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Learning styles of entrepreneurs in knowledge-intensive industries

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Abstract

Purpose – The purpose of this paper is to explore whether there is a prevalent entrepreneurial learning style trait associated with successful knowledge industry entrepreneurial practice.

Design/methodology/approach – The paper reviews prior entrepreneurship studies utilizing experiential learning theory and examines the learning style preferences of 168 knowledge industry entrepreneurs to deduce a hypothesized entrepreneurial learning style. The entrepreneur participants' Kolb Learning Style Inventory scores are modeled to explore causal links to individual and firm level entrepreneurial success.

Findings – Preference for the Kolb Active Experimentation (AE) learning mode over Reflective Observation (RO) predicts adoption of a key entrepreneurial innovation behavior and significant entrepreneurial performance benefits. In contrast to published theories, the RO learning mode exhibits surprising negative effects on entrepreneurial performance. Data analysis also reveals that 90 percent of sampled co-founder/partners had at least one partner with the hypothesized entrepreneurial style.

Research limitations/implications – The study fills a major research gap in entrepreneurial learning literature by identifying learning style traits associated with entrepreneurial success. The study findings can also be used by educators, practitioners and investors to help identify, appraise and develop entrepreneurial talent.

Originality/value – The study provides novel insights into the learning styles of practicing technology entrepreneurs by establishing a significant preference within this community for the AE and Concrete Experience learning modes. The study illustrates the negative effects of the RO learning mode which has previously linked to successful entrepreneurial practice.

Keywords High technology firms, Learning, Start-ups, Cognition, Entrepreneurial education

Paper type Research paper

Introduction

Researchers' efforts to identify a particular personality or unique personal trait associated with entrepreneurial success, the "entrepreneurial type," have been largely fruitless. Successful entrepreneurs possess a wide range of core traits such as age, ethnicity, gender and personality. Some traits, such as conscientiousness from the Big Five personality inventory, are linked with business career success in general (Judge *et al.*, 1999), but empirical evidence of a specific trait marker for entrepreneurial talent has been fleeting at best (Gartner, 1988; Gartner *et al.*, 1994).

Cognition provides an interesting middle terrain for entrepreneurial trait research, situated between non-context sensitive core traits (such as personality) and highly contextual behaviors (Curry, 1983). The cognition of learning is closely related to innovation (Brown and Duguid, 1991) and is therefore well-suited for studying entrepreneurs who are most reliant upon the knowledge and learning resources required to create disruptive new products in knowledge-intensive industries.

Learning has been an intense subject of research and a variety of theories have been proposed to describe how individuals, teams and complete organizations learn. The Kolb experiential learning theory (Kolb, 1984) has emerged as a useful tool in entrepreneurship research because it models learning as a process of knowledge construction that most

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This paper forms part of a special section Entrepreneurial learning dynamics in knowledge intensive enterprises.



closely parallels innovation and creative cognition. While the Kolb theory has been used in numerous entrepreneurship studies (Armstrong and Mahmud, 2008; Baum *et al.*, 2011; Corbett, 2007), no particular learning trait or style has been established as a significant causal indicator of successful entrepreneurial practice in knowledge-intensive industries.

A hypothetical entrepreneurial learning style is deduced from both prior studies utilizing the Kolb Learning Style Inventory (LSI) (Kolb and Kolb, 2005b) and by examining the distribution of learning styles among 168 active technology entrepreneurs. The learning modes associated with this hypothesized style are then analyzed using structural equation modeling to determine their causal effects on entrepreneurial performance and success.

This research utilizes extraordinarily difficult-to-obtain technology entrepreneur data to reveal empirical evidence of an entrepreneurial learning style and to demonstrate the utility of learning style assessment for appraising entrepreneurial proclivity and talent. The study's findings help explain why some candidates for entrepreneurship actually become successful entrepreneurs while others struggle or choose non-entrepreneurial career paths.

The entrepreneurial and investment community will benefit from an objective and theoretically sound means of appraising and developing entrepreneurial talent. Educators will find the study results useful for assessing students (especially those pursuing popular hypothesis-based entrepreneurship methods) and for improved student team composition design.

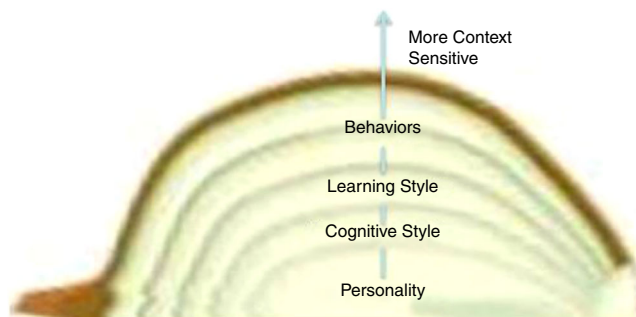
Theoretical background

The entrepreneur and learning

This study focuses on entrepreneurial learning as a process whereby the learning traits and behaviors of the entrepreneurial founders are instrumental in creating innovative new companies. This “upper echelon theory” perspective (Hambrick and Mason, 1984) presupposes that the roles, traits and actions of the top management team are a predominant determinant of firm performance.

Human traits can be visualized as analogous to layers of an onion (see Figure 1) with personality at the core wrapped by the cognitive style layer followed by an outer learning style layer (Curry, 1983). The personality core represents a relatively fixed and non-varying trait, while each subsequent layer becomes increasingly more context sensitive. This stratified layer model of human traits envisions learning style as a moderately context sensitive trait, situated between general cognitive style and highly contextual behaviors. While individuals have measureable preferences for certain learning modes (their learning style), learners also possess some degree of flexibility to engage different styles depending on the situation (Sharma and Kolb, 2009).

The particularly prominent role of knowledge and learning in knowledge-intensive new business formation is well established in entrepreneurial learning literature (Wang and Chugh, 2014). Knowledge is complex, multi-dimensional, and can be either explicit



Source: Curry (1983)

Figure 1.
Human traits as
“layers of an onion”

(codified and easily communicated) or tacit (less codified) and more difficult to transfer (Nonaka, 1994). Technical knowledge necessary for knowledge-intensive company formation is usually relatively explicit but also paradigmatic and subject to rapid shifts and obsolescence. In contrast, organizational learning in a business setting is often highly experiential by nature (Argote and Miron-Spektor, 2011; Levitt and March, 1988) and within business disciplines, “entrepreneurial” knowledge is viewed as among the most highly tacit and most easily acquired through experiential learning activities (Holcomb *et al.*, 2009).

It is therefore not surprising that many theories of entrepreneurial learning heavily emphasize “learning by doing” (Cope and Watts, 2000) to augment relatively explicit technology or market-specific domain knowledge with more tacit knowledge of “how to be an entrepreneur” (Minniti and Bygrave, 2001). Entrepreneurs develop tacit knowledge experientially by learning from past experiences (Hakala and Kohtamäki, 2011) and by monitoring the outcomes of experiments that test competing hypotheses, both directly (experientially) and vicariously through indirect observation of the actions and results achieved by others (Holcomb *et al.*, 2009; Minniti and Bygrave, 2001).

Top management teams engage in both exploratory and exploitative learning to discover and develop new business opportunities (March, 1991). Politis (2005) extended theories of exploratory and exploitative learning into the entrepreneurship domain by theorizing exploration and exploitation as transformational processes that shape the entrepreneur’s experiences into entrepreneurial knowledge. Entrepreneurs with a track record of past success are theorized to more likely adopt exploratory learning methods, whereas entrepreneurs with a track record of failures will likely deal with liabilities of newness using exploitative learning.

While entrepreneurship research has often focused on the entrepreneur as an individual, entrepreneurial learning research now also includes strong interest in founding team learning traits and interactions (Chandler and Lyon, 2009; Gartner *et al.*, 1994; West, 2007). Founding team composition is now understood to be highly impactful to firm performance (Beckman, 2006; Forbes *et al.*, 2006; Forster and Jansen, 2010; Hambrick *et al.*, 1996; Ruef *et al.*, 2003; West, 2007) and co-founder cognitive trait diversity has been positively linked to new technology venture performance (Ensley and Hmieleski, 2005). There is solid circumstantial and anecdotal evidence that many prominent entrepreneurs, including Steve Jobs and Bill Gates, would have never started their companies without the strong influence and connection with one key co-founder (Linzmayr, 2004; Wallace and Erickson, 1993). Recent data estimated that roughly half of start-ups in knowledge-based industries form through a particularly intense dyadic relationship between two co-founders (Gemmell *et al.*, 2011).

Kolb’s experiential learning theory

A core theory utilized in this study is the Kolb experiential learning theory (Kolb, 1984). The Kolb experiential learning theory has been applied to the real world issues of problem solving, entrepreneurial innovation and organizational learning in a variety of domains, including entrepreneurship. The principles of experiential learning permeate other similar theories of learning, demonstrating the vast impact of experiential learning theory on scholars.

According to Kolb, learners have a preference for certain learning modes that are mapped into a two dimensional space with two axes, one that measures how a learner acquires experience and the other for how they process experience into new meaning and understanding. These two axes define four learning modes: Concrete Experience (CE), Reflective Observation (RO), Abstract Conceptualization (AC) and Active Experimentation (AE). According to Kolb, learners grasp experience from either “apprehension” (CE) or “comprehension” (AC) that is then processed through either “extension” (AE) or “intention” (RO).

The Kolb model builds upon Jean Piaget’s concept of “social constructivism,” whereby knowledge is internalized through processes of accommodation and assimilation (Piaget, 1972). Assimilation involves incorporation of experience into existing mental models, whereas

accommodation goes a step further by adapting mental models based upon contradictions sensed through one's experience and observation. The social constructivists attribute a great deal of learning to social engagement; knowledge is shared and constructed first socially and later ultimately appropriated by individuals (Vygotsky, 1978). This social learning process is key and believed to yield learning results superior to solitary learning absent social interactions.

Five primary learning styles reside in the spaces between the four learning modes (axes) plus the centrally located balanced style and are defined as follows:

Imagining Style (CE and RO): Imagining learners prefer concrete experiences and tend to use divergent thinking processes to generate multiple solutions and ideas to problems while processing these trial solutions through reflection (RO). Imagining style learners are often attracted to the arts or other creativity-oriented careers. An earlier version of the Kolb model referred to individuals possessing this style as "Divergers."

Analyzing Style (RO and AC): Analyzing learners prefer to assimilate abstract information through reflection. Analyzing learners enjoy logical problem solving and theory formulation and are attracted to a range of careers involving theory and analysis. An earlier version of the Kolb model referred to individuals possessing this style as "Assimilators."

Deciding Style (AC and AE): Deciding learners are drawn to application of theory through practical task-oriented problem solving. Deciding learners are often attracted to careers such as engineering and applied science. An earlier version of the Kolb model referred to individuals possessing this style as "Convergers."

Initiating (AE and CE): Initiating learners are also interested in practical, hands-on activities that more likely engage their sense of intuition rather than intense analysis or theory. Initiating learners are more likely to learn through social interactions and are the most flexible and open-minded of the four distinctive styles (Sharma and Kolb, 2009). An earlier version of the Kolb model referred to individuals possessing this style as "Accommodators" based on the Piaget concept of accommodation or learning through adaptation of mental models.

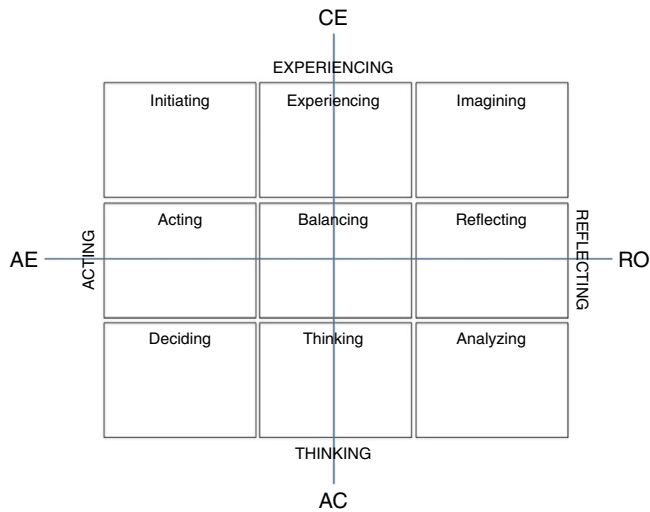
Balanced: Learners may also have a balanced or flexible style that allows them to adapt their learning on a situational basis (Kolb and Kolb, 2005a; Sharma and Kolb, 2009).

Four additional styles were added in Kolb's LSI v. 4.0 to provide additional granularity with four styles anchored on each of the four axes (see Figure 2). These four additional styles bring the total number of styles to nine and include: Experiencing Style (CE), Reflecting Style (RO), Thinking Style (AC) and Acting Style (AE).

Kolb's experiential learning theory and the LSI tool has been utilized in numerous prior entrepreneurial learning studies. Researchers have reported that managers with a "northwestern" or "Accommodating" learning style, as evidenced by their preference for Kolb's CE and AE learning modes, more readily acquire tacit knowledge such as the "entrepreneurial" knowledge possessed by successful entrepreneurs (Armstrong and Mahmud, 2008).

The process of entrepreneurial opportunity recognition and new product ideation have been mapped into the Kolb learning cycle (Corbett, 2005; Gemmell *et al.*, 2011). The "southern" more analytical region of the Kolb learning space (reliant on the AC learning mode) has been associated with successful opportunity recognition while the "northern" region (reliant on CE) is theorized to be key to the selection of which opportunities to pursue and successful execution of a start-up business plan (Corbett, 2005, 2007). Variations in the learning styles among different entrepreneurs are theorized to account for the knowledge asymmetries that explain why some entrepreneurs recognize a particular opportunity while others do not (Corbett, 2007).

A case study of entrepreneurial ideation demonstrated that while an expert entrepreneur utilizes the whole cycle of learning, key entrepreneurial practices and behaviors can be most closely associated with the AE learning mode (Gemmell *et al.*, 2011). Similarly, "Practical intelligence," defined as the ability to deal with everyday problems and tasks in a common sense and practical way (Sternberg and Wagner, 1986), has been shown to interact



Source: Kolb LSI v. 4.0

Figure 2.
Nine learning styles

with the AE and CE learning mode scores of printing company CEOs to predict firm-level growth (Baum *et al.*, 2011).

Experiential learning theory has been used to explain contextual influences on entrepreneurial ideas as they emerge from the Crossan *et al.* (1999) process of intuiting (analogous to Kolb’s CE) and interpreting (analogous to Kolb’s RO) (Dimov, 2007). Learners reflect on new experiences, both individually and socially with others, as part of a creative process to incubate and ultimately elaborate and pursue actionable new business opportunities (Dimov, 2007; Hansen *et al.*, 2011).

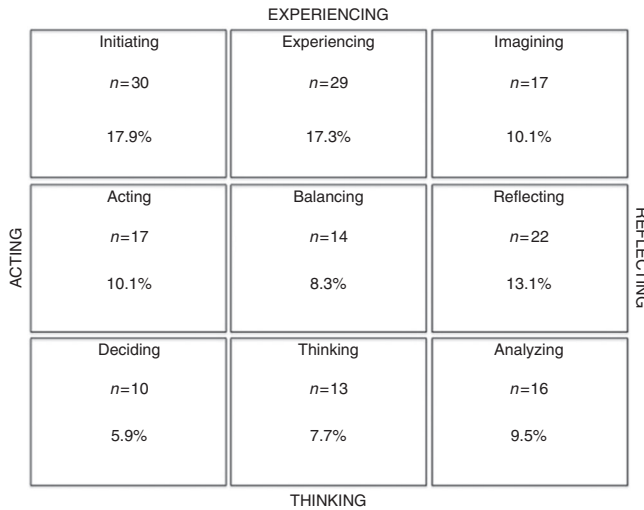
The results of these various studies are wide ranging and suggest successful entrepreneurs use all of the learning modes in Kolb’s experiential learning cycle. While the AE learning mode appears to play an especially key role, there has been no definitive study of knowledge industry entrepreneurs to identify an entrepreneurial learning style associated with entrepreneurial success. This gap in the entrepreneurship literature is addressed by this paper in two ways – first, by examining the distribution of learning styles among a sample of 168 active technology entrepreneurs and second, by modeling the effects of their learning mode preferences on entrepreneurial success.

Learning styles of technology entrepreneurs and co-founder/partners

Figure 3 shows the distribution of learning styles of the 168 technology entrepreneur participants in this study (see Table I for a profile of study participants). All of these participants had launched and were fully committed to operating their start-up company as their full-time career. Over half (68.5 percent) of the study participants were repeat (serial) entrepreneurs, having started multiple companies over their career.

The data shown in Figure 5 illustrates the concentration of our technology entrepreneur sample toward the “northwest” initiating and experiencing styles with 35 percent of participants fitting into 22 percent of the learning style space (two out of the nine total styles).

Study participants were also asked if they had one particular co-founder “who knows the intricate details of your business, someone you work and communicate with frequently (daily or several times per week), someone you rely upon to share responsibility for the business and with whom you share all important ideas and major business decisions.” Slightly



Note: *n* = 168

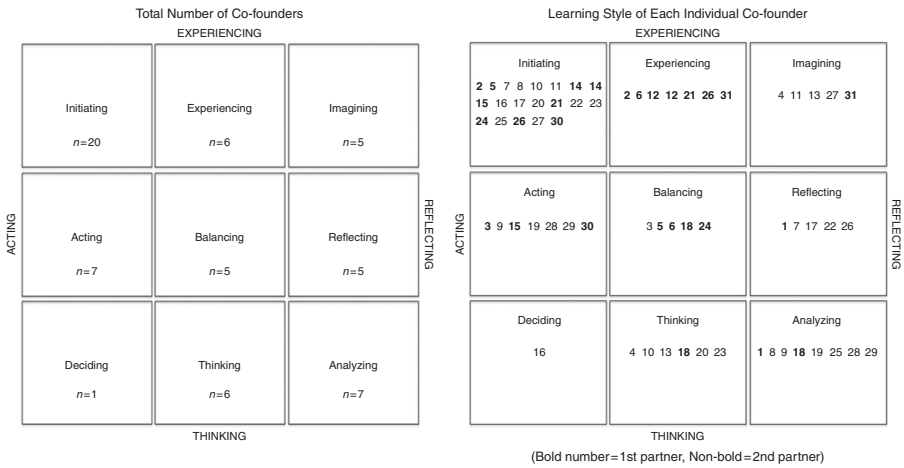
Figure 3. Learning styles of technology entrepreneurs

<i>n</i> = 168	No. Responses	%
<i>Region</i>		
Northeast USA	12	7
Southeast USA	44	26
Midwest USA	21	12
Southwest USA	9	5
Western USA	21	12
Not reported	61	38
<i>Industry</i>		
Hardware/software systems	41	24
Software	34	20
Internet/e-commerce	53	31
Electronics	12	7
Biotechnology	4	2
Clean energy	4	2
Telecom	3	2
Medical devices	5	3
Other technology	12	9
<i>Education</i>		
High school	11	6
Some college	46	27
College degree	58	34
Master's degree	39	23
Doctoral degree/professional degree (JD, MD)	13	8
Not reported	1	3

Table I. Summary profile of technology entrepreneur study participants

over half (56 percent) of study respondents acknowledged having a key co-founder relationship. The participants were encouraged to pass the survey along to their co-founder/partner resulting in 31 companies where both co-entrepreneurs took the survey. Figure 4 summarizes the learning styles of these 31 founder/partner pairs (total of 62 data points).

Figure 4.
Learning styles of 31
Co-founder/Partner
Dyad Pairs



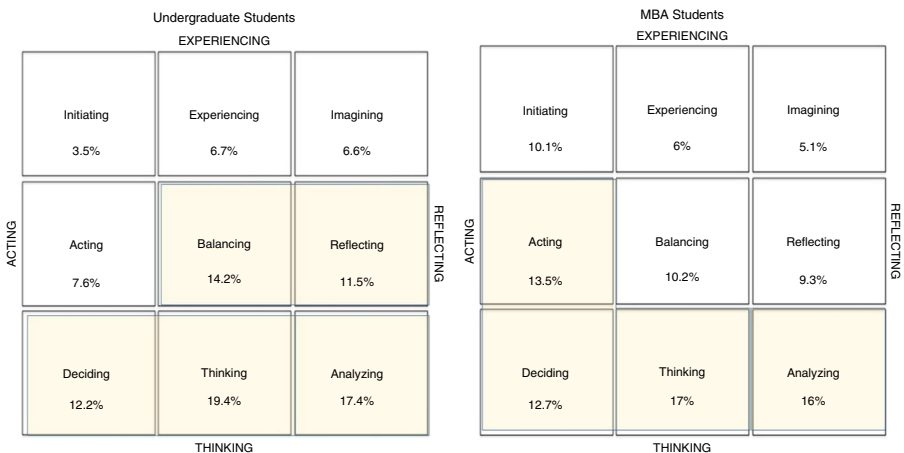
Note: Total, *n*=62

An obviously striking observation from these data are (once again) the high concentration of initiating styles with 32 percent of total respondents situated in only 11 percent of the total learning style space.

Figure 4 reveals that 90 percent of this sample of company co-founder dyads (28 of 31) have at least one (or sometimes both) of the two key co-founders possessing the “northwest” style.

Kolb and Kolb’s (2005a) paper examined the learning styles of Case Western Reserve University undergraduates (most of whom were majoring in engineering or business) and Case Western Reserve University graduate business students. These data revealed the “southern” predominantly convergent and analytical styles of Case Western Reserve University business and engineering students (see Figure 5), all of whom could be viewed as candidates for entrepreneurial careers in knowledge-intensive industries. Note that these students exhibited a tendency toward “southern” and “southeastern” learning styles in stark contrast to the “northwestern” styles of practicing technology entrepreneurs.

Figure 5.
Learning styles case
Western reserve
undergraduate
students, *n* = 288 and
MBA students,
n = 1,286



Source: Kolb and Kolb (2005a)

Research model design and hypotheses

Prior studies in entrepreneurial learning literature, combined with the comparative and co-founder data exhibited above, provide solid evidence to hypothesize that individuals with a “northwest” learning style who prefer AE and CE learning modes are more likely to exhibit entrepreneurial intentions and to successfully launch a company.

Traits may have direct effects on firm-level outcomes; however, these individual effects on firm-level outcomes are more commonly mediated by strategic actions, behaviors or competencies (Baum, 1995; Epstein and O'Brien, 1985). Core cognitive traits such as intelligence typically account for only perhaps 20 percent of performance (Sternberg and Hedlund, 2002) and the direct influence of traits on firm performance is likely even weaker in complex technology industries with less process orientation and higher trait variability than in task/process-oriented industries (i.e. assembly lines) with lower trait variability (Mischel, 1968).

This study selected Iterative Experimentation as a behavioral mediator because the concept of entrepreneurial experimentation, in general (Nicholls-Nixon *et al.*, 2000; Thomke, 2003), and the established efficacy of this construct, specifically, has been proven in other studies of entrepreneurial innovation (Baum and Bird, 2010). Furthermore, commonly used hypothesis-based entrepreneurial methods (Eisenmann *et al.*, 2012) involve iterative empirical/experimental social testing of key hypotheses to identify ideal target markets while incrementally developing a sound business model (Figure 6).

The following six hypotheses are therefore proposed for empirical testing (see also Figure 7):

H1a, b, c. Technology entrepreneurs with a preference for the AE learning mode over RO will achieve greater firm-level performance and entrepreneurial success.

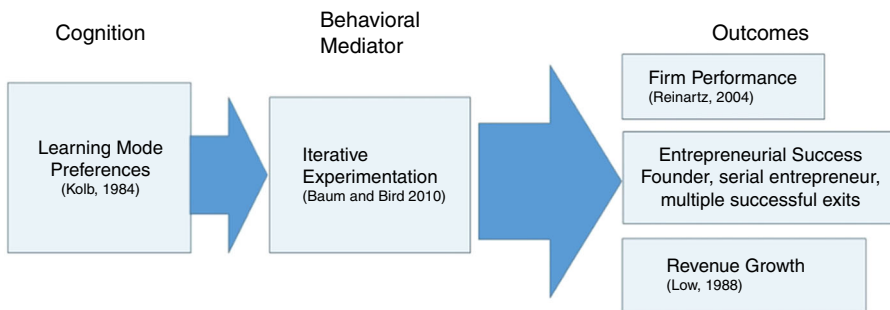


Figure 6. Conceptual diagram of research model design

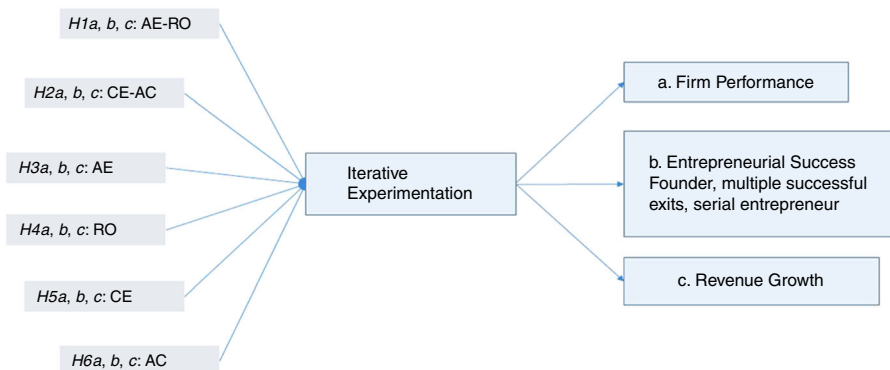


Figure 7. Six hypotheses for entrepreneurial learning style analysis

This effect will be positively mediated by use of Iterative Experimentation as a method for developing their new business.

H2a, b, c. Technology entrepreneurs with a preference for the CE learning mode over AC will achieve greater firm-level performance and entrepreneurial success. This effect will be positively mediated by use of Iterative Experimentation as a method of developing their new business.

H3a, b, c. Technology entrepreneurs' preference for the AE learning mode will result in greater firm-level performance and entrepreneurial success. This effect will be positively mediated by use of Iterative Experimentation as a method of developing a new business.

H4a, b, c. In spite of theorized benefits of RO in literature (Corbett 2005; Dimov, 2007), the preponderance of evidence from prior literature, combined with data presented in Figure 5 showing a greater reliance on AE than RO by practicing entrepreneurs, suggests technology entrepreneurs' preference for the RO learning mode will result in less firm-level performance and entrepreneurial success. This effect will be negatively mediated (exhibit negative direct and indirect effects) via the Iterative Experimentation mediator.

H5a, b, c. Technology entrepreneurs' preference for the CE learning mode will result in greater firm-level performance and entrepreneurial success. This effect will be positively mediated by use of Iterative Experimentation as a behavioral method of developing a new business.

H6a, b, c. Technology entrepreneurs' preference for the AC learning mode will result in less firm-level performance and entrepreneurial success. This effect is negatively mediated via the Iterative Experimentation mediator.

Research methods

Data collection and sample

Data were collected over a three-month period from May to July 2011 via an online survey using Qualtrics with participants who were either entrepreneurs within the principal researcher's professional network or referrals from investors or start-up company support networks such as university incubators.

The survey instrument totaled 46 items (including demographic data items) and was organized in sections by factor (not randomized), starting with a mix of both exogenous and endogenous factors and ending with the 20 items for the Kolb LSI. The total of 168 respondents from a wide range of knowledge-intensive industries throughout the USA participated in the study (see Table I).

Measures

AE-RO. The Kolb Learning Style Inventory (LSI v. 4.0) is composed of 20 forced-choice questions asking the participant to rank four choices of their preferred learning method (4 = most like me; 1 = least like me). Each choice represents one of four learning modes and the ranked score for each mode over the first 12 questions is summed to create four raw Learning Style scores. AE-RO is the AE raw score minus the RO raw score.

CE-AC. Similarly, the CE-AC score is calculated by subtracting the AC raw score from the CE raw score.

Some researchers contend the four learning modes should be measured using normative rather than ipsative (forced choice) scales (Geiger *et al.*, 1993) and question Kolb's basic premise of dialectic tension between opposing learning modes. Learning involves not only

thoughts, but also higher-level integration of the five senses, behaviors, emotions, experiences and social interactions through a dialectical process of acquisition and transformation (Akrivou, 2008; Brown, 2000; Kolb, 1984). The dialectic nature of Kolb's experiential learning requires forced-choice questions to resolve the tension and preference for polar opposite modes.

It should be further noted that while the four learning mode scales are ipsative, the AE-RO and CE-AC combination scores are not ipsative (Kolb and Kolb, 2005b). Regardless, the impact of ipsative scales has been proven to be minor (Greer and Dunlap, 1997) and recent revisions of the Kolb LSI have largely addressed expressed issues of scale validity, especially for purposes of profiling individual learning preferences in coaching and personal development (Kayes, 2002).

Iterative Experimentation. Iterative Experimentation (Cronbach's $\alpha = 0.784$) was measured using five items based upon "Multiple Iterative Items" from Baum and Bird (2010). Typical statements were, "We frequently experiment with product and process improvements," "Continuous improvement in our products and processes is a priority," and "We regularly try to figure out how to make products work better." Each item was measured using a five-point Likert scale (1 = Strongly disagree; 5 = Strongly agree).

Performance. This study uses a single broad firm performance construct from Reinartz *et al.* (2004) with four items that asked participants to self-rate overall financial performance and success of their current firm regarding market share, growth and profitability. Each item used a five-point Likert scale (1 = Poor; 5 = Excellent).

Entrepreneurial success. Entrepreneurial success (Chronbach's $\alpha = 0.728$) is a new construct developed to measure the track record and career success of an individual entrepreneur calculated through a weighted sum of key career success factors: position and status upon joining the current company (CEO vs senior executive/officer/founder/early employee), number of strategic exits/liquidity events, largest strategic exit/liquidity event and serial entrepreneurialism. This Entrepreneurial success scale yielded a measure of career success ranging from 2 to 27 (Mean = 12.971, SD = 3.945) for this sample.

Revenue growth. Revenue growth was measured with a single item per Low and Macmillan (1988), "Approximately what percentage annualized revenue growth has your company experienced over the last year?" The item was measured over a six-point scale (1 = Revenue declined; 6 = 50+ percent). Revenue growth is a measure of current entrepreneurial firm revenue performance.

Data analysis

The research models were tested using AMOS and SPSS for Windows (PASW Statistics v. 22, 2015). Data set survey responses were screened for missing data and the Iterative Experimentation construct data were checked for modeling assumptions of normality, skewness, kurtosis, homoscedasticity, multi-collinearity and linearity.

The Kolb LSI is a well-verified psychometric test with high construct validity based upon various factor analysis studies (Katz, 1986; Willcoxson and Prosser, 1996). One study of science students likely possessing many similar educational traits as the technology entrepreneurs in our study, verified high internal consistency (coefficient α ranged from 0.81 to 0.87) and two distinct learning dimensions per Kolb's theory. It was therefore not necessary to refactor the 20 items in the Kolb LSI and the learning mode scores were used as-is.

Learning mode scores were converted to the AE-RO and CE-AC measures; otherwise, no additional processing of Kolb LSI data was necessary. Entrepreneurial success was also calculated based upon participant responses regarding their entrepreneurial track record as a founder and repeat entrepreneur with successful exits.

Exploratory factor analysis (Costello and Osborne, 2005) was performed using SPSS software, Principle Axis Factoring, and Promax rotation on the four Iterative Experimentation items, yielding satisfactory loadings (≥ 0.715) and convergent validity (Chronbach's $\alpha = 0.784$, mean = 2.411, SD = 0.43).

Structural equation modeling (Bollen, 1989; Bollen and Long, 1993; Fabrigar *et al.*, 1999) was conducted followed by mediation analysis using causal and intervening variable methodology techniques (Baron and Kenny, 1986; MacKinnon *et al.*, 2002; Mathieu and Taylor, 2006). Mediated paths between independent variables and dependent variables via the Iterative Experimentation mediator were analyzed for direct, indirect and total effects. For each of the mediation hypotheses being tested, a model was first run for direct effects (only) and then performed again using the AMOS bootstrapping option to assess direct and indirect effects with mediation (Hair *et al.*, 2010).

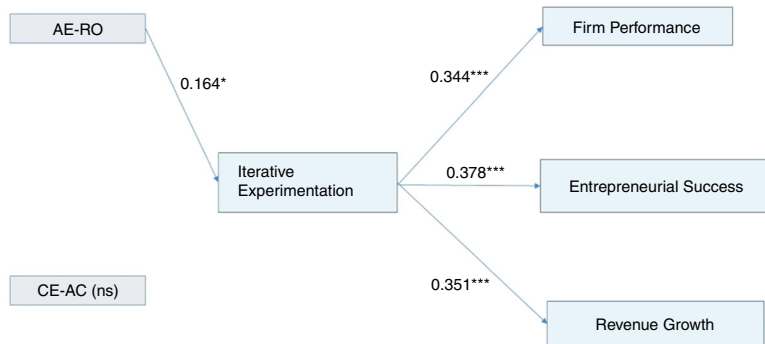
The following final trimmed models were developed by restoring the full model and trimming insignificant paths.

Model testing

The first research model tested for the direct effects of AE-RO (preference for AE learning mode over RO, the horizontal axis in the Kolb model) and CE-AC (preference for CE over AC on the vertical axis of the Kolb model) on the three DVs – performance, entrepreneurial success and revenue growth. Figure 8 shows the Research Model 1 with trimmed path loadings and significance.

Table II summarizes the model fit parameters for Research Model 1. The goodness of fit analysis yielded a good fit, based primarily on the following parameters (Hu and Bentler, 1999): χ^2 ; CMIN/df (Tabachnick and Fidell, 2000); RMSEA, SRMR and AGFI (Hu and Bentler, 1999), and PCLOSE (Jöreskog and Sörbom, 1997).

The second and third research models tested for the direct effects of AE and RO (the two horizontal axis learning modes in the Kolb model) and the effects of CE and AC (the two vertical



Notes: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Figure 8. Research Model 1, effects of AE-RO and CE-AC on iterative experimentation, firm performance, entrepreneurial success and revenue growth

Table II. Model fit statistics for Model 1, AE-RO and CE-AC effects

χ^2	3.603
df	2
CMIN/df	1.802
SRMR	0.0378
AGFI	0.937
RMSEA	0.069
PCLOSE	0.286

axis learning modes) on the three DVs, performance, entrepreneurial success and revenue growth. Tables III and IV again summarize model fit statistic, indicating once again a good fit based upon χ^2 , CMIN/df, RMSEA, SRMR, AGFI and PCLOSE (Figures 9 and 10).

Hypotheses testing results and findings

As expected, AE-RO (the horizontal axis in the Kolb model) showed significant positive effects on Iterative Experimentation ($\beta = 0.164, p < 0.05$) which means entrepreneurs who favor the AE learning mode over RO are more likely to adopt the iterative experimental approaches commonly associated with successful entrepreneurial practice. AE-RO showed a significant positive effect on performance although the effect was weak and indirect (only).

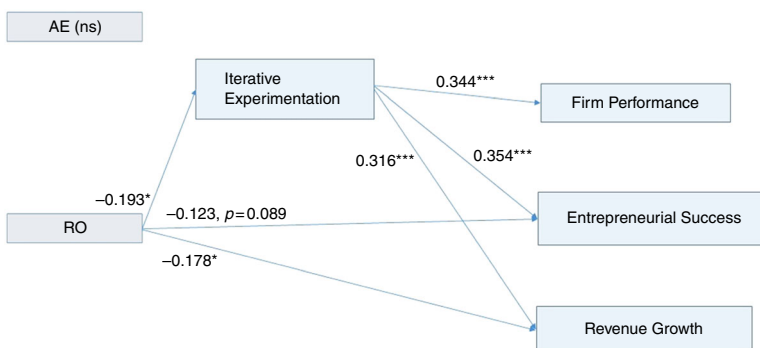
Positive full mediation effects were (as hypothesized) evident in the link between AE-RO and both entrepreneurial success and revenue growth via the Iterative Experimentation mediator (see Table V). Strong positive relationships between the Iterative Experimentation behavior construct and firm performance ($\beta = 0.344, p < 0.001$), entrepreneurial success ($\beta = 0.378, p < 0.001$) and revenue growth ($\beta = 0.351, p < 0.001$) were clearly evident as expected.

χ^2	3.237
df	2
CMIN/df	1.618
SRMR	0.0346
AGFI	0.943
RMSEA	0.061
PCLOSE	0.326

Table III. Model fit statistics for Model 2, AE and RO effects

χ^2	3.541
df	2
CMIN/df	1.770
SRMR	0.0354
AGFI	0.938
RMSEA	0.068
PCLOSE	0.292

Table IV. Model fit statistics for Model 3, AC and CE effects



Notes: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Figure 9. Research Model 2, effects of AE and RO learning modes on iterative experimentation, firm performance, entrepreneurial success and revenue growth

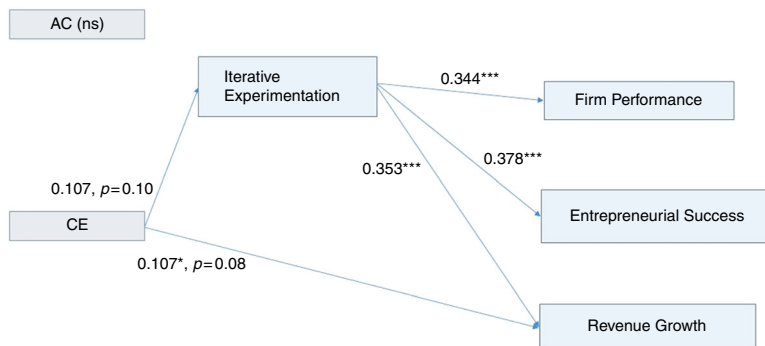
Surprisingly, the CE-AC measure had no effects on either the mediator or DV constructs, however, CE did exhibit borderline significant positive effects directly upon revenue growth (but no mediation).

Testing for the effects of the AE and RO learning modes yielded a major surprise: the effect of AE was insignificant. However, the effect of RO on all DVs was significant and negative, indicating that the AE-RO effects were more a function of negative effects from RO than positive effects from AE. Furthermore, RO exhibited significant direct negative effects on entrepreneurial success and revenue growth in addition to indirect or partially mediated effects on all three DVs. Preference for the RO learning mode predicted a lower adoption of Iterative Experimentation behaviors ($\beta = -0.193, p < 0.05$).

Table V summarizes the mediation testing results, with direct and indirect betas and significance listed for each test.

Discussion

The analysis comparing the learning style preferences of technology entrepreneurs to university business and engineering students provided solid preliminary evidence that the accommodating or “northwest” learning style would be an important psychometric marker for entrepreneurial intentions and success. The quantitative findings provide support for this hypothesis, although in a somewhat surprising way. The largest and most significant learning



Notes: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Figure 10. Research Model 3, effects of AC and CE learning modes on iterative experimentation, firm performance, entrepreneurial success and revenue growth

Hypotheses	Direct β without mediator	Direct β with mediator	Indirect β	Mediation observed
H1a: AE-RO→IterativeExp→Performance	0.111 ns	0.056 ns	0.055*	Indirect effects
H1b: AE-RO→IterativeExp→ENT Success	0.141 ($p = 0.07$)	0.080 ns	0.060*	Full mediation (borderline)
H1c: AE-RO→IterativeExp→RevGrowth	0.170*	0.116 ns	0.054*	Full mediation
H2a, b, c: CE-AC→IterativeExp→DVs	ns	ns	ns	No effects
H3a, b, c: AE→IterativeExp→DVs	0.123 ns	0.092 ns	0.031 ns	No effects
H4a: RO→IterativeExp→Performance	-0.074 ns	-0.008 ns	-0.066**	Indirect effects
H4b: RO→IterativeExp→ENT Success	-0.194*	-0.123*	-0.068**	Partial mediation
H4c: RO→IterativeExp→RevGrowth	-0.239**	-0.178*	-0.061**	Partial mediation
H5a: CE→IterativeExp→Performance	-0.037 ns	-0.035 ns	-0.002 ns	No effects
H5b: CE→IterativeExp→ENT Success	0.040 ns	0.042 ns	-0.003 ns	“
H5c: CE→IterativeExp→RevGrowth	0.126 ($p = 0.10$)	-0.007 ns	-0.002 ns	Borderline direct effects
H6a, b, c: AC→IterativeExp→DVs	ns	ns	ns	No effects

Notes: Exact p -values denote borderline significance ($p \leq 0.10$). * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table V. Summary of mediation testing results

mode impact was the negative effect of the RO learning mode on the mediator and DVs. Especially surprising was the presence of direct negative effects of RO on revenue growth ($\beta = -0.239$, $p < 0.001$) and entrepreneurial success ($\beta = -0.194$, $p < 0.05$), in spite of prior literature describing the role and benefits of reflection, particularly for opportunity recognition.

Why would entrepreneurs with a highly reflective learning style struggle to achieve success? High levels of RO can lead to rumination and retroreflection (a gestalt term referring to reflection turned back on itself instead of leading to action (Kolb, 2015)). A reflective entrepreneur could therefore easily struggle with doubt and suffer from the rejections that are essential elements of an entrepreneurial journey. Successful entrepreneurs appear to rarely engage in overt acts of introspective doubt, but rather more often exhibit a sense of self-efficacy and confidence bordering on hubris (Hayward *et al.*, 2006). Reflective thought, otherwise valuable and perhaps instrumental to certain stages of the entrepreneurial process, can become destructive to an entrepreneur dealing with the perpetual psychological strain of their daily challenges and failures (Shepherd, 2003). Successful entrepreneurs find ways to keep moving ahead with a positive attitude while compartmentalizing periodic failures as minor bumps on a path to longer term business success (Huovinen and Tihula, 2008; Politis and Gabriellson, 2009).

Scholars have described how relatively analytical and reflective business practitioners can struggle with cognitive inflexibility and entrenchment that limits their ability to innovate (Dane, 2010; Kolb and Kolb, 2005a; Pinard and Allio, 2005). Assimilating learners (“southeast” style) are especially vulnerable to inflexibility of knowledge schemas and limited capacity to vary their learning cognition based on the situation (Sharma and Kolb, 2009). This learning inflexibility trait can be compounded by the fact that most knowledge industry entrepreneurs are experts in some area of science or engineering (Dane, 2010), making them further prone to “competency traps” (Levitt and March, 1988, p. 322) that stifle innovation. Entrepreneurial innovation requires action to elaborate a creative idea, as the idea itself does not constitute a business (Amabile, 1996).

Preference for the CE learning mode appears, as hypothesized, to have a positive (albeit weak) influence on firm performance. However, the study exhibited revealed no statistically significant link between firm outcomes and preference for CE or AC, which suggests that the horizontal “transformation” axis of the Kolb learning model plays a much bigger role in entrepreneurial learning cognition than the vertical “grasping” axis.

The benefits of learning indirectly from non-concrete secondary sources does exist in the entrepreneurship literature. Vicarious learning, or the process of benefiting “second hand” from the CEs of others, has been shown to be useful to entrepreneurs (Holcomb *et al.*, 2009). However, learning from secondary sources is likely less informative and influential to entrepreneurs than personal “critical experiences” such as major setbacks or successes (Cope and Watts, 2000).

In spite of the prevalence for practicing entrepreneurs to favor CE, entrepreneurs can apparently succeed by grasping knowledge from either AC or CE. The mode of transformation or processing of experience appears to be more crucial to entrepreneurs than whether the experience is apprehended concretely or comprehended through abstraction of others’ experiences.

It is easy to find examples of successful entrepreneurs with every possible learning style, raising an important question: How do these entrepreneurs succeed in spite of their having a non-advantageous learning style? One possible explanation could involve co-founder shared cognition whereby various members of the entrepreneurial team contribute different cognitive resources necessary for firm success (Beckman, 2006; Dahlin *et al.*, 2005; Forbes *et al.*, 2006; Forster and Jansen, 2010; Gemmill *et al.*, 2011; Hambrick *et al.*, 1996; Hutchins, 1991; Ruff *et al.*, 2003; West, 2007). The co-founder data in this study illustrates how having the entrepreneurial learning style within the combined co-founder cognitive resources appears commonplace and might be a key to success.

Conclusion, implications and future research

In conclusion, this research provides clear findings of measureable entrepreneurial learning style traits that will be useful to both practitioners and educators. This study demonstrates that a preference for the AE learning mode is rather strongly linked to entrepreneurial success. Additionally, preference for the CE mode is clearly very prevalent among practicing technology entrepreneurs, although the effects and benefits of the CE learning mode on firm performance are less conclusive. The “northwestern” style that combines AE and CE is also prevalent and present in nearly all (90 percent) of the co-founder dyads sampled for this study.

This study’s findings also have potential pedagogical implications worthy of follow-on research. Hypothesis-based (“Lean”) entrepreneurship methods (Eisenmann *et al.*, 2012) are being adopted on a large scale by nearly every university entrepreneurship program. Proponents of Lean find the method of particular value for developing market discovery and assessment skills with students who are not used to intense customer interactions. The Lean Method requires such interactions, as students endeavor to formulate and test key business assumptions (“hypotheses”) through customer interviews rigorously designed to harvest valuable feedback that either validates or invalidates hypotheses.

There are obvious parallels between Lean and experiential learning theory, dating back to some of the early reflective learning theory proposed of John Dewey (1922). Kolb’s LSI essentially operationalizes the Dewey learning cycle, making it possible to study links between learning style and student proclivity for the Lean Entrepreneur Method. Action-oriented entrepreneurs with the entrepreneurial learning style might find the Lean Method relatively straight forward and easy to adopt. However, good hypothesis-based entrepreneurship practice also requires development of sound, meaningful hypotheses, a process that might come easier to a learner who prefers using the RO and AC modes. The Kolb LSI could be a useful tool for instructors of the Lean Entrepreneur method, for example to assist in assembling an effective team based on a blend of learning styles that (based on this study’s findings) should include at least one student with a northwestern/entrepreneurial style.

Additional research regarding co-founder trait heterogeneity and shared cognition could have a major impact on start-up team formation and composition. Given the apparent importance and prevalence of co-founder dyads in technology start-ups, further research into the nature and ideal composition of such partnerships is also clearly warranted.

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