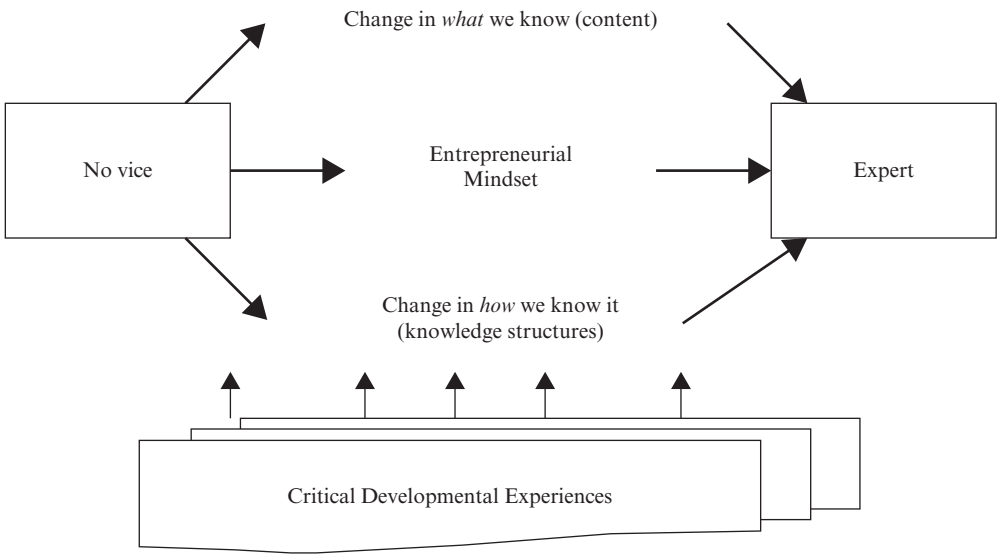
How knowledge evolves

Again, knowledge is not just an accumulation of data; knowledge requires both the information content *and* the structure by which we organize it. But, this raises one critical

issue: to advance a learner's knowledge almost always requires confronting significant discrepancies and contradictions. Prior knowledge, assumptions and beliefs may prove problematic, even dysfunctional. Constructivistic education offers mechanisms for helping learners confront and learn from challenges and resolve contradictions in their constructed knowledge base. In fact, progress generally requires an ongoing, iterative process of construction and re-construction of knowledge. Consider Thomas Kuhn's *The Structure of Scientific Revolutions* (1962) where he describes a parallel phenomenon of how a strongly held shared mental model (the 'paradigm') evolves in a scientific field. Another parallel lies in the difference between transactional and transformational leadership; too much of education is transactional, despite recognizing that true learning is significantly transformational. A final useful parallel is the process of participatory action research where research subjects become co-investigators.

A big part of being an expert is knowing what you do not know; a big part of staying an expert is continuing to reassess how one structures knowledge and the deep beliefs that anchor those structures. While teachers may intend to assist students toward more expert thinking, they need to model the same learning and openness to cognitive change that they desire in students. In constructivistic classrooms, the teacher–student distinction is thus blurred mindfully; both are learners, both are teachers.

The net result is that we are providing learners with the opportunity and environment to change not just what they think, but *how* they think (see Figure 4.1). This is important. We need to help students change how they structure what they know about entrepreneurship. This requires giving them opportunities for critical developmental experiences that help them to re-shape their mental models.



Source: Adapted from Krueger, (2007).

Figure 4.1 What we really do in entrepreneurship education

Thinking-centered learning

Learning is a process by which we construct meaning jointly from our context and from informational cues. Construction of meaning occurs within the learner rather than simply a process of assimilating information from the environment. Learning is situated, though. That is, learning is independent of neither the context nor the learner. The landmark research of Jean Piaget and his successors demonstrates clearly that learning is not a literal transfer of knowledge from teacher to student. Learners of any age construct new knowledge by integrating the new data into relationships with prior knowledge, connecting new information in more than one way. Knowledge is thus constructed as an interrelated whole, not as a set of isolated brute facts. Thus, master educator David Perkins's (1994) felicitous phrase 'thinking-centered learning' proves most appropriate.

Constructivism and the learning cycle

Research has clearly identified a natural learning cycle: first, we discover an issue (and its seeming implications), next we identify critical concepts that may help us explain the phenomenon in question, and finally we seek to apply our newly constructed knowledge and test it against reality (ibid.).

The natural learning cycle assumes that 'big ideas' and 'big questions' are inherently complex. Perhaps oddly, we need complexity to accelerate learning. Oversimplification can actually confuse us when we first confront a 'big idea'. Only after we have immersed ourselves in the problem is it useful to move to a more reductionist approach to isolate key principles. Then, as we struggle to apply the key principles that we have extracted, we return to more complexity. Finally, we must evaluate our resolution to the problem and re-think the process anew, actively seeking contradictions and counter-examples. Note we use the word '*re*solution' instead of 'solution'. The word 'resolution' captures both the iterative nature of the learning process and the recognition that few perfect solutions exist. It also illustrates the dialogic nature of learning a concept. However, as Prawat (1992) notes, students' exploration still requires some sort of 'road map'. Instructors need to provide focus and coherence to prevent the breadth of inquiry from degenerating into unproductive wandering through trivia.

Key principles of constructivistic education

Constructivism's five key principles follow the learning cycle (Brooks and Brooks, 1993):

1. '*Authentic' (and 'important') questions* Learners need to 'own' their knowledge, thus they need to find their 'own' problems in a given subject area. Educators can assist by posing 'authentic' problems of emerging relevance to learners. This has the further advantage of engaging learner emotions productively. For example: planning a desired new business takes on extra meaning when it is potentially 'for real' even though it often complicates our efforts.
2. '*Big ideas'* We should structure learning around primary concepts, not minutiae. If we light a fire with one or more primary concepts with which learners relate directly, they will identify and adopt details as needed. We want students to grasp the essence of a given phenomenon. For example: entrepreneurship is more than identifying an opportunity, it is about understanding how we learn to see the opportunities that we

do (and those we do not). A colleague of the author has introductory entrepreneurship students (many with zero business courses) identify a small business innovation research topic for a feasibility study – and students learn what personally they see as opportunities, often in quite surprising fashion. This is a particularly welcome model for classes including students from science, social science and/or engineering. (Arts and humanities students might also be able to identify grant-based opportunities.) Social entrepreneurship is thus a fast-growing topic in any entrepreneurship course and is often the centerpiece for cross-campus entrepreneurship, as this Handbook demonstrates. Where better to connect learners with big, authentic ideas?

3. *Constructing meaning requires triangulation* We should focus on and value learners' different points of view; accommodating multiple perspectives often entails team teaching. (This takes advantage of multiple types of intelligence in the class.) For example: team projects that are designed to be truly interdependent force students to bring their differing perspectives to bear in productive fashion. An even better example is the action-learning model that allows students to see how 'book' knowledge squares with practice in hands-on situations (Leitch and Harrison, 1999). Consider how the cognitive diversity in a cross-campus course requires negotiation of often radically different mindsets.
4. *Coaching, not lecturing* The curriculum should follow students' inquiries (their process of constructing knowledge) not the instructor's own process. (This does not imply an 'anything goes' approach, however.) For example: informal interaction between students and the instructor is critical; but so too is allowing (or requiring) students to coach one another.
5. *Assessment and evaluation techniques should reflect these processes* They should not reflect the ability to merely 'regurgitate'. Also, different majors are accustomed to often quite different modes of assessment and evaluation (for example, the portfolios used in art). Why not ask students to negotiate the most efficacious metrics? For example: assessment and evaluation processes themselves need to be assessed and evaluated with student involvement.

Re-read the above list and consider how these are reflected in a well-done analysis of a case study or in a hands-on small business institute-type project. (The SBI approach uses real businesses as a 'live-ammo' case.) We begin with a focus on 'big ideas' and authentic questions in an environment that offers a 'safety net' (for example, it is acceptable to try to fail). Learners will accept almost *any* challenge if they frame the learning situation as an opportunity, but to perceive an opportunity requires perceptions of control and competence that are very much in the eye of the beholder. How do we help *them* to frame it as an opportunity? The instructor can foster and reinforce those perceptions, but a student's peers are equally important in promoting a sense of safety and of challenge. Making it safe for students to explore is more difficult than we realize and requires constant vigilance. For example, too much visible knowledge can actually impede knowledge; if students see one possible answer, they can see it as 'the' answer. Similarly, if they see the instructor as having 'the' answer, learners may focus on extracting that answer. The author can attest that instructor ego can be problematic. As such, the constructivists suggest emphasizing questions that clearly have no one single answer. Sound familiar?

The human mind comprises an ever-evolving set of cognitive structures that help us

Table 4.1 A simplified view of how modern pedagogy has evolved

			(more behavioristic)
Key theory	Core assumption	Key activity	Sample tool
Teacher-centered	Expert teacher; passive student	Memorization	Fact-based lectures
Teaching-centered	Expert teacher; active student	Skill development	Pro formas; business plans
Learner-centered	Learners need to control learning process (student as customer)	Teacher–student interaction	Case studies
Learning-centered	Metacognitive understanding of learning (from what we know to how we know it)	Problem-based learning	Self-managed field projects
			(more constructivistic)

Source: Adapted from Krueger (2007).

make sense of our environment and our place in that environment. This includes perceptions of opportunity; we increase the potential for entrepreneurial behaviors if we increase the perceived range of possible opportunities (Krueger and Brazeal, 1994). If we accept this cognitive framework, we must, however, abandon much of the behavioristic tradition that still dominates educational theory and practice (for example, Table 4.1). Learning is not just a stimulus-response phenomenon (Langer, 1994). Memorizing facts or other mimetic activity is not learning; brute facts without context offer little meaning beyond 'We need to know this for the next test!'.

Entrepreneurial learning in practice

The literatures on entrepreneurship, small business, family business and so on all offer considerable evidence that supports the constructivistic paradigm. Bouchhiki argues explicitly that entrepreneurs appear to construct their environments (1993) while Jelinek and Litterer (1995) describe in great detail how a truly entrepreneurial organization encourages its members to construct an opportunity-friendly cognitive infrastructure. Perceptions of self-efficacy, something that constructivistic learning is better at developing, are already closely linked to entrepreneurial intentions (Krueger et al., 2000), opportunity perceptions (Krueger and Dickson, 1994), venture performance (Chandler and Jansen, 1992), and entrepreneurial career choice (Scherer et al., 1989). We also see evidence that entrepreneurial performance is associated strongly with ability in self-directed learning (Guglielmino and Klatt, 1993). Finally, recall that entrepreneurs appear to be motivated far more by intrinsic (for example, autonomy, mastery) than extrinsic (for example, money) considerations (Brockhaus, 1987). These all suggest that if the entrepreneurship-friendly cognitive infrastructure is constructed, then it makes a lot of sense to emphasize learning that is consonant with the constructivist model. If entrepreneurship education works in theory, then it should also work in practice.

Consider the range of best practices that the field of entrepreneurship has developed. While beyond the scope of this chapter, it would be relatively easy to examine, for example, award-winning pedagogies and see the inherently constructivistic principles

at work. Many awardees place novice learners in learning situations where they do not answer questions; they must first identify the proper questions. Rather than fulfill a relatively well-structured task such as 'write a business plan for your client', the students must first assess what tasks would solve the client's seeming problem (and may need to assess whether the apparent problem is a root cause or merely a symptom).

True problem-based learning (PBL) is much more than 'learning by doing', as powerful as that may be. Students are forced to structure the problem and the knowledge and skills required (again, as we see prevalent in medical and legal training). Consider, too, the very nature of PBL. We know that genuine PBL enhances students' entrepreneurial thinking to a remarkable degree, even showing evidence of changing knowledge structures in a few months (for example, Krueger, 2001; Hanke et al., 2005; Souitaris, 2005; Cooper and Lucas, 2007; Post et al., 2007; Tegtmeier, 2007; Chapters 11 and 15, this volume). However, the particular value of PBL in entrepreneurship pedagogy is that PBL requires learners to move from answer finding to question creating, to take personal (cognitive) ownership of their projects. Faced with very high uncertainty, extreme time pressures and competing demands on their time and effort, PBL mirrors what an entrepreneur faces on a daily basis. As students proceed, their reflections invariably lead them to that realization: the necessity for further improving their personal role identity as an entrepreneur. (It would be difficult for me to sustain any mental prototype of 'entrepreneur' that does not include 'me'.)

If we are therefore to assist novice entrepreneurial thinkers to become more expert, we need to apply some of the latest research on entrepreneurial cognition to address central questions of how expert entrepreneurs differ, not just in terms of surface knowledge and skills, but in how deep structures affect how they think.

How I think this discussion might apply in the entrepreneurship classroom centers on what we are trying to achieve: we seek to develop more individuals with the entrepreneurial mindset and, more importantly, to develop them better at being entrepreneurial. In the language of cognitive science, we are helping novice entrepreneurs to become expert entrepreneurs. Observers such as former *Inc.* editor George Gendron[1] have argued that entrepreneurship has grown increasingly professionalized and, in turn, that entrepreneurs increasingly require assistance to help them grow as professionals. Whether or not one considers entrepreneurship to be a profession, we now know that there are expert entrepreneurs. As we improve our understanding of what differentiates the expert entrepreneur, we also need to focus our pedagogy in directions that help students and trainees to grow in that direction.

Along those lines, Jack and Anderson (1999) suggest that we should be creating 'reflective practitioners' with higher-level skills, both practical and cognitive. Creating reflective practitioners requires more than the mere acquisition of information and skills. Again, genuine knowledge is both the raw information *and* the structures by which we organize that information. If we are to truly change our students' entrepreneurial thinking, we must also help them develop new cognitive structures at a much deeper level. In turn, this requires creating a cognitive infrastructure in the classroom that mindfully facilitates such changes.

Tom Monroy was perhaps the first to articulate that traditional classroom methods were not only less frequently used in entrepreneurship classes but they are less effective than more experiential approaches (Monroy, 1995). Rather we tend to emphasize

'problem-based learning' where learners focus on real-world issues, a focus that is a staple of most entrepreneurship courses. Indeed, the most popular and successful training techniques used in entrepreneurship tend to strongly reflect the constructivistic model: living cases (for example, small business institute), business plans, shadowing and so on (Krueger and Hamilton, 1996).

Garavan and O'Cinneide (1994; see also Alberti et al., 2004) published an interesting overview of different entrepreneurship training programs as to key approaches used, key constraints and so on and it illuminates the strong bias we have for hands-on, experiential learning. In particular, *action learning* represents a model of education that seems particularly applicable to entrepreneurship training (Leitch and Harrison, 1999). Action learning is perhaps the most prominent incarnation of the constructivist model.

Much of constructivist pedagogy focuses more on cognitive phenomena, while action learning focuses more on a set of techniques to facilitate that change. Creating Jack and Anderson's (1999) 'reflective practitioners' with both practical and cognitive skills requires action learning's iterative combination of both classroom and hands-on learning in synergistic fashion. Action learning is typically most efficacious in a team setting, as befits the situated nature of the learning, especially a team setting that reflects considerable cognitive diversity (for example, Chapter 11, this volume). Think Senge's (1990) cross-functional high-performance work teams.

'Informed' intent

Who would you bet on? An experienced, successful entrepreneur with a moderate intent or a complete novice with an intense, even passionate intent? What can it possibly benefit us if we increase students' attitudes and intentions toward entrepreneurship, if we fail to prepare them (or, worse, encourage them unrealistically). Increasing intent is one thing, nurturing an informed intent is far more important (Krueger et al., 2007).

We have recently seen exciting research expanding the richness of our understanding of entrepreneurial intentions and, in particular, the relevance to pedagogy and the critical importance of expertise. As entrepreneurial expertise is increasingly important to scholars and educators alike, why not ask about 'entrepreneurial intent among novices versus entrepreneurial intent among experts? If entrepreneurship is not fully recognized as a profession, it certainly has become more and more professionalized. What does it mean to be "expert" in the entrepreneurial domain? How can we help people get there?'

As entrepreneurship researchers and educators, we do not want to turn out entrepreneurs *per se*, rather we are attempting to help them become as expert as possible in the skills and processes entrepreneurs need to exhibit. As educators we can assist them in this journey from novice to expert and that is exactly what we need to be doing. But, that begs the question of content – what should they be working to become expert at? The growing body of work in entrepreneurial cognition argues persuasively that what differentiates entrepreneurs is not necessarily knowledge content and even surface-level skills.

What differentiates entrepreneurs is entrepreneurial thinking; our job is to nurture students into thinking like an expert entrepreneurial thinker. That requires changing some very deep beliefs, deep assumptions that anchor our mental prototypes. To do that requires giving students opportunities for critical developmental experiences (again see Figure 4.1).

Current research has focused on how entrepreneurial education changes intentions and attitudes. Formal training/teaching does seem to matter in the emergence and evolution

of entrepreneurial thinking. Nicole Peterman's thesis work found that an entrepreneurial training program significantly influenced the various antecedents of entrepreneurial attitudes and intentions (Peterman, 2000). Even formal coursework (Cox, 1996; Krueger, 2001; Lucas and Cooper, 2004; Post et al., 2007; Tegtmeier, 2007) appears to have a small but measurable impact on critical beliefs (for example, self-efficacy) and attitudes (including intent).

Again, however, developing entrepreneurial thinking requires changes in deeper cognitive structures. This offers us many opportunities to research the specific impacts of different training activities and other experiences to further improve our learning (Duckworth, 1986). Prior experience certainly influences perception of future opportunities (for example, Krueger and Brazeal, 1994). For example, we have some evidence that growing up in a family business influences attitudes and intentions toward entrepreneurship (Krueger, 1993; Delmar and Davidsson, 2000). Exposure to competitive sports seems particularly potent in more collective-minded cultures (Neergaard and Krueger, 2005); one might even make the case that children's fairy tales might affect deep beliefs (Neergard and Smith, 2007). While it may be unrealistic to place students in their own family business, what are the 'lessons learned' that we might replicate? (And that we are likely doing already.)

Skills and self-efficacy

What *are* some critical developmental experiences that we can fruitfully offer? What specific kinds of skills, what specific kinds of training and what specific kinds of experiences are truly transformative in terms of enhancing entrepreneurial thinking? For example, Robert Baum and colleagues (Baum et al., 2001) found that a venture's growth depended on both specific motivations and specific skills of the founder. However, education researchers argue that skills acquisition is necessary but not sufficient, whether acquired via hands-on mastery or vicarious learning through behavioral modeling.

Learning a skill changes knowledge content, learning that one can use that skill successfully can change how you structure knowledge. Learners must internalize knowledge and skills to the point where they feel comfortable enough to apply them to new, even highly risky situations. Self-efficacy theory (Eden, 1992; Bandura, 1993) suggests that just acquiring skills is not enough to fundamentally change how we think, it also requires believing in those skills (perceived efficacy versus actual efficacy). No self-efficacy, no long-term skills acquisition – or skill usage.

However, self-efficacy without the actual skills hardly reflects an informed intent. Bandura himself would also argue that acquiring the correct skills is also imperative for long-term, sustained change in our thought processes as we move from a more novice mindset toward a more expert mindset. In the entrepreneurship domain, we are beginning to focus on identifying those skills that appear to make the most impact on subsequent entrepreneurial behavior. These tend to also reflect changes in entrepreneurial thinking. For example, opportunity identification often reflects relatively sophisticated skills of counterfactual thinking. Based on this, Gaglio trains her students in advanced counterfactual thinking techniques to increase their abilities to identify opportunities (Gaglio, 2004). How better to expand students' 'what-if' thinking than to have a broader range of life, work and school experiences in the classroom, as you would find in a cross-campus course.

The entrepreneurship program at the University of Victoria (Victoria, BC) focuses most of their activities explicitly on moving students from a novice entrepreneurial script toward an expert script; the expert script serves as a guide to accelerate student progress (for example, Morse and Mitchell, 2005). Baron's (2006) argument that expert entrepreneurs are better at 'connecting the dots' suggests that we find ways to train students in related skills; and deliberate practice seems to be one such method (for example, see Mitchell, 2005; Baron and Henry, 2006). However, this is a process that requires fairly intense reflection, something that other majors are far more comfortable with – and can assist business students.

For yet another example, Fiet and Barney (2002) show that certain key skills related to identifying highly credible opportunities can be identified and taught, thereby raising students' self-efficacy at opportunity identification in a broader, more diverse range of possibilities. This permits instructors to tailor experiential exercises to develop and assess those skills. However, the more diverse the existing base of knowledge and beliefs that the student have, the easier that task will be.

Deep beliefs

Finally, what is the essence of being successfully 'entrepreneurial'? Expert entrepreneurial thinking seems a critical perspective. Successful entrepreneurs should be characterized by an expert mindset. Evidence indicates that the content of an expert's knowledge base need not differ from that of a novice, but experts typically organize or structure the content differently. This begs the question concerning how expert entrepreneurs structure their knowledge. Ericsson (for example, Ericsson and Charness, 1994) has shown that while some individuals move from novice to expert, yet others do not. And, that change manifests itself in significant changes in deep cognitive structures. One key implication of Ericsson's work is that experts, including entrepreneurs, are definitely made, not born. There may be some innate 'hard wiring' but expertise appears to be learned. Some deep beliefs may coalesce at a very early age (for example, Neergaard and Smith, 2007) but they evolve over time (for example, Erikson, 1980).

The research also indicates that experts consistently and reliably follow recognizable cognitive behaviors and processes (for example, Mitchell, 2005; Baron and Henry, 2006). Consequently, if we want to understand entrepreneurship, then it is vital for the field of entrepreneurship to learn as much as we can about what differs in the deep cognitive structures of expert entrepreneurs (maps, scripts, schemas and so on and the deep beliefs and assumptions driving them). When we gain a better understanding of how such deep structures evolve, our ability to help entrepreneurs grows in parallel.

Cognitive diversity

In recent years, we have found remarkable new insights into how we learn to think entrepreneurially. We have found constructs that fully moderate the intentions model. For a striking example, differences in cognitive style can yield dramatically different pathways in the formation of intent. That is, the intentions model for learners who score as preferring intuitive thinking differs significantly from the model for those scoring as preferring an analytic cognitive style (Krueger and Kickul, 2006). That implies explicit consideration of differing cognitive styles among our students and, given the constructivist paradigm, to encourage a broad range of cognitive style and

other learning styles in our students. If the differences in something as simple as cognitive style matters that much, then how about all the other ways that students may differ cognitively?

What better way to do that than to have students from every imaginable major. Barring that, we need to surface the unique mental models that all of us possess. However, consider how business students can influence how non-business students think; consider even further how non-business students can influence business students. But first we must surface as much cognitive diversity as we can, then use that to everyone's advantage.

Building a constructivistic classroom

What teaching tools are constructivistic?

How do we actually implement a constructivistic curriculum? Again, let us turn to Brooks and Brooks (1993):

> A constructivist framework challenges teachers to create environments in which they and their students are encouraged to think and explore. To do otherwise is to perpetuate the ever-present behavioralist approach to teaching and learning. (p. 30)

> [C]onstructivistic teachers seek to ask one big question, to give students time to think about it, and to lead them to the resources to answer it. (p. 39)

In short, we need to focus much more on the learning process going on inside the heads of the learners and less on filling those heads with details. If we improve the students' abilities to learn, the details will follow. Straight lecturing is far from optimal. A charismatic instructor may 'light a fire' in students even in straight lecture mode, but be assured the learning comes from the motivation not the details. Even testing should be a significant learning experience. What do students learn from parroting the text or lecture notes? From multiple-choice, true–false, or matching types of tests? They may even learn that they do not do these kinds of test very well, reducing both their interest level and their self-efficacy perceptions.

Operationalizing constructivism

Brooks and Brooks also offer 12 concrete steps to operationalize these principles. Let us look at them in the context of the entrepreneurship classroom, where students engage in hands-on projects that offer the potential for critical developmental experiences:

1. *Explicitly encourage, accept, and honor students' autonomy and initiative* Self-managed, self-organized work teams require that students take considerable initiative.
2. *Try to use raw data and primary sources as fodder for student inquiry* Requiring student initiative and responsibility also requires that the instructor give them the authority to guide the direction of their own projects after launching.
3. *Students' tasks are to classify, analyze, predict, and create (not simply memorize)* Real-world projects inevitably involve both primary and secondary data collection as grist for the students' mill.

4. *Student responses on a topic should direct strategy and content of teaching* The projects (and essay exams) force the students to think critically, to integrate and apply what they are learning with projects (and with past life, work and school experiences).
5. *Ask for students' understanding before we give them our perspective* They also require that class discussions be centered around the students' authentic questions, often about how to apply a concept to their project.
6. *Encourage dialogues between students and teacher, each other, family, even outsiders* The projects require students to discuss their efforts with each other, clients and others in the community with the knowledge and expertise needed for the project.
7. *Ask open-ended questions; encourage students to also do so* The exam takes this approach, while experiential projects themselves naturally induce open-ended questions (often to a harrowing degree). Moreover, students feel free to ask tough questions of each other.
8. *Ask for elaborations of initial responses* Similarly, students in self-managed team projects rarely let their peers give evasive answers (but are coached to be supportive as well.)
9. *Don't accept quick answers; encourage reflection* Similarly, giving the students two months for the essay exam affords them an opportunity to elaborate and reflect, even argue with one another.
10. *Actively seek contradictions* Interestingly, hands-on projects under high cognitive diversity appear to naturally encourage the students increasingly toward initiating dialogues that are more Socratic in nature, as they struggle to make sense of ill-structured projects in ill-structured domains.
11. *Actively seek metaphors* Metaphorical reasoning is not inherent in these projects (nor in the exam) although students have a propensity toward analogical reasoning, even where spurious, affording teaching moments for the instructor. Here again, cognitive diversity becomes a true ally.
12. *Take advantage of the natural learning cycle (from discovery to concept introduction to application), balancing both challenge and safety* For example, the extended time afforded by take-home exams with deep, 'stretch' questions allows students to work through this cycle. Extremely challenging team projects work best when students realize that there is a safety net in the form of both the instructor *and* their fellow students.

Impediments to constructivistic curricula

Another aspect of that is how educators' prior expectations can cloud their perceptions of what is happening in the classroom. A trap we are all familiar with: it is very easy in case-study discussions to assume that the discussion will eventually end up taking the same general directions and end up with the same general conclusions. Prawat (1992) notes the existence of four critical cognitive impediments to implementing a more constructivistic curriculum:

1. dichotomous view of teaching and learning;
2. student interest and involvement is necessary and sufficient for deep learning;

3. dichotomous view of comprehension and application; and
4. the curriculum is a fixed agenda (dichotomous view of content and process).

These erroneous assumptions reflect instructors' own role identity as a teacher. We can test ourselves – are we guilty of these assumptions? Assumptions may be hard to change, but we can raise our awareness of them. Prawat suggests that these assumptions reflect dichotomous, 'either/or' thinking about learning, though experienced educators are fully aware of the sizable 'grey areas'. Let us consider this in terms of cross-campus entrepreneurship education.

Teaching and learning as distinct implies the folk wisdom that education is a transfer of knowledge from teacher to student. An entrepreneurial setting often requires the student to bring considerable information to the class and, in many cases, a distinctly different mental model of the problem at hand. The latter is particularly powerful in helping students (and teachers) to construct newer, more apt mental models.

A classroom where many different majors are present (and not just different business majors) forces these differing mental models to the surface immediately. It is this iterative, reflective process of constructing and re-constructing deep knowledge structures that makes for deep learning. All the student and teacher passion in the world will not help if we ignore the constructivistic nature of deep human learning.

Prawat's third impediment is that we often think of learning as a sequential process: we learn, then we apply our learning. Action learning models (for example, Leitch and Harrison, 1999) have long argued that deep learning is accelerated when we act, then seek to understand. Entrepreneurs need to act and learn essentially in tandem, making it difficult to arbitrarily separate even classroom learning from action. Our classroom exercises must reflect that, rarely being mere transfers of knowledge without the context of action. It is easier to get students to routinely ask 'Why?' and 'How?' when their mental models differ as much as they do in a cross-disciplinary setting.

Prawat's final impediment is really the culmination of the first three. How do we overcome the first three impediments, while following a rigid syllabus? Even with students with a shared mental model (for example, accountants) one never quite knows when important teaching (and learning) moments can occur. The more cognitive diversity in the classroom, the more likely it is that any key learning moment can occur at almost any time and the instructor (and the students) need to be prepared. If entrepreneurs thrive on serendipity, then so too should entrepreneurship education.

Let us look briefly at how one might grow a constructivistic learning partnership.

Exemplars of constructivistic classrooms

Providing learners with authentic questions (or helping surface them) that engage them at a deep level and letting them take ownership of how they address those questions (and how that changes how they think) is key. Doing so requires that the instructor truly understand the entrepreneurial mindset, but the payoff is significant. Not only does the engagement benefit the community, but the constructivistic process enables learners to change how they think about entrepreneurial thinking. You simply cannot change the entrepreneurial mindset through 'memorize and regurgitate' training

Appendix 4A offers two examples that the author is closely familiar with and most readers will find them well within their comfort zones. Again, much of what

entrepreneurship educators do routinely leans heavily toward the constructivistic; these examples lean even further, including an intensive engagement with the community. Both examples also lend themselves quite readily to university-wide programs.

What other kinds of exercise are congruent with the constructivistic learning approach? Case studies seem an obvious approach. Case-study analysis compels students to construct working models and to re-construct them as they work through the ramifications. The iterative process is immensely valuable as it enhances students' ability to 'learn how to learn' in new directions. (When we learn to do mathematics, we engage in the same 'patterning' process.) Cases can surface students' most stubbornly held assumptions, but only if we encourage reflective thinking and we encourage 'out-of-the-box' thinking. For example, some case instructors insist that students not invoke outside knowledge, but we are rarely dealing with legal cases where precedent is paramount. If you are teaching case studies and students 'go the extra mile' to find additional data, why punish them?

One useful approach in this domain is the semi-structured 'living cases' such as those used by many schools. The reality of a living case compels action learning and a constructivistic approach. The good news is that most entrepreneurship educators have embraced the reality aspect and many focus heavily on experiential learning. However, a deeper understanding of the key principles of constructivism and of methods that embrace them (for example, action learning) will enhance learners' experience even further.

Once again, a caution: experiential exercises need to be *truly* experiential exercises. Not all such named exercises are really so. 'Hands-on' does not necessarily equal 'experiential'. Truly experiential exercises give careful consideration to process and content – and give students room to make mistakes. An example of this would be a business simulation game that in the long run rewards early mistakes, rather than a game that overly rewards early success, even if it results purely from chance. In short, truly experiential exercises change how students think – not just changing the content of knowledge but also changing deeper cognitive structures.

Consider examples from this Handbook. Entrepreneurship in the sciences requires an entrepreneurial approach. Biologist Daniel Johnson asked his students to write a chapter for an authentic biology text, while biophysicist Jed Macosko engaged students in computer graphics, both with a truly entrepreneurial spin and genuine problem-based learning (Chapter 9, this volume)

A remarkable example from this Handbook is Lynnette Claire's entrepreneurship film project (Chapter 12, this volume) where students with little or no exposure to entrepreneurship or to film-making were tasked with studying a local entrepreneur and creating a compelling short film on their subject. This required bringing in resources from across the University of Puget Sound (Tacoma, WA) and engaging the community at a deep level, all the while helping students reflect on their experiences and the impact on their own entrepreneurial self-efficacy.

Community engagement in general is a potent way to get learners to identify truly authentic questions. We have already noted that social and sustainable entrepreneurship is often at the heart of cross-campus entrepreneurship programs. What better than projects that allow learners to learn at a very deep level and channel their passion in ways that enhance their cognitive development toward more expert entrepreneurial thinking?

Getting started

Business students are often well-schooled in the traditional learning approaches. True collaboration is likely to seem threatening to students who assume that education is a competitive process. Perkins and others argue that we can begin the process with deceptively simple exercises such as 'Fermi' problems. (A Fermi problem asks a simple question with no simple answer, such as 'How many pencils are there in Chicago?'.) The pursuit of a Fermi problem forces students to be creative and to use multiple perspectives and approaches. In turn, this leads them toward collaboration and toward the realization of the world's inherent messiness and noisiness. We observe other simple approaches such as using metaphors ('firm as a machine' or 'firm as a tree' and so on as suggested by Morgan, 1986) or debates or even a mock 'town meeting'.

'Students as true co-investigators' is another powerful model (Yager, 1991). Consider John Bunch at Benedictine (Atchison, KS) who lets students do 'How-To' papers that show the reader how to handle some useful task such as how to arrange a letter of credit for exporting to France. The student identifies the topic area (thus an 'authentic' problem), negotiates its scope with instructor as essentially co-learner, then delivers a report that is available to classmates, present and future. We are developing a program where students will co-write white papers with local technology clients; this may even become a profit center to help support student activities.

Not all group projects offer such benefits; poorly structured group projects can impede learning. True group projects involve pervasive collaboration and exhibit many characteristics of cooperative learning (true interdependence in goals, in the means to those goals, and in rewards). Some instructors have found success in journal writing and other tangible supports to students' ability to think reflectively on the learning process in that class – how their thoughts have changed and how their ways of thinking have changed. One tangible output might be writing a case study, especially now with formal case-writing competitions that are welcoming student efforts.

Any such approach lends itself to a cooperative learning environment where students are wholly interdependent on each other for their goals, their strategies, and their rewards. Many business school programs use such teams exclusively with great success. A low-risk approach is the group outside presentation where the team must present to some real-world group on a topic of value and interest. This pushes students to select an 'authentic' problem and grants them the freedom to pursue it autonomously. As might be expected, team teaching is often useful, offering multiple perspectives to the students. A prominent example is the Experiential Classroom Program at Syracuse (NY) that teams entrepreneurs with academics.

We need to provide a safe environment where failure is clearly and emphatically a learning experience. Some entrepreneurship classes even insist that students must 'push the envelope' until they actually fail, learning that adversity really is a learning experience. One popular model is to assign students a project to induce some actual, visible change in some organization that involves more than one person (who must be persuaded, not ordered). Setbacks on an 'impossible' task are often much less ego-threatening.

Daryl Mitton (1994) offered a series of experiential exercises to build what he calls entrepreneurial 'clout' (essentially tacit knowledge and self-efficacy). Exercises many use include the 'dollar' exercise (create a profitable, legal business for $1) and the 'five strangers' (go ask five strangers about your business idea). Learning experiences such as

these are generally done outside of class at the student's choice of time and place. The exercises encourage breadth of thinking and, more important, increase student perceptions of self-efficacy at the task or skill in question. They allow students to change their mental models with a minimum of risk to ego or self-image.

How do we evaluate progress?

One key advantage of the behaviorist, content-oriented model is that it is relatively easy to assess whether the content knowledge has been transferred. It is considerably more challenging to assess whether knowledge structures have changed (and in positive directions). What we can do is focus on the constructivistic process and to keep firmly in mind that our goal is to help students move toward more expert entrepreneurial thinking.

Let us return to the issue of how learning processes can change deep mental models in the direction of better entrepreneurial thinking, whether in terms of learning to see more/better opportunities or to see oneself as an entrepreneur (or, as we have noted, both). Both Baron (2006) and Gaglio (2004) demonstrate how the cognitive mechanism of counterfactual reasoning is a potent lever for stimulating students to question their existing mental models. And, again, at the University of Victoria, Ron Mitchell, Brock Smith and Kristie Seawright and Eric Morse have developed a pedagogy that heavily emphasizes helping students acquire expert scripts (2000). This clearly suggests that measures of deep structures, whether scripts or maps or other possibilities, can be usefully deployed to research how entrepreneurial thinking changes across a training program (Mitchell et al., 2000; Krueger, 2001).

How do we best evaluate student performance formally? We have suggested above that in constructivistic learning, it can be powerful indeed to engage the students in designing assessment and evaluation metrics. An excellent starting-point is something that students, especially non-business majors, often suggest: the 'portfolio' concept that collects a wide variety of student outputs. Perkins (1994) argues for 'process-olios' which also include throughputs to vividly demonstrate student progress. (That is, the process-olio includes interim and draft reports.) Requiring multiple projects in the portfolio/process-olio taps into more than one kind of intelligence and more than one type of skill, showing how students take advantage of their strengths and how they remediate their weaknesses. In short, they show how the students learn how to think more entrepreneurially. SBI reports are ideal candidates. However, we would be remiss if we neglected the growing use of portfolios in entrepreneurship education with at least three Academy of Management pedagogy awards going to portfolio-based programs, two of which are explicitly script focused (San Francisco State and Victoria.) Never lose sight that the metrics and the evaluation process itself should have visible connection to the change in deep beliefs and knowledge structures that we are seeking.

Where next?

More important questions remain. As models and methods continue to evolve, especially those suggested by recent breakthroughs in neuroscience, we will be able to take closer and closer looks at how specific educational experiences affect specific changes in how we structure knowledge. However, we still have relatively limited evidence even at the surface level. Unlike the education field (for example, Hamilton and Hitz, 1994) we have not studied how students' reflections change over time (for example, through

even simple mechanisms such as reflective journals). Would it not be amazing to track the changes of business majors versus non-business majors? Even if they converge at the same points, the paths will likely differ. (Even if they start at similar spots, the paths may differ!) We already know in social entrepreneurship (a frequent theme in cross-campus programs) that someone with the role identity of an 'entrepreneur' starts with very different knowledge structures from someone with the role identity of 'social activist', even if they too end at the same point (Simms and Robinson, 2006). Cross-campus courses represent a powerful venue for cutting-edge research in entrepreneurial cognition.

It is also imperative that entrepreneurship educators do more assessment of the impact of their teaching. As noted, we consistently see that our classrooms do change students' thinking. From the constructivistic perspective, it is almost unthinkable that we would not. However, that begs two questions. First, why are we not doing more of this research? Why are we not doing research that addresses directly the legitimacy of what we do? With accrediting bodies nudging schools to use practitioners less in the classroom and administrators trying to shoehorn entrepreneurship into the mainstream, why then are we not providing the very evidence that demonstrates that what we do matters? That how we do it matters?

Second is a more troubling question: are we always changing minds in the right directions? Are we actually moving them in the general direction of expert thinking? If the constructivist model has a large drawback, it is that the instructor needs to fully understand (and likely share) the expert entrepreneurial mindset. What if the people teaching entrepreneurship have serious misconceptions about the entrepreneurial mindset? Even a talented, passionate amateur may be painfully hostage to the novice mindset to the detriment of students.

Entrepreneurship is not linear; entrepreneurial thinking must not be linear

Considering that entrepreneurial processes are rarely linear, becoming an entrepreneur comprises a set of ill-structured, even wicked tasks. We know that planning a venture requires effectual, not causal logic (Sarasvathy, 2004). However, what about instructors who teach entrepreneurship as essentially a linear process? There is growing evidence that simply teaching someone to write a business plan is dysfunctional at best, educational malpractice at worst. Meanwhile, leading educators have grown increasingly contemptuous of 'cookbook' business plan classes – and contests (for example, Meyer, 2001).

On the other hand, we are seeing the rise of cross-campus competitions such as the University of Texas's 'Idea To Product' (www.ideatoproduct.org) global contest where multidisciplinary student teams turn raw intellectual property into plausible products. Helping students learn to turn ideas into reality is powerfully constructivistic in itself; adding the cognitive diversity of multiple disciplines makes it work.

The political context? ('Anyone can teach entrepreneurship!')

Yet, little of this has seen print. Why? Business plans are essentially the 'killer app' that brought entrepreneurship into wider acceptance in business schools. Business plan contests are great theater and potentially great fund-raisers for schools, even if we cannot identify measurable impacts on entrepreneurial thinking. What administrator wants to hear that business plans are too often mediocre pedagogy? We have seen how

problem-based learning is far more powerful and more productive, yet if it requires an expert thinker to do it properly, then that constrains administrators who would prefer to believe that 'anyone can teach entrepreneurship' (Fernandes, 2006). However, do we really know what the impacts are, positives as well as negatives, of using the business plan 'cookbook' as the centerpiece of entrepreneurship education? Would we not be better off if we took a constructivist approach to teaching business plans (Honig, 2004)? That is one nettle we need to grasp; we now have the tools to do so. How does this linear approach actually change deep knowledge structures?

Instructor effects?

Case studies are a middle ground that can also be fruitfully explored. An inexperienced case teacher may be too prone to follow the 'recipe' suggested by the teaching notes, both the intended conclusions and the paths to get there. Meanwhile, an experienced (expert?) case teacher can operate in a much more nonlinear fashion, yet providing linearity where needed. As such, we could hypothesize that instructor differences might play a significant role. In much of the foregoing, we have argued that the key instructor difference lies in him/her having or knowing the expert entrepreneurial mindset. Here we may find that the key difference is being an expert in case teaching. Hanke et al. (2005) seem to argue that having expertise in true problem-based learning is the critical leverage point, not necessarily having the expert entrepreneurial mindset. Finally, we would also be remiss in not arguing that we need to study student effects. (Might not cross-campus courses provide fertile ground for studying that?) Our research needs to tease out the differential impacts of instruction, instructor and student.

In sum, it should be obvious that not only does the constructivist model offer us a powerful, productive way to understand and improve entrepreneurship education, but there is also a rich, deep array of theoretically interesting – and practically useful – topics for future research.

Constructivism: major conclusions

1. The number one objective of constructivistic education is: deep understanding, not just superficial skills. Even complex skills necessary for success are acquired more quickly and thoroughly through this kind of approach. Being a successful entrepreneur requires this. And, as we have seen, the cognitive diversity offered by a cross-campus program can accelerate this process measurably.
2. Gaining a deep understanding requires 'learning how to learn' from multiple perspectives. How better to do this than in settings where the multiple perspectives define the setting (as in cross-campus classes)?
3. The constructivistic model of education confirms conceptually much of what we already know to be efficacious educational practice.
4. The constructivistic model affirms the criticality of context: the situation and co-learners are vital to students gaining a deep understanding of the subject area.
5. Constructivistic teaching works (but it is not easy!).

'Education is not the filling of a vessel but the lighting of a fire' (William Butler Yeats). To borrow an old adage, our goal as entrepreneurship educators is not human resource

development, rather the goal is developing resourceful humans. Where better than in entrepreneurship to light – and fan – the fire?

Appendix 4A Two examples of constructivistic classrooms

Example 1 The virtual accelerator course for nascent gazelles
The University of California at Los Angeles (UCLA) pioneered a model program (GAP) where MBA capstone (all majors) students were matched as teams with nascent gazelle entrepreneurs with high potential for explosive growth and figured out ways to help them toward meeting their promise. (UCLA was not the only pioneer, in fact, many schools now follow this general model such as Georgia Tech's TiGER program, the multi-school program developed by N2TEC (www.n2tec.org, led by USC and Fresno State, CA). However, UCLA's Alan Carsrud was first to market with this model.)

Basic GAP model Student teams are matched with nascent tech entrepreneurs (firm already started but not yet launched). Team goal is to help accelerate the business's development, ideally resulting in major external funding, acquisition and/or major customer acquired.

- *Step 1: Recruitment* Obviously, the client businesses are carefully vetted, but so too are the instructors required to support this process (comfort with and skills with regard to problem-based learning is imperative).
- *Step 2: Launching* Students (and faculty) and entrepreneurs come together for a 'kickoff' weekend where the teams and their entrepreneurs can bond and develop the initial action plan for the semester. This includes a 2+ day entrepreneurship boot camp that gets students and others up to speed on the task ahead. This crash course can also be shared with a broader audience. The event closes with brief student presentations on their proposed 'battle plan' (including benchmarks and milestones), pitched to a 'murder board' of experts in new ventures and the firm's industry.
- *Step 3: The work* Student teams go home to begin work on their plan, revising as need be. They identify an advisory board for their project using members of their community (wherever possible), even national experts. It really is up to the team; however, at regular intervals, additional course material is presented to students and other material is provided to faculty and team advisors to use.
- *Step 4: The celebration/competition* Student teams return at the term's end for a celebration of what all the teams have been able to do and a final formal presentation to an extremely high-powered, experienced 'murder board' selected specifically for each team. (This can obviously be structured as a competition, of course.) The celebration combines this with a second boot camp that can be shared with the public, this time focusing on later-stage issues such as presentation skills.

From a constructivist perspective, note how the GAP program lives up to the key criteria for constructivistic learning, using the criteria provided by Brooks and Brooks (1993).

1. 'Authentic' (and 'important') questions
2. 'Big ideas'
3. Constructing meaning requires triangulation
4. Coaching, not lecturing
5. Assessment and evaluation techniques should reflect these processes

- *Authentic questions and big ideas:* GAP offers projects with genuine, significant real-world consequences, where both success and failure will be highly visible. Students realize immediately that they will play a significant role in what happens.
- *Triangulation:* Nascent entrepreneurs operate in an environment where information is problematic, requiring students to work with all manner of information sources, including human sources whose intel requires triangulation, but also teach them about the mental models of industry insiders and outside experts.
- *Coaching:* The instructors provide key information in the initial boot camp and are available for consultation (and intervention, if need be) throughout the term. However, it is common that student teams must teach themselves key skills.
- *Evaluation:* Students are evaluated by the 'murder board' expert panels and by their peers.

Example 2: Technology commercialization and economic development

A 'TEAMS' approach? TEAMS was at the heart of a complex partnership between Boise State University (Boise, ID) (later other schools), the Idaho National Lab (www.inl.gov) and the Inland Northwest Research Alliance (Idaho Falls, ID) (www.inra.org) and the universities in the INRA region, supported by these partners and the Ewing Marion Kauffman Foundation (Kansas, City, MO). Student project teams work on a diverse set of entrepreneurial projects that provide a rich, ill-structured learning environment while helping their communities via commercializing novel cutting-edge technologies and economic development (including social ventures).

The TEAMS process Each team works with external clients to negotiate project scope. Teams working with a community negotiate their project with local contacts and the instructor. During the semester teams share their progress (and their hurdles) with other teams, including a midterm formal progress report and presentation. At the end of the semester the team presents formally to their clients, usually on-site, with a final formal presentation with guests from the local business and technology communities.

Technology commercialization projects Most of a wide range of technology projects were recruited from the large federal research lab here in Idaho, the Idaho National Lab (INL). Commercialization assessments begin with a thorough industry analysis followed by a market analysis (*à la* QuickLook). Student teams develop a strategic plan for implementing commercialization, presented to the inventors and tech transfer professionals.

Students primarily worked with new technologies developed that INL wants to license, such as software (data warehousing, computer security monitoring), biotech, and environmental remediation, plus the local high-tech community (for example, www.kickstand.org).

Economic development Similarly, INL's economic development group and others offered projects where student teams can help local communities. With the technology projects the successful student work attracted interest from other development entities in the region.

- *Community assessments*, such as developing opportunity-capacity matrices to guide future projects. (For these, students present to development professionals and local leaders.)
- *Feasibility studies for new industries* One project proved the high potential for a new industry cluster based on hydroponics, while another team prepared a feasibility study for the Sacajawea Interpretive Center in Salmon, Idaho.
- *Designing new development efforts* Past projects include designing a next-generation producers' co-op for rural Idaho and designing a distance learning center in northeast Idaho.
- *Specialized projects* Teams from three different Idaho universities inventoried telecommunications resources in several Idaho cities, presenting their findings to the Governor and other top officials from government and industry at a major conference to ramp up rural connectivity.

Key student lessons learned TEAMS projects gave an opportunity for hands-on experience at creating true entrepreneurial value in constructivistic problem-based learning where they applied process skills such as:

- ill-structured problem solving (and project management under such conditions);
- building and maintaining a self-managed high-performance cross-functional work team;
- integrating and applying a wide range of business skills in an entrepreneurial setting; and
- an inside look at how large real-world projects get designed and implemented.

Tangible outcomes

1. Student excitement: Students now maneuver to be in these capstone sections.
2. Tangible impact on high-stakes technology commercialization decisions.
3. Tangible impact on local communities, often rural (but could easily be urban).
4. Improved student skills at team building, problem-solving and written/oral presentation skills.
5. Projects provide real-world context to illustrate key concepts such as business models, competitive intelligence, industry analysis, benchmarking and, of course, business plans.

TEAMS as constructivistic learning How does the TEAMS program live up to the key criteria for constructivistic learning? Let us return to the useful criteria provided by Brooks and Brooks (1993):

- *Authentic questions & big ideas:* Projects have genuine, significant real-world consequences, something that catches the students' attention – and keeps it. Student projects have provided INL with information used directly in patenting and licensing decisions. Economic developers have used student projects to advance their communities (for example, the producers co-op for eastern Idaho relies heavily on the students' research and analysis).
- *Triangulation:* Projects also require using multiple sources of information, often conflicting, and sometimes working with key contacts who themselves have very different agendas. Students get multiple perspectives on their projects directly and en route gain multiple perspectives on critical course concepts. Working in a true self-managed work team adds additional triangulation (for example, Senge 1990). With the addition of other universities to the TEAMS effort, students also triangulate with the experiences of others.
- *Coaching*: The bulk of the instructor's time is spent working with the teams and clients. To further move away from lecturing, each student team is charged with teaching a text chapter, explicitly linking that chapter's key concepts to their own project. Students also coach each other on peer teaching presentations.
- *Evaluation:* Students are evaluated on their projects by their peers, clients and outside experts.

Note

1. See www.pioneerentrepreneurs.net/bigidea_gendron.php.

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