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EXECUTIVE SUMMARY

A Knowledge-Based View of the Venture Creation Process: How Technology Entrepreneurs Mix Knowledge to Create Radical Innovations

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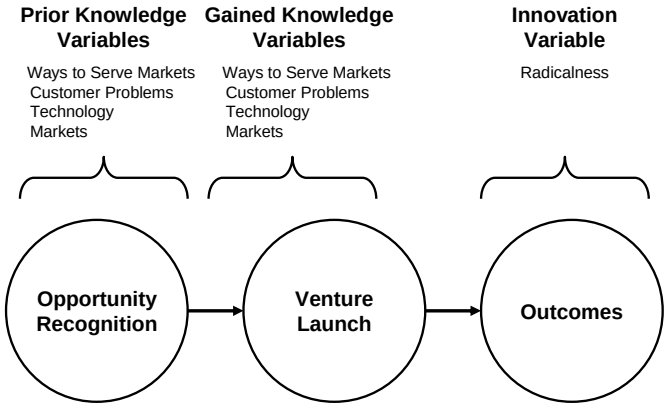
Abstract

Survey-based research was used to investigate technology entrepreneurs' (n=145) knowledge within the venture creation process and the innovativeness of their product or service. Technology entrepreneurs recalled their prior knowledge at the time their opportunity was first recognized and the gained knowledge between opportunity recognition and venture formation using Shane's (2000) knowledge framework. Constructivist learning theory was drawn on to demonstrate how knowledge is constructed within the venture creation process and shaped into innovation outcomes using a scale developed from the radical innovation literature. Constructivist learning emphasizes the building that occurs in peoples' minds as they construct meaning and used to understand the development of an opportunity. The results of the study support the view of venture creation as a constructive knowledge-based learning process. Results showed both prior knowledge at opportunity recognition and gained knowledge forward to venture formation are vital to explaining the radicalness of succeeding innovation outcomes. These findings support previous research that theorized the importance of individual differences in knowledge and demonstrated how differences in these knowledge mechanisms result in differences in innovation outcomes. Opportunities with radical innovation outcomes were positively associated with prior technology knowledge at opportunity recognition while prior knowledge of ways to serve markets was negatively associated with innovation radicalness. This finding was somewhat counterintuitive—the less one knows about ways to serve a particular market at opportunity recognition, the better the chance of using prior technology knowledge to create breakthrough innovations within it. Once an opportunity had been recognized, gained knowledge was needed in larger amounts for radical innovation more so than for incremental innovation. Therefore, persons who embrace and practice learning may be better prepared to develop and exploit an opportunity with more radical outcomes. These results suggest that the sequence as well as the presence of knowledge play an essential role in explaining the creation of breakthrough innovation.

Purpose of the Study

The purpose of the study was to explore the knowledge of technology entrepreneurs within the venture creation process and link to innovation outcomes. Prior knowledge at opportunity recognition and gained knowledge forward until the venture launch were assessed using scales developed from a constructivist view of Shane's (2000) knowledge framework. The framework includes: (1) ways to serve markets, (2) customer problems, (3) technology, and (4) markets. Behaviors have been shown to differ across industries and consequently the knowledge within the venture creation process may differ respectively. Therefore, the assessed prior knowledge and gained knowledge types were compared to determine if they differ by industry and controlled for accordingly. The innovativeness of the venture's product or service was measured using a scale developed from the incremental and radical innovation literature. The predictive relationship between knowledge within the venture creation process and innovation outcomes was explored.

Figure 1: Venture Creation Process and Foci of Study



Research Questions

1. *What mix of prior knowledge was present when the opportunity was first recognized?*

2. *What mix of knowledge was gained from the time the opportunity was first recognized forward to venture launch?*

3. *Do research questions 1 and 2 differ by industry?*

4. *What mix of knowledge within the venture creation process predicts radical innovation outcomes?*

    a. *Does prior knowledge, gained knowledge, or both prior and gained knowledge together best predict radical innovation outcomes?*

    b. *What knowledge types within prior and gained knowledge best predict radical innovation outcomes?*

Method

A purposeful sample (n =145) was used consisting of technology entrepreneurs (i.e., founders of technology-based ventures) in incubators throughout the Midwest. Incubators were targeted to identify technology entrepreneurs who recently started a venture and to minimize recall. In total, 13 incubators took part in the study which resulted in 145 meetings with founders of young technology ventures. Survey items addressed types of knowledge and were developed from the knowledge framework using deductive scale development. Survey items also concerned the innovativeness of the product or service and developed from research distinguishing among incremental and radical innovation (i.e., Hage, 1980; Leifer, McDermott, O'Connor, Peters, Rice & Veryzer, 2000. Experts in scale development and entrepreneurship research were consulted throughout construction of the items and scales.

Discussion of Results

The results of the study support previous research that theorized the importance of individual differences in knowledge and entrepreneurship as a learning process. Some of the findings compliment previous theoretical and empirical work while other findings reveal new knowledge. The discussion of results is organized by the four research questions of the study. Each research question is presented followed by a summation and discussion of the results.

Research Question 1: What mix of prior knowledge was present when the opportunity was first recognized?

Of the four prior knowledge variables, technology knowledge was scored highest at opportunity recognition followed by ways to serve markets, customer problems, and markets. Considering technology knowledge was scored highest, this finding suggests that prior knowledge of technology may be of greatest value for opportunity recognition in the context of technology entrepreneurship. Prior knowledge of ways to serve markets, customer problems, and technology were all scored more similarly compared to prior knowledge of markets—which was scored noticeably lower. Therefore, one might conclude that the former three types of knowledge were more conducive to opportunity recognition more so than prior knowledge of markets. Another explanation may be that, in general, the starting point for technology entrepreneurship is a particular technology suspected to have value especially considering the disparity between technology and market knowledge. This would support the case of *a technology in search of an application*, meaning a form of entrepreneurship in which a person is knowledgeable of a technology having a unique capability although the person does not know what market would have need for such a capability.

Research Question 2: What mix of knowledge was gained from the time the opportunity was first recognized forward to venture launch?

Of the four gained knowledge variables, customer problems scored highest followed by technology, ways to serve markets, and markets. Taken in aggregate the four gained knowledge variables were scored very similarly. This finding suggests the four knowledge types may be needed in comparable amounts following opportunity recognition forward until a venture is launched. While previous research has examined the knowledge necessary for opportunity recognition, the literature is devoid of the knowledge resources needed after discovery until a venture is launched. Given the similar gained knowledge variable scores, there is evidence that the knowledge types identified by Shane (2000) are pertinent not only to opportunity recognition but to the venture creation process as a whole.

Research Question 3: Do research questions 1 and 2 differ by industry?

A multiple analysis of variance was performed indicated there were no statistically significant differences between the knowledge variables and industry category. This finding indicates that neither the prior knowledge types present at opportunity recognition nor the gained knowledge types forward from opportunity recognition to venture launch differ by industry in the context of technology entrepreneurship.

Research Question 4: What mix of knowledge within the venture creation process predicts radical innovation outcomes?

a. *Does prior knowledge, gained knowledge, or both prior and gained knowledge together best predict radical innovation outcomes?*

b. *What knowledge types within prior and gained knowledge best predict radical innovation outcomes?*

To respond to Research Question 4a and thus determine the knowledge mixes that best explain innovation, hierarchical multiple regression was employed. The prior knowledge mix at opportunity recognition and the gained knowledge mix both individually and collectively played a critical role in explaining succeeding innovation outcomes. Each set of knowledge variables (i.e., prior, gained, and prior and gained together) explained a significant portion of variance. Although the best predictor of innovation outcomes was when the prior and gained knowledge sets were used together. This indicates that creating innovation is not solely dependent on knowledge during opportunity recognition or the following gained knowledge until exploitation. Instead, innovation is an outcome of a constructive process where both sequences of knowledge are used together to shape succeeding outcomes. Knowledge is constructed during recognition of the opportunity and further assembled within the process resulting in a venture. These sequences of knowledge development within the venture creation process have great consequences as they impact innovation outcomes and are discussed further. These results provide evidence the knowledge-based process of venture creation explained subsequent innovation outcomes.

To respond to Research Question 4b and thus determine the knowledge types within prior and gained knowledge that best predict the radicalness of innovation outcomes the eight knowledge types considered in the regression were examined further. These included the four prior knowledge type variables and four gained knowledge type variables. The four prior knowledge types are discussed first followed by the four gained knowledge types and their affect on innovation radicalness.

Prior Knowledge Types and Innovation Radicalness

Prior technology knowledge at opportunity recognition was the single best predictor overall and positively correlated to innovation radicalness. This finding underscores the vitality of technology knowledge at opportunity recognition to radical innovation. Individuals with greater technology knowledge or who have a heightened alertness to technology knowledge at discovery are better equipped to create breakthrough innovations. Both prior knowledge of ways to serve markets and prior knowledge of markets at opportunity recognition were significant and negatively correlated with innovation radicalness. This indicates that these knowledge types seemingly stifle radical innovation. This suggests technology entrepreneurs were more prepared to create breakthrough products or services the less they knew about their future markets or about ways to package their product or service. Over familiarity with markets and development standards may hinder discovery or exploitation of opportunities with radical outcomes. Knowledge of markets and ways to serve markets may lead to preconceived notions of the possibilities and limit the opportunities considered and developed. Considerable knowledge of

the accepted standards and behaviors of markets may precondition a person to dismiss potential opportunities with radical outcomes and therefore limit their opportunity set. A person who is not conditioned to the accepted norms of a market and development processes, but rich with technology knowledge, are best positioned to recognize, develop and exploit opportunities with breakthrough potential.

Gained Knowledge Types and Innovation Radicalness

Gained knowledge of ways to serve markets, technology, and markets were all statistically significant in explaining radical innovation. However, gained knowledge of technology and markets was positively correlated with radical innovation while ways to serve markets was negatively correlated with radical innovation. Given that gained knowledge of technology and markets were positively correlated with radical innovation indicates that those who create breakthrough products and services learn at increased levels compared to their less radical—or incremental—counterparts. One explanation for this higher level of learning may be necessity. The entrepreneur has technology knowledge suspected to have value and therefore learning to further develop their opportunity. The opportunity is constructed of different types and amounts of knowledge and when arranged in a particular way, specific to the individual, it is exploited through the launch of their venture. Another explanation for the higher level of gained knowledge may be that those technology entrepreneurs who create radical innovation embrace learning to a greater extent than those who create incremental innovation. This supports the argument that venture creation is a learning process and therefore individuals who practice continuous learning may be better equipped for more desirable outcomes. Gained knowledge of ways to serve markets was the only gained knowledge type negatively correlated to innovation radicalness and was significant in explaining innovation outcomes. An explanation may be technology entrepreneurs who create breakthrough innovation are most concerned with identifying potential customers and identifying which markets their technology is best suited for. Before technology entrepreneurs are concerned with specific standards, development processes and ways to package their solution for a particular application the customers and markets must be identified. Until a threshold of customers and markets knowledge is met, the technology entrepreneur can not adequately package their solution for customers and market applications.

Knowledge and Innovation Graphical Analysis

To demonstrate the relationship between knowledge types and high and low innovation, two graphical analyses were performed. The innovation variable was used to create two groups of cases which included a *high group* (n=23) typifying radical innovation that scored one standard deviation above the innovation variable mean and a *low group* (n=23) typifying incremental innovation that scored one standard deviation below the innovation variable mean. Two sets of relationships were plotted and included the prior knowledge variable means of the two innovation groups, and the gained knowledge variable means of the two innovation groups. The four knowledge types were plotted along the x-axis, mean knowledge scores were plotted along the y-axis, and high and low innovation lines displayed within the plot area. The relationship between the prior knowledge variable means and the innovation groups is illustrated in Figure 2 and the relationship between the gained knowledge variable means and the innovation groups is shown in Figure 3.

Figure 2: Prior Knowledge and Innovation Groups Relationship

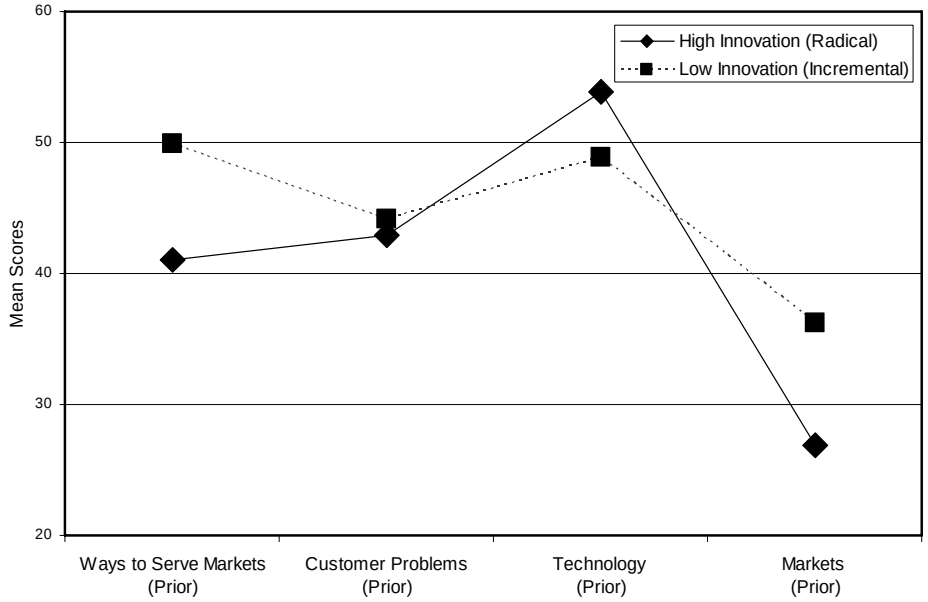


Figure 2 shows the greatest prior knowledge mean for high innovation was prior knowledge of technology. The low innovation group had greater prior knowledge means for each knowledge type except prior knowledge of technology. For the high innovation group, the prior technology knowledge mean was highest followed by customer problems, ways to serve markets, and markets. For the low innovation group, the prior knowledge of ways to serve markets mean was highest followed by technology, customer problems, and markets.

Figure 3: Gained Knowledge and Innovation Groups Relationship

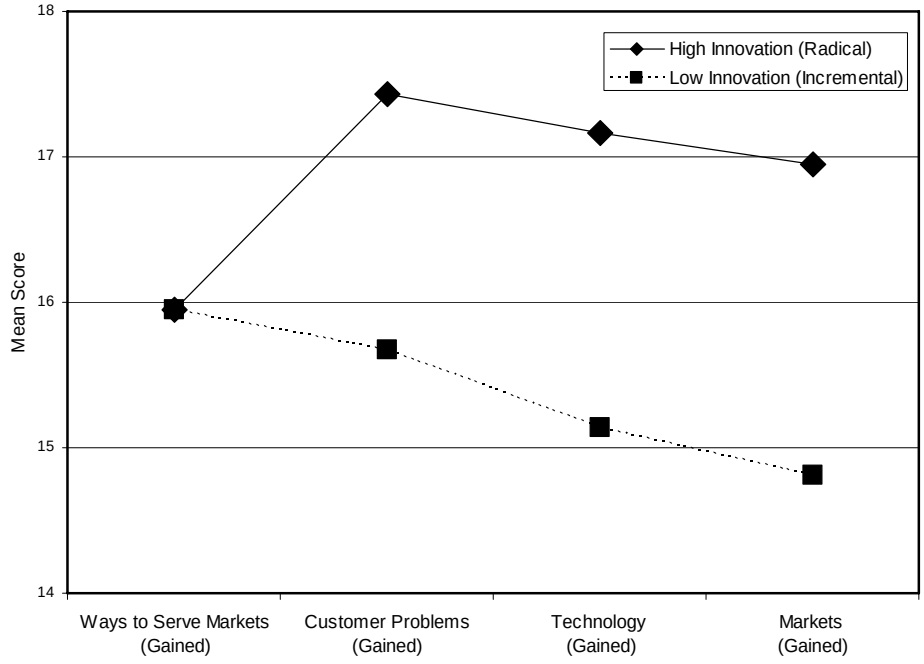


Figure 3 reveals the means for gained knowledge of customer problems, technology and markets were all greater for the high innovation group as compared to the low innovation group. The gained knowledge of ways to serve markets mean was similar across both the high and low innovation groups. For the high innovation group, the mean gained knowledge of customer problems was highest followed by technology, markets, and ways to serve markets. For the low innovation group, the mean score for ways to serve markets was highest, followed by customer problems, technology, and markets. Of note, the mean gained knowledge of ways to serve markets was the least gained knowledge type for high innovation compared to the highest gained knowledge type for low innovation.

Contributions

This study represents the inaugural investigation of a knowledge-based view of technology entrepreneurship and contributes to the literature in four broad ways. First, the study compliments the work of Shane (2000) as scales were developed from his knowledge framework and used to provide a richer understanding of knowledge within venture creation than previously available. Shane (2000) introduced the types of knowledge necessary to recognize opportunities but not until this study were the amounts and importance of these prior knowledge types known. Therefore, the research extends what has been a partial understanding of knowledge at opportunity recognition. Second, the research provides a baseline understanding of the mix of knowledge sought out from opportunity recognition until the launch of a venture. The evidence suggests the knowledge types identified by Shane (2000) are pertinent not only to opportunity recognition but to the venture creation process as a whole. Third, the study demonstrates that the prior knowledge mix at opportunity recognition and the gained knowledge mix from opportunity recognition forward to launch each play a critical role in explaining subsequent innovation outcomes. Although research has empirically linked entrepreneurship to innovation at a macro level how this is accomplished through knowledge at a micro-level has eluded scholars. This study fills that void and provides insights as to *what knowledge* and *when* within the venture creation process it is leveraged to create innovations radical in nature. Fourth, the thesis supports the view of venture creation as a constructive learning process. Knowledge is constructed during recognition of the opportunity and further assembled within the process resulting in a venture. These sequences of knowledge development within the venture creation process have great consequences as they impact the radicalness of innovation outcomes.

Entrepreneurship Education

The contributions of the thesis include a number of insights as to how entrepreneurship education may be enhanced and teach the ability to recognize and shape opportunities with radical innovation potential. Entrepreneurship education programs are surging and almost exclusively found within business schools (Kuratko, 2005). Common entrepreneurship courses include venture creation, venture capital, and business planning. Vesper (1999) concluded business schools are well versed in generalist entrepreneurship courses although lacking in opportunity-specific and venture-specific areas. Opportunities with radical potential result from technology knowledge. While business students are versed in market analysis, strategy, financials, and so on, they are not equipped with a supply of technology or scientific knowledge to leverage. While the current study examined knowledge mixes of individuals, conceptually a

mix of knowledge also applies to a group of individuals—or team. An individual who possesses technology knowledge presumed to have value could be teamed with others who have complimentary knowledge of markets and customer needs. This sequence of taking primarily technology knowledge and mixing it with knowledge of customer problems and markets simulates a venture creation process resulting in radical innovations. To comprise a team to facilitate the process within the context of higher education it seems most appropriate to combine students from multiple disciplines. For example, teaming hard-science upperclassmen such as an electrical or mechanical engineer with an idea construed to have potential value with students in entrepreneurship, marketing or other business majors. The idea of starting with a supply of technology knowledge suspected to be advantageous for a likely unknown market application and collecting and analyzing information about demand (i.e., customers and markets) lends itself to a feasibility analysis project. As the name implies, a feasibility analysis examines the viability of an idea and fitting it with a potential market application. The feasibility study focuses on helping answer the essential question of *should we proceed with the proposed idea?*

These types of experiential learning opportunities may compliment the work of higher education as they struggle with technology transfer. The passage of the Bayh-Dole Act (1980) enabled universities to own and patent inventions developed under federally funded research programs. Universities have seen significant increases in technology transfer activity. For example, before 1980, fewer than 250 patents were issued to U.S. universities each year and discoveries were seldom commercialized. In contrast, in 2002, 4,673 new license agreements were signed. Between 1991 and 2002, annual invention disclosures increased nearly 250% percent, new patents filed increased more than 310%, and new licenses and options executed increased more than 365% (www.autm.org). To meet this demand, universities professionals must constantly screen opportunities, assess their viability, conduct marketing research, and negotiate license agreements. Involving students within these processes would compliment entrepreneurship education and may provide increased value to the universities themselves. This study indicates these types of experiential learning activities would better prepare students for the constructive process of creating radical innovation.

Conclusion

This thesis contributed to one of the most important questions facing entrepreneurship research today of why some people, and not others, recognize opportunities and with what effect. The study responded directly to this fundamental, yet unresolved, question. The work demonstrated how entrepreneurship research can benefit from the view of a constructive learning process and highlights the importance of different types of knowledge and the sequence in which are applied. The findings underscore the importance of individual knowledge within the venture creation process and demonstrated how differences in these knowledge mechanisms result in differences in innovation outcomes.

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