

The Necessity of Engineering Entrepreneurship Education for Developing Economies

A. A. Refaat

Abstract—Knowledge is recognized as an important ingredient for economic growth in addition to physical capital and labor. Entrepreneurship can be an important mechanism by which knowledge spills over and becomes commercialized. Entrepreneurship involves the nexus of two phenomena: the presence of lucrative opportunities and the presence of enterprising individuals. The process of opportunity enactment is outlined as a conceptual extension of a given body of knowledge into a perceived possibility of economic gain. An engineer is assumed to be endowed with a certain stock of knowledge; accordingly, he will be confronted with the choice of how best to appropriate the economic return from that knowledge. So, future engineers have to be trained how to recognize and develop new technologies and to take the technologies to market and to practice industry proven commercialization processes within an academic environment. The encouragement of high-technology entrepreneurship is an increasing focus of enterprise agency activities in growing numbers of developed economies. Developing countries need to encourage entrepreneurial cultures in order to enhance their economic growth and improve the quality of life of their people. This study is designed to investigate the nature of entrepreneurship, the potential impact of entrepreneurship education and the imperative need of engineering entrepreneurship education for developing economies; taking Egypt as an example

Keywords— Entrepreneurship, Engineering education, Opportunity recognition, Entrepreneurial abilities.

I. ENTREPRENEURSHIP

ENTREPRENEURSHIP involves the nexus of two phenomena: the presence of lucrative opportunities and the presence of enterprising individuals.

A. Definition of Entrepreneurship

Entrepreneurship is an activity that involves the discovery, evaluation, and exploitation of opportunities to introduce new goods and services, ways of organizing, markets, process, and raw materials through organizing efforts that previously had not existed [1], [2]. Given this definition, the academic field of entrepreneurship incorporates, in its domain, explanations for why, when and how entrepreneurial opportunities exist; the sources of those opportunities and the forms that they take; the

processes of opportunity discovery and evaluation; the acquisition of resources for the exploitation of these opportunities; the act of opportunity exploitation; why, when, and how some individuals and not others discover, evaluate, gather resources for and exploit opportunities; the strategies used to pursue opportunities; and the organizing efforts to exploit them [2].

The nexus between individual and opportunity underlies a central question in entrepreneurship research, namely why some individuals and not other recognize certain opportunities [2]. There is a lack of theoretical precision among the current conceptualizations of individual differences in regard to opportunity recognition. While prior knowledge is unequivocally important for recognizing opportunities [3], it is not clear why people with broadly similar knowledge would differ in recognizing opportunities. Similarly, while opportunity recognition may be associated with distinct cognitive processes [4], it is not clear why, by whom, and for what purpose these cognitive processes become activated.

The main theoretical advances in understanding opportunity recognition originate from key ideas from the Austrian Economics School: Hayek's (1945) dispersed nature of knowledge and Kirzner's (1979) entrepreneurial alertness. Stevenson and Jarillo-Mossi (1986) viewed entrepreneurship as the process of creating value by combining resources to exploit an opportunity. Christensen, Madsen and Peterson (1994) defined opportunity recognition as either "a) perceiving a possibility to create a new business, or b) significantly improving the position of an existing business, in both cases resulting in a new profit potential." Stevenson, Roberts, & Grousbeck (1989) argued that the pursuit of the opportunity may occur regardless of resources controlled. Bygrave and Hofer (1991) proposed a broad definition of the entrepreneur as "someone who perceives an opportunity and creates an organization to pursue it." Clearly, these definitions underscore the critical importance of opportunity to entrepreneurship [5]. Shane and Venkataraman (2000) made a compelling argument that opportunity recognition comprises constructs that fall within the unique domain of entrepreneurship and that opportunity recognition should be a central focus of related research [2].

A. A. Refaat is a teaching assistant at the Department of Chemical Engineering, Faculty of Engineering, Cairo University (phone: +20122277897; e-mail: aarefaat@hotmail.com).

B. Opportunity

PI Kirzner [6], [7] defined an opportunity as special knowledge an entrepreneur might acquire about goods or services sold in new markets or combined and sold at a profit. Furthermore, he noted that ideas become an opportunity when their commercial value is recognized. DeBono (1978) defined opportunity as a “course of action that is possible and worth pursuing.” He also pointed out that recognizing opportunities involves non-linear or lateral creative thinking, that is, “thinking outside the box”. Long and McMullan (1984) stated that opportunity is “an elaborated vision of a new venture which involves a searching preview of the mechanics of translating the concept into reality with an industrial setting.” and Hulbert, Brown and Adams (1997) stated that a business opportunity is the chance to meet an unsatisfied need that is potentially profitable [8]. Ardichvili, Cardozo and Ray (2003) defined it as the chance to meet a market need (or interest or want) through a creative combination of resources to deliver superior value [9]. A more recent definition of opportunity was adopted by Alvarez (2005), in which he defined opportunity as a perceived possibility of economic gain. He pointed to two perceived conditions that precede the identification of an opportunity – gain and control. Gain pertains to the finding that opportunities are associated with a benefit to be derived if they are exploited. Control pertains to the perceived command of the opportunity situation [10].

C. Opportunity Model

There have been attempts to model opportunity recognition and these models have come from differing perspectives and disciplines. One of the earliest models to appear in the literature was developed by Long and McMullan (1984). In developing their model they made the assumption that opportunity recognition is a process, under personal control (at least partly), which becomes realizable after substantial preparatory work, therefore personalizing it and making it inaccessible to others. They also noted that the process described in the model is not linear and may take considerable time. The model they developed was presented as a 4-step process: 1) Pre-vision; 2) Point of Vision; 3) Opportunity Elaboration; and 4) Decision to Proceed. The Lumpkin, Hills, and Shrader (2003) model was explicitly developed on the creativity process and parallels the Long and McMullan model in a 5-step process: 1) Preparation; 2) Incubation; 3) Insight; 4) Evaluation; 5) Elaboration. This model of creativity first appeared in the psychology literature in 1926 and it is the basis for a redesigned model that was introduced by Csikszentmihalyi (1996) [10].

The model introduced by Bhava (1994) suggested that opportunity recognition can either be a result of internal or external stimulation. An externally stimulated opportunity is one in which the entrepreneur first decides to start a business, followed then by search for and recognition of an opportunity. Internally stimulated opportunities occur when the entrepreneur first discovers market needs that were fulfilled by existing businesses – an opportunity which leads the

entrepreneur to launch a new venture to satisfy that need [11]. In addition to making the distinction between internally versus externally stimulated opportunities, an interesting important contribution was noting the filtration and refinement that often takes place before the business concept is identified. Bhava (1994) defines the business concept as a fully refined opportunity. The model indicates that opportunity recognition does not occur through a discrete linear process. Rather, a “simmering” effect takes place as a variety of opportunities are examined before one is selected as the formal business concept. The concept of considering multiple opportunities over time, before an opportunity is selected, is an important feature of the model. The development of ideas into entrepreneurial opportunities may require numerous modifications. The time required for the developmental steps required to turn ideas into opportunities will differ depending on the type of opportunity, the environment, and the entrepreneur. For some entrepreneurs, the recognition of the idea and opportunity may be simultaneous, while others take weeks, days, and even years before recognizing an opportunity from a new venture idea [12].

Another stream of research has focused on opportunity recognition as an innate skill or cognitive process [4], [7], [12]. Much of this work has evolved out of Kirzner’s work [6], [7]. He introduced the idea of entrepreneurial alertness – “the ability to notice without search opportunities that have hitherto been overlooked”. In his view, opportunity recognition is experienced as a flash of insight, the “aha” experience (Point of Vision and Insight). Focus on Kirzner’s research discouraged attention to deliberate search, partly due to his belief that opportunities cannot be discovered through search because they are “unknowable a priori”. He believed that if the situation is “right” – an alert individual with the ability and possibility of gain - the cognitive process of assessment reasoning, that is, the process that provides an accurate assessment of the situation, will be initiated. Studies have found that entrepreneurs and executives may approach tasks of searching for business ideas [4] and time spent on information search [12] differently. The framework offered by Gaglio (1997) builds on Kirzner’s (1979) model. Opportunity recognition is that moment of insight that an idea has commercial potential. The entrepreneur must be “alert” and have both the ability and potential for gain. If these conditions are satisfied and one can break the existing framework, then an opportunity can be recognized. Gaglio further developed this idea by introducing cognitive schemas. These represent the entrepreneur’s knowledge about the market process – essentially mental models that guide information processing. Gaglio’s model showed that assessment of an idea will activate chronic schema. A chronic schema is one that is habitually activated, regardless of its appropriateness. She goes on to say that entrepreneurial alertness can be conceptualized as an example of chronic schema. Examples of chronic schemas that entrepreneurs may activate include: familiarity [12], market disequilibrium and discontinuity and commercial potential.

Entrepreneurs may then use counterfactual thinking (imagining alternatives) or simulations to break the framework and recognize opportunities.

Focusing on value creation and opportunities, Santos and Eisenhardt (2004) concluded, “entrepreneurs perceive new opportunities for the creation of value, and construct a market around those opportunities”. This view could have enormous implications for the study of opportunity recognition because, as they noted, new market opportunities may not be seen as inevitable outcomes of demographic or technological changes, but rather as “fragile social constructions....willed into existence by active entrepreneurs...”. So instead of entrepreneurs’ recognizing an existing product/market opportunity that is waiting to be seen, focus is on seeing the opportunity to create value – and a profitable venture only follows the proactive development of a nascent market [10].

D. Typology of Opportunity Enactment

Each opportunity has particular content, i.e. demand and supply parameters bounded in a particular space and time. Similar to a hypothesis, an opportunity emerges from a body of knowledge that is conceptually extended to form a perceived relationship that is to be empirically tested. This conceptual extension represents the structure of opportunity enactment.

As an opportunity involves the matching of demand and supply in the market place, one possible difference to the knowledge base involved in opportunity enactment has to do with whether there is perceived knowledge of a source of demand or a source of supply, or both. This focus on demand supply reflects some of the attempts at developing opportunity typologies [9].

The labels of “replication,” “demand,” and “supply” refer to the knowledge base from which the hypothesis is derived. For example, a person may be aware of a current business and consider its replication; another may be aware of unsatisfied customer needs and conceive a way of satisfying these needs; yet another may be aware of a new technological invention and conceive of a need that this invention may satisfy. These three types of opportunity-derivation processes may be termed replication-, demand-, and supply-driven respectively.

The essence of this typology is that it outlines three distinct enactment processes, each characterized by its unique epistemological context.

- Opportunity recognition: If both sources of supply and demand exist rather obviously, the opportunity for bringing them together has to be “recognized” and then the match-up between supply and demand has to be implemented either through an existing firm or a new firm.
- Opportunity discovery: If only one side exists in an obvious manner and the other side either does not exist or is so latent as to be virtually non-existent for most people – that is, demand exists, but supply does not, and vice-versa – then, the non-existent side has to be “discovered” before the march-up can be implemented.
- Opportunity creation: If neither supply nor demand exist

in an obvious manner, one or both have to be “created,” and several economic inventions in marketing, financing, management etc. have to be made, for the opportunity to come into existence.

The process of opportunity enactment is outlined as a conceptual extension of a given body of knowledge into a perceived possibility of economic gain.

E. Opportunities: Objective or Subjective?

Shane and Venkataraman (2000) defined entrepreneurial opportunities as “those situations in which new goods, services, raw materials, and organizing methods can be introduced and sold at greater than their cost of production.” These opportunities are treated as objective phenomena, though their existence is not known to all agents. Shane and Venkataraman also distinguish entrepreneurial opportunities from profit opportunities more generally. While the latter reflect opportunities to create value by enhancing the efficiency of producing existing goods, services, and processes, the former refer to value creation through “the discovery of new frameworks” [2].

Almost all of the initial empirical investigations of alertness have focused on the means by which an individual might literally “notice without search.” For example, Kaish and Gilad (1991) interpret this as having an aptitude to position oneself in the flow of information so that the probability of encountering opportunities without a deliberate search for a specific opportunity is maximized. Therefore, in their operational measures of alertness, they asked founders to recall: (a) the amount of time and effort exerted in generating an information flow; (b) the selection of information sources for generating an information flow; and (c) the cues inherent in information that signal the presence of an opportunity. From this data the authors deduced: (d) the quantity of information in the flow and (e) the breadth and diversity of information in the flow. Their results conform to expectations in some ways but also reveal some unexpected patterns. Compared to the sample of corporate executives, the sample of new venture founders do appear to spend more time generating an information flow and do seem more likely to use unconventional sources of information. Interestingly, the founders do seem more attentive to risk cues rather than to market potential cues. However, the data also revealed that only inexperienced or unsuccessful founders engage in such intense information collection efforts. Successful founders actually behave more like the sample of corporate executives [12].

Cooper and co-authors (1995) found a similar pattern of results in their survey of 1100 firms although Busenitz (1996), in an altered replication of Kaish and Gilad's survey, did not. Indeed Busenitz found few significant differences between corporate managers and new venture founders. In addition, validity checks of the survey measures yielded low reliability scores, which led the author to conclude that future research in alertness required improved theoretical and operational precision [13], [14]. Contemporary entrepreneurship scholars,

considering whether opportunities are objective or subjective [8], [15], note that Kirzner tends to treat them as objective.

The Knightian perspective also treats entrepreneurship as an instrumental construct. Profit is a reward for correctly anticipating the uncertain future (e.g., purchasing factors of production at prices below the eventual selling price of the product), and exists only in a world of “true” uncertainty. In such a world, given that production takes time, entrepreneurs will earn either profits or losses based on the differences between factor prices paid and product prices received. For Knight, in other words, opportunities do not exist, waiting to be discovered (and hence, by definition, exploited). Rather, entrepreneurs invest resources based on their expectations of future consumer demands and market conditions, investments that may or may not yield positive return. Here the focus is not on opportunities, but on investment and uncertainty. Expectations about the future are inherently subjective and, under conditions of uncertainty rather than risk, constitute judgments that are not themselves modelable.

Subjectivism implies that opportunities are neither “discovered” nor “created”, but perceived [16]. They may or may not exist, in an objective sense. Hence a research program based on formalizing and studying empirically the processes leading individuals to discover opportunities, whether based on economics or psychology, are misguided. Opportunities for entrepreneurial gain are thus inherently subjective, in the sense that they do not exist until profits are realized [17].

F. Opportunity as a Black Box

Confusion over the nature of opportunities is increasingly recognized. Do we need a precise definition of opportunities to move forward? Can one do entrepreneurship research without specifying what, exactly, entrepreneurial opportunities “are”? Can we treat opportunities as a “black box,” much as other concepts in management such as culture, leadership, routines, capabilities, and the like are treated [18]? One approach is to focus not on what opportunities are, but what opportunities do [19].

By treating opportunities as a latent construct, this approach sidesteps the problem of defining opportunities as objective or subjective, real or imagined, and so on. The formation of entrepreneurial beliefs is treated as a potentially interesting psychological problem, but not part of the economic analysis of entrepreneurship. It also avoids thorny questions about whether alertness or judgment is simply luck [20], a kind of intuition [21], or something else entirely.

One way to capture the Knightian concept of entrepreneurial action is Casson’s notion of “projects” [22]. A project is a stock of resources committed to particular activities for a specified period of time. (Opportunities are defined as potential, but currently inactive, projects). Focusing on projects, rather than opportunities, implies an emphasis not on opportunity identification, but on opportunity exploitation. More generally, this perspective suggests that entrepreneurship research should focus on the execution of business plans.

G. Entrepreneurship and Management

Entrepreneurship is one of the fastest-growing subfields in management research, and is increasingly appearing in economics, finance, and even law. It is only very recently that the strategic management field has realized the need for a closer relationship with entrepreneurship, resulting in the 2008 start-up of the Strategic Entrepreneurship Journal [18].

One side of the coin, strategic management, has to do with the achievement of ends - obtaining market share, profit and sustained competitive advantage. The other side of the coin, entrepreneurship, has to do with the achievement of beginnings - creating products, firms, and markets.

Some management disciplines have been criticized for having too many theories, and not enough theoretical and empirical integration. The use of a more integrated view of entrepreneurship seen through an integral lens may make it possible for the different hypotheses of entrepreneurship and entrepreneurship research to come to some kind of mutual accommodation, through the recognition of the “correct-but-partial” nature of all of these different views [23].

II. ENTREPRENEURSHIP EDUCATION

A. Perspectives on Entrepreneurship Education

1) Definition of Entrepreneurship Education

Entrepreneurship education is made up of all kinds of experiences that give students the ability and vision of how to access and transform opportunities of different kinds. It goes beyond business creation. It is about increasing students’ ability to anticipate and respond to societal changes. Entrepreneurship education is education and training which allows students to develop and use their creativity, and to take initiatives, responsibility and risks.

The definitions of entrepreneurship education in developed countries (creativity, innovation and thinking outside the box) and developing countries (a way to develop positive attitude towards entrepreneurship and self-employment) are different.

2) Objectives of Entrepreneurship Education

- To create and harness the power of entrepreneurship in education in order to turn out a new generation of students who can start new enterprises or renew existing businesses.
- To nurture and develop entrepreneurial characteristics in an individual and encourage that individual to become an entrepreneur while acknowledging that not all individuals who are exposed to entrepreneurship will become entrepreneurs and establish businesses. Entrepreneurship education has two strands – being an entrepreneur and being entrepreneurial. Both the academic and vocational streams need entrepreneurial education.

- To develop innovation in young people and to develop their skills to identify, create, initiate and successfully manage personal, community, business and work opportunities of which owning an enterprise is just one example.

3) Importance of Entrepreneurship Education

Stimulating innovative and growth-oriented entrepreneurship is a key economic and societal challenge to

which universities and colleges have much to contribute. The development of entrepreneurship is an essential prerequisite for economic growth and development and can provide important new sources of higher quality employment.

4) *Impact of Entrepreneurship Education*

Fostering a robust entrepreneurial culture will maximize individual and collective economic and social success on a local, national, and global scale. People exposed to entrepreneurship frequently express that they have more opportunity to exercise creative freedoms, higher self esteem, and an overall greater sense of control over their own lives.

Available studies indicate that entrepreneurship courses have a positive effect on student career paths. The University of Arizona's Business School has conducted one of the most comprehensive studies on entrepreneurship education, covering 2500 entrepreneurship graduates. The study showed that compared to non-entrepreneurship students, students with an entrepreneurial background are more inclined to start a business. Furthermore, entrepreneurship students tend to perform better in well-established companies as compared to non-entrepreneurial students [24].

While it remains difficult to measure the direct impact of entrepreneurship education, other studies have addressed the issue from a qualitative point of view. One such analysis shows that the University of San Diego, through its entrepreneurship programmes, has played a significant role in transforming the San Diego area from a traditional industrial economy to a high-growth knowledge-based economy [25].

5) *The Underlying Debates*

The key question which arises is whether entrepreneurship considered an innate ability or an acquired skill? That is, can entrepreneurial acumen be achieved and enhanced through education and training, or are certain people "born" to be entrepreneurs or to act entrepreneurially? The question is not whether small-business management can be taught, but whether Schumpeterian innovation, Knightian uncertainty-bearing, Kirznerian alertness, or other manifestations of the entrepreneurial function can be taught [26].

Surprisingly, some people still argue that it is not possible to teach entrepreneurship. For them, entrepreneurship is a matter of personality, and psychological characteristics. One of the arguments that have been advanced is that talent and temperament cannot be taught [27]. This is true of all professions and professional situations. Nobody will dispute the fact that medicine, law, or engineering can be taught, and yet, there are doctors, lawyers and engineers who are talented and others who are not [28]. A similar reflection can be applied to entrepreneurship and entrepreneurs. There is no doubt that it is possible to educate people in entrepreneurship, however, like in any discipline, it is impossible to tell whether these professionals will be talented or not, just as it is impossible to guarantee a priori the success of a given course of action.

The question: 'can entrepreneurship be taught?' is no longer relevant today. Nowadays, entrepreneurship is considered learnable, both as codified knowledge that can be acquired

through formal instruction and education and as tacit knowledge that can be acquired as advice, as know-how and as experiential learning, for example as apprentice in a business [29].

The harder question is how, both from an educational perspective and a policy standpoint. The challenge is finding techniques that are useful for training individuals to be entrepreneurs or recognizing which individuals have entrepreneurial talent. The challenge is to conceptualize and articulate entrepreneurship as a way of thinking, as a multidisciplinary approach to the process of creating economic and social value in the face of uncertainty and limited resources [26].

6) *Entrepreneurship and Higher Education*

Entrepreneurship has entered the realm of higher learning in a variety of knowledge transfer activities which promote entrepreneurship, either directly (as in academic spin-offs) or indirectly (through research, training and education) [30]. As organizations in the society, universities provide a structure for human interaction with the wider environment. This structure is afforded through the education of students for, primarily the future workplace, pure and applied research, skills training and, increasingly, the "third way" of outreach with industry and the wider community of people and organizations. Tailoring the academic program and all activities supporting it to serve the goal of promoting entrepreneurship appears to be imperative [31].

B. Personal Capabilities

1) *Innovation*

Probably the best-known concept of entrepreneurship in economics is Joseph Schumpeter's idea of the entrepreneur as innovator. The entrepreneur-innovator was introduced in Schumpeter's ground-breaking Theory of Economic Development (1911) and developed further in his two-volume work, Business Cycles (1939). Schumpeter argued that entrepreneurs, or new firms, drive the economic development process. Innovation unleashes a wave of creative destruction that displaces existing firms and leads the economy to higher market equilibriums. Schumpeter juxtaposed entrepreneurs with managers, change with routine, and static equilibrium with dynamic disequilibrium [32], [33], [34].

2) *Alertness*

Entrepreneurship can also be conceived as "alertness" to profit opportunities. While present in Cantillon's and J. B. Clark's notions of entrepreneurship, this concept has been elaborated most fully by Israel Kirzner. Kirzner's formulation emphasizes the nature of competition as a discovery process: the source of entrepreneurial profit is superior foresight; the discovery of something (new products, cost-saving technology) unknown to other market participants. Kirzner's entrepreneur is alert to a new product or a superior production process and steps in to fill this market gap before others. Success, in this view, comes not from following a well-specified maximization problem, but from having some knowledge or insight that no one else has. Ideas become an

opportunity when their commercial value is recognized [6], [7], [35].

Two main propellers of alertness have been identified: possessed knowledge and personal characteristics (traits). The first views alertness as possessing relevant prior knowledge about an opportunity. Specifically, Shane (2003) posits that knowledge of markets, of how to serve markets, and of customer problems influences both opportunity recognition and opportunity exploitation processes. His detailed, qualitative analysis of 8 different opportunities based on the same technology invention unequivocally establishes that the way different individuals respond to the same innovation stimulus is related to their particular knowledge and understanding of the processes they are currently involved in [3].

While this approach is powerful for ex post explanation of opportunity discovery, the utility of the approach for making ex ante predictions is less clear. The reason for this lies in the almost unfathomable depth of personal knowledge and in the difficulty in determining an appropriate level of detail at which to judge one's knowledge. If we dig down to the tiniest detail, at which each individual is unique in terms of the knowledge possessed, then the theory loses power since its set of actors is limited to one. If we stay at a higher level of detail, at which there are many individuals possessing particular knowledge, then the theory loses precision since it is not clear which of these actors will act as entrepreneurs. What this suggests is that prior knowledge is a necessary but not sufficient condition for opportunity recognition to occur. It is thus necessary to consider not only the amount or type of knowledge one possesses but also the way one applies and extends his current knowledge.

3) *Information Search Behavior*

A Within the broad notion of alertness as a personal characteristic, one stream has explored information search behavior, while another has focused on internal cognitive processes. In terms of information search behavior, a much cited by Kaish and Gilad (1991) suggests differences between entrepreneurs and executives in terms of time spent on information search and scanning, sources of information used, and attention to risk cues [12]. However, a wider-scale replication of this study by Busenitz (1996) failed to re-confirm these results and suggested that the self-reporting scales used by Kaish and Gilad (1991) had low reliability [14]. Subsequent studies within this stream have reported no individual differences in self-perceived alertness as well as in the proportions of sought and triggered opportunities. This lack of consistent results outlines the difficulties in identifying enduring behaviors that are independent of context [36].

In terms of internal cognitive processes, entrepreneurs are seen as possessing distinct information processing skills and capacity that allows them to uncover enshrined opportunities. Two such capacities are mental schemas and mental simulation and counterfactual thinking. Mental schemas represent an individual's understanding of how the external world works [4]. In this context entrepreneurial alertness is conceptualized

as a particular schema that is of higher complexity and flexibility, and involves heightened sensitivity to market disequilibrium signals [4]. Mental simulations and counterfactual thinking, which pertain to reflection over past and future events, are also seen as distinctive features of opportunity finders. This perspective has been united under the broader notion of entrepreneurial cognition; as a distinct resource that entrepreneurs possess [37].

4) *The Stock of Knowledge (Human Capital)*

Motivation aside, an individual's action in an economic domain is essentially based on having relevant knowledge on how different commodities can be obtained and used, according to Hayek (1937, 1945). As such knowledge is widely dispersed, an individual's action set is bound by the particular knowledge he or she possesses. In the context of opportunity recognition, this particularity pertains to the specific knowledge of markets, of how to serve markets, and of customer problems, each of which is positively associated with discovering opportunities within these market domains [3]. The nature of such specific knowledge may be both, explicit, as acquired through formal education and training, and tacit, as acquired through personal experience. One's accumulation of explicit and tacit knowledge in a given market domain is well captured by the concept of human capital, representing one's knowledge and skills acquired through education and practical experience. The utility of specific human capital for the enactment of opportunities comes from the absorptive capacity it gives the individual in regard to new information arriving in a particular context, particularly information about possible market demand or supply [38].

5) *Experiential Learning Style*

Experiential learning theory by Kolb (1984) presents a structural model of learning from experience. It outlines two main dimensions to the structure of learning - grasping and transformation - representing accordingly how experience is acquired and transformed.

The grasping dimension contains the modes of 'concrete experience' and 'abstract conceptualization,' Concrete experience involves immediate sensory perception and an intuitive, holistic representation, while abstract conceptualization involves analytical deliberation and thus imposes concepts or symbols that detach the experience from its immediate sensory content. These two modes of acquiring experience reflect the traditional duality between thinking and feeling, representing two independent but complementary system of information acquisition - cognitive (rational) and affective (experiential) [39].

The transformation dimension contains the modes of 'reflective observation' and 'active experimentation,' which determine whether one would elaborate on an acquired experience internally (reflection) or externally (action). Reflective observation involves standing aback and probing deeper into the essence of acquired experience, while active experimentation involves a propensity to act, try out the acquired experience. This action-reflection duality has a close correspondence to the motivational strategies of approach and

avoidance, which highlight an individual's concern with maximizing success or minimizing failure [40].

6) *Ability to Adjust*

Schumpeter, who saw economic progress as the result of disruptions to existing equilibrium states, assumed that equilibrium is quickly regained following such a disruption. Schultz, by contrast, took innovation as given, and focused how economic agents adjust to exogenous shocks. Schultz recognized that markets do not automatically and instantaneously regain equilibrium following an exogenous shock. Regaining equilibrium takes time, and how people proceed over time depends on their efficiency in responding to any given disequilibrium and on the costs and returns of the sequence of adjustments available to them [41]. In Schultz's formulation, entrepreneurship is the ability to adjust, or reallocate one's resources, in response to changing circumstances.

7) *Judgment*

In the entrepreneurial judgment approach, the theory of the firm becomes a theory of how the entrepreneur arranges his capital assets, including which combinations of assets he will seek to acquire and which assets he may later divest in an attempt to carry out the commercial experiment that embodies his judgment [42].

Judgment refers primarily to business decision-making. It is distinct from boldness, innovation, alertness, and leadership. Judgment must be exercised in mundane circumstances, for ongoing operations as well as new ventures. While alertness tends to be passive (perhaps even hard to distinguish from luck) [20], judgment is active. Alertness is the ability to react to existing opportunities while judgment refers to the creation of new opportunities.

Entrepreneurs "are those who seek to profit by actively promoting adjustment to change. They are not content to passively adjust their activities to readily foreseeable changes or changes that have already occurred in their circumstances; rather, they regard change itself as an opportunity to meliorate their own conditions and aggressively attempt to anticipate and exploit it" [43]. Those who specialize in judgmental decision-making may be dynamic, charismatic leaders, but they need not possess these traits.

Knight introduced the notion of judgment to link profit and the firm to the existence of uncertainty [44]. Decision making under uncertainty is entrepreneurial, whether it involves imagination, creativity, leadership, and related factors or not. Recent work links entrepreneurship to the economic theory of firm using the Knightian concept of entrepreneurship as judgment. When judgment is complementary to other assets and these assets or their services are traded in well-functioning markets, it makes sense for entrepreneurs to hire labor and own assets. The entrepreneur's role, then, is to arrange or organize the human and capital assets under his control. Foss and co-workers [42] extended this Knightian concept of the firm by developing a theory of delegation under Knightian uncertainty. What they have called original judgment belonging exclusively to owners, but owners may delegate a

wide range of decision rights to subordinates, who exercise derived judgment. They have called these employees "proxy-entrepreneurs".

8) *Self-insight*

People are typically overly optimistic when evaluating the quality of their performance on social and intellectual tasks. In particular, poor performers grossly overestimate their performances because their incompetence deprives them of the skills needed to recognize their deficits. Five studies demonstrated that poor performers lack insight into their shortcomings even in real world settings and when given incentives to be accurate. An additional meta-analysis showed that it was lack of insight into their own errors (and not mistaken assessments of their peers) that led to overly optimistic estimates among poor performers. Along the way, these studies ruled out recent alternative accounts that have been proposed to explain why poor performers hold such positive impressions of their performance [45].

9) *The Time Frames of Entrepreneurs*

Relationships between time and important life matters (e.g., future orientation and economic prosperity; time horizons and organizational performance; and pace of city life and death rates from coronary heart disease) suggest that time and temporal variables can contribute to understanding entrepreneurs and entrepreneurship.

In a study conducted by Bluedorn and Martin (2008), a significant positive correlation was found between past and future temporal depths, and relationships were examined between both temporal depths and polychronicity, preference for working fast, perceived temporal flexibility of work, emphasis on schedules and deadlines, emphasis on punctuality, and general life stress. Entrepreneurs' ages, lengths of future temporal depth, and perceived temporal flexibility were all found to be negatively related to life stress in a hierarchical regression analysis [46].

The study illustrated the importance of time and temporal variables for understanding the behaviors of entrepreneurs and the contexts in which entrepreneurs work. Given the findings presented in this article and recent theoretical work by scholars such as Das (2006), great potential is indicated for future research into the relationships between temporal depth and entrepreneurial decision making, especially in regard to decisions about alliances and alliance partners [47].

C. Acquired Skills

Entrepreneurship is more than the mere creation of business. The characteristics of seeking opportunities, taking risks beyond security, and having the tenacity to push an idea through to reality combine into a special perspective that permeates entrepreneurs. It is this perspective that has revolutionized the way business is conducted at every level and in every country.

Entrepreneurial education must include skill building courses in negotiation, leadership, new product development, creative thinking and exposure to technological innovation. Other areas identified as important for entrepreneurial

education include awareness of entrepreneur career options, sources of venture capital, idea protection, ambiguity tolerance, the characteristics that define the entrepreneurial personality and the challenges associated with each stage of venture development.

The reported types of learning tools include: business plans, consultation with practicing entrepreneurs, computer simulations, behavioral simulations, interviews with entrepreneurs, environmental scans, field trips and the use of videos and films.

The essence of entrepreneurship education is the ability to envision and chart a course for a new business venture by combining information from the functional disciplines and from the external environment in the context of the extraordinary uncertainty and ambiguity which faces a new business venture. It manifests itself in creative strategies, innovative tactics, uncanny perception of trends and market mood changes, courageous leadership when the way forward is not obvious and so on. What we need is to instill and enhance these abilities.

1) *Managing Existing Resources*

Effective management of existing resources, whether in new or established organizations, requires not only technical business skills (accounting, marketing, finance, operations, business law), but also leadership and strategic decision making. Stewart and co-authors (1999) distinguished conceptually between entrepreneurship and the management of existing enterprises, though they acknowledge considerable overlap between the two [48]. The entrepreneurial and managerial domains are not mutually exclusive but overlap to a certain extent. The former is more opportunity-driven, and the latter is more resource-driven.

Courses emphasizing new venture formation skills and activities typically employ a combination of traditional classroom instruction (lectures and discussion), applied team projects, and, increasingly, the case method.

2) *Acquiring new resources*

Many entrepreneurship courses focus on the acquisition of new resources: writing business plans, acquiring venture or angel capital, marketing new products, acquiring intellectual property, and so on.

These skills are usually taught through a combination of basic analytical principles, historical case studies and examples, classroom simulations, and real-world projects.

3) *Identifying existing opportunities and creating new ones*

Opportunity identification involves not only technical skills like financial analysis and market research, but also less tangible forms of creativity, team building, problem solving, and leadership [49].

Opportunity identification is typically taught through innovative problem-solving and creative-thinking exercises and techniques rather than traditional classroom activities (though some courses also emphasize financial analysis, intellectual property protection, new products marketing, and so on).

D. *Standardizing Entrepreneurship Education*

The Standards and their supporting Performance Indicators can measure the perception of entrepreneurship experts of the quantity and quality of entrepreneurship education [50]. They form a framework for teachers to use in building appropriate objectives, learning activities, and assessments for their target audience. Using this framework, students will have: progressively more challenging educational activities; experiences that will enable them to develop the insight needed to discover and create entrepreneurial opportunities; and the expertise to successfully start and manage their own businesses to take advantage of these opportunities.

III. ENTREPRENEURSHIP EDUCATION IN DEVELOPING COUNTRIES

The research program Global Entrepreneurship Monitor (GEM), conducted by the international consortium Global Entrepreneurship Research Association (GERA) showed that 2008 surveys in most countries consistently report that entrepreneurship education and training is poor or inadequate. This is why entrepreneurship education and training was chosen as a special topic for GEM 2008. One of the major strengths of the project is the application of uniform definitions and data collection across countries for international comparisons [51]. The relationship between training in starting a business and entrepreneurial attitudes, aspirations and activity is generally positive, but varies by phase of economic development. Around one-fifth of respondents had received some form of training in starting a business, but this proportion varied widely by country. For example, among factor-driven countries, the proportion of individuals who had received any training in starting a business, either in school or after school, varied from 40% in Colombia to 8% in Egypt. In efficiency-driven countries, it varied from 43% in Chile to 6% in Turkey. In innovation-driven countries, it varied from 48% in Finland to 13% in Israel. Almost 10% of the respondents had engaged in self-directed learning, such as reading or observing or working in other people's businesses, but this too varied widely by country. The next most frequent overall training choice was voluntary formal education, followed by voluntary training provided by a college or university but outside the formal education system [52]. The survey also showed that in factor-driven economies (including Egypt), the higher the quality and quantity of after-school training, the higher the levels of necessity entrepreneurship. This is because factor-driven economies provide few other opportunities for employment.

Entrepreneurship in emerging markets is distinctive from that practiced in more developed countries. The distinctions between growth-oriented entrepreneurs in developing and developed markets are rooted in the inefficiency of markets in many developing countries, but the response of entrepreneurs to these inefficiencies is often surprising and counterintuitive [53]. Opportunities for entrepreneurs in developing countries are broader in scope than in developed markets, allowing firms

to pursue a portfolio approach to strategy that can efficiently manage the higher levels of business and market risk. Entrepreneurs in developing countries face a different set of circumstances than their counterparts in developed economies [54]. These differences are rooted in the underlying economies in which they operate. Emerging markets lack a stable of mature markets and the consistency that such markets offer. Consequently, the opportunity for entrepreneurship in emerging markets is pervasive. While Western entrepreneurs operate at the fringes of the economy, emerging market entrepreneurs operate closer to the core – the needs and opportunities are more widespread. Emerging markets require revolutionary change but have few people with the requisite skills and experience to effect such change.

The force of entrepreneurship has also been identified in many African countries as a possible solution for economic problems. In South Africa, Isaacs and co-authors (2007) argued that the contribution of small to medium-sized enterprises (SMEs) to the growth of their country can be much higher if entrepreneurship education is implemented, and that better entrepreneurship education could make a significant contribution to job creation and ultimately to poverty alleviation [55]. In Nigeria, Jegede (2008) concluded in his study that the persistence of economic poverty is attributed to low level of literacy, inappropriate economic structures and processes created by non-culturalisation of micro economic strategies such as sub-contracting system in the technological development framework of the state [56].

In a review commissioned by the World Bank (2002) to identify and investigate the “Integrated Entrepreneurship Education” in Botswana, Uganda and Kenya showed that informal Micro, Small and Medium sized Enterprises (MSMEs) are important providers of decentralized employment and income, and contribute to poverty reduction in the SSA region (Sub-Saharan Africa). Thus, stimulation and growth of new entrepreneurs is a critical issue in all the SSA countries facing the challenges of a declining economy and growing unemployment [57].

In a rapidly changing environment, the company's entrepreneurship and market orientation have a central role in endeavors to achieve innovation capability and sustained competitive advantage [58]. Recognizing the size and complexity of the challenge, the UNDP concluded that it is necessary to channel private capabilities and resources into unleashing the private sector in developing countries [59].

A publication of the Inter-American development Bank (2002) presented the findings from a comparative study on the factors that critically influence the business start-up process in nine countries in Latin America and East Asia (Argentina, Brazil, Mexico, Peru and Costa Rica in Latin America, and Japan, Korea, Taiwan and Singapore) [60]. The study recommended long-term approach to fostering economic development through entrepreneurship; human capital, social capital, intellectual capital, and cultural capital are as much a part of its value proposition as is financial capital. The study

also recommended enlarging the base of would-be entrepreneurs by collaborating with local universities to incorporate entrepreneurial case studies and experiential learning opportunities into the curricula. More recent studies by the Inter-American development Bank (2006, 2009) applied to Latin American and Caribbean countries supported the same idea pointing out to the significance of the educational experience of entrepreneurs [61], [62].

IV. ENTREPRENEURSHIP IN ENGINEERING EDUCATION

Traditionally, courses on entrepreneurship originated in business or management schools. This began to change during the last decade when many educational institutions began to introduce entrepreneurial education in the engineering curriculum. Entrepreneurship programmes should venture beyond traditional business and economic schools and target other disciplines. An engineer is assumed to be endowed with a certain stock of knowledge; accordingly, he will be confronted with the choice of how best to appropriate the economic return from that knowledge. Entrepreneurship can be an important mechanism by which knowledge spills over and becomes commercialized. So, future engineers have to be trained how to recognize and develop new technologies and to take the technologies to market and to practice industry proven commercialization processes within an academic environment.

In their recommendations regarding the acquisition of Chartered Engineer status, and within the context of continued professional development, the various Institutes of Engineering are beginning to specify not just management training or education experience, but specifically, that involving enterprise, for example, in the UK, the UK-SPEC Regulations for Registration developed by the Engineering Council (UK) include that students of engineering should receive professional competencies that include enterprise to achieve credit as a Chartered Engineer. The rationale here is that through enterprise the engineering industries can stay competitive in the context of a global knowledge economy [63].

In Canada, 84% of entrepreneurship courses are offered by the faculties of business, 16% by the faculties of engineering and a minor share by other faculties [30]. UK universities have established science enterprise centers whose aims are “to foster the commercialization of research and new ideas, to stimulate scientific entrepreneurialism, to incorporate the teaching of enterprise into the science and engineering curricula, and to act as centers of excellence for the transfer and exploitation of scientific knowledge and expertise” [64].

Learning to become an entrepreneur is a lifelong process, an amalgam of experience moulded with formal learning. The learning process for new engineers can be anticipated to incorporate the cognitive approaches of self-efficacy, attitudes, perceived feasibility and desirability with entrepreneurial intentions.

The following features should be incorporated in an engineering entrepreneurial curriculum:

- The program should be obligatory for all engineering students.
- The program should involve hand-on business experience based on innovating engineering projects.
- The program should be based on multidisciplinary teamwork projects.
- Mixing people from different colleges and backgrounds will add versatility and functionality to the teams and broaden their entrepreneurial experience. Within one college, the heterogeneity can be achieved by mixing students from several departments.
- The program should encourage the competitive component of the entrepreneurial education by encouraging the students to act on their talent and ideas.

V. ENGINEERING ENTREPRENEURSHIP EDUCATION IN EGYPT

The Egyptian Economy is classified as a factor-driven economy [52]. Countries in the factor-driven stage compete through low cost efficiencies in the production of commodities or low value-added products. This stage is marked with high rates of non-agricultural self-employment. Sole proprietorships, i.e., the self-employed, probably account for most small manufacturing firms and service firms. These countries neither create knowledge for innovation nor use knowledge for exporting. To move into the second stage, the efficiency-driven stage, countries must increase their production efficiency and educate the workforce to be able to adapt in the subsequent technological development phase [54].

To explore the role of entrepreneurship in national economic growth GEM program researchers collected data on both opportunity entrepreneurship (starting a business to exploit a perceived business opportunity) and necessity entrepreneurship (starting a business because you were pushed into it). However, both measures show higher levels in developing countries than in developed countries [52].

The proportion of individuals who had received any training in starting a business, either in school or after school, in Egypt, was only 8%. Referring to the entrepreneurial attitudes and perceptions of the Egyptians, 73% has considered entrepreneurship as desirable career choice.

Each society has its different needs and different socio-economic circumstances. In the Egyptian economy, as a developing economy, the majority of innovative products and services could evolve from entrepreneurial ventures. Entrepreneurial education is in accordance with the increased government emphasis on creating new ventures and alleviating unemployment.

Engineering education in Egypt, in most cases, is devoid of any courses related to entrepreneurship. This must change, and change rapidly. This change must be reflected in the curricula, but more importantly, in the attitude at the academic institutions.

John Maynard Keynes said, "The greatest difficulty is not for people to accept new ideas, but to make them forget about old ones". We are talking about prospects for the future, not

about the inheritance of the past.

VI. CONCLUSION

Entrepreneurship can be taught, or at least encouraged, by entrepreneurship education. An engineer is assumed to be endowed with a certain stock of knowledge; accordingly, he will be confronted with the choice of how best to appropriate the economic return from that knowledge. Entrepreneurship can be an important mechanism by which knowledge spills over and becomes commercialized. So, future engineers have to be trained how to recognize and develop new technologies and to take the technologies to market and to practice industry proven commercialization processes within an academic environment.

Engineering education in Egypt, in most cases, is devoid of any courses related to entrepreneurship. This must change, and change rapidly. This change must be reflected in the curricula, but more importantly, in the attitude at the academic institutions.

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