USING A TACIT KNOWLEDGE METHODOLOGY TO DEFINE EXPERTISE[1]

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Abstract: Consideration of the nature of expertise is inherent in expert systems development efforts. A number of assumptions regarding expertise are often made which can be problematic, particularly in management domains. This paper identifies a pre-knowledge acquisition activity that can be performed in order to address these assumptions. This activity is centered around the psychological concept of tacit knowledge. The paper outlines how the tacit knowledge methodology is being used to define and delineate expertise in the domain of entrepreneurship.

INTRODUCTION

There are many possible uses of expert systems technology. Expert systems can be used to assist experts, to train experts, to replace experts, and to augment expertise. However, a common thread in all types of applications is the focus on "experts" and "expertise." Any project aimed at developing an expert system must address the issue of what these terms mean in the context of the application under consideration. Wensley (1989) is critical of the extent to which this typically is done and points out consequences of a lack of attention to the issue:

> The best that can be said is that researchers have equated expertise with a particular type of knowledge -- usually knowledge that the researcher is able to understand and represent relatively easily. This has two serious consequences. First, it often results in the construction of woefully inadequate expert systems which are justifiably rejected by the experts as mere toys.

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Second, if the experts are seduced by the system as many of them often are, their performance may well be degraded to the level of the system and they will not be aware of it." (p. 252)

A question which is often discussed with respect to the nature of expertise is whether relevant expert knowledge is domain-specific or domain-independent. Cognitive science research has made gains in documenting a variety of seemingly generalizable expert-novice cognitive differences (see, for example, Galotti, 1989), and researchers who have analyzed a variety of domains have uncovered a number of generalized abstract concepts. However, Breuker and Wielinga (1987) argue that while the structure of these concepts is domain-independent, their instances are domain-specific. Hence, the conventional approach to expert system development is capturing large amounts of domain-specific knowledge (Feigenbaum, 1979). Moreover, a limitation of domain-independent assumptions from a development perspective, is that they must be tested for each new application area under investigation. Thus, it is necessary to come to terms with the definition and delineation of expertise in each chosen domain of application.

An initial objective of defining and delineating expertise in a domain is to provide a basis on which to identify relevant domain experts from whom knowledge should be elicited. This is particularly problematic in management domains because of the heterogeneity in the background experiences of "expert" decision makers. In addition, the knowledge which differentiates successful and unsuccessful practitioners may be open to question.

This paper describes a methodology that is being used to define expertise in the domain of entrepreneurship. The methodology is based on the concept of tacit knowledge, and is used to identify domain experts as well as the relevant dimensions on which expertise is delineated. The paper begins by examining assumptions about the nature of expertise that often underlie expert system development. It proceeds to a discussion of the psychological concept of tacit knowledge and outlines how the tacit knowledge methodology has been adapted for this study. Finally, the paper addresses the implications of the study for further research.

ASSUMPTIONS REGARDING EXPERTISE

Three assumptions regarding the nature of expertise often made in developing expert systems are discussed below. These assumptions are not made in all development efforts, nor are they always dysfunctional. However, they are worthy of explicit consideration since they are sufficiently prevalent and can be called into question.

1. Experience = Expertise

In many domains of expert systems application (such as medicine and auditing), individuals must pass professional examinations in order to practice, and then follow a standardized career path where promotion from one level to the next occurs at regular intervals. Identifying "experts" in these domains often involves using job title or years of experience as a proxy for level of expertise.

The assumption that knowledge acquisition is directly proportional to length of prior participation in a domain, or, in other words, that experience is equivalent to expertise, is troublesome. There will be more and less competent individuals at any job level. An analogy here is that of formal schooling. Given the wide variation in scholastic performance among individuals exposed to the same duration and types of schooling, it can not be assumed that the amount learned in school is proportional to the number of years spent in school. Similarly, it can not be assumed that there is no variation in the knowledge and skills acquired by individuals who have been exposed for equal duration to similar job-related situations. Thus, a distinction has to be drawn both conceptually and operationally between experience and experientially acquired knowledge (expertise), where the latter is specifically associated with success although the former may not be (Reuber, Dyke and Fischer, 1990).

2. Expertise Can Be Articulated

Certain knowledge acquisition techniques (such as protocol analysis) are based on the assumption that experts are able to articulate the bases on which they make decisions. This ability may be stronger in some domains than in others. For example, in performing their jobs, experts in professional fields are expected to articulate the reasons underlying their judgments. Part of this expectation stems from legal and professional requirements to document decisions, and part of it stems from the role of experienced individuals in training novices in these fields. Thus, professional experts may be familiar with explaining their decisions and how they arrived at them.

However, it can not be assumed that an ability and a willingness to discuss decision processes yields a true reflection of these processes. Nisbett and Wilson (1977) argue that there may be "little or no direct introspective to higher order cognitive processes" (p. 231). There may be attribution effects which lead to individuals "telling more than they can know," and cognitive heuristics and biases that influence what is articulated (Nisbett and Wilson 1977). Conversely, Polanyi (1966) argues that much experiential knowledge is unconscious and unarticulated: individuals "know more than they can tell."

3. Existing Activities are Relevant Activities

Expert systems development normally is targeted to activities and problem solving tasks that individuals are currently involved in. The ways in which activities are conceived, the information used to solve problems, and the decision outcomes, are available and used in constructing (and often validating) the system. In some cases, an initial prototype system is constructed on the basis of existing written procedures.

A risk in focusing on current activities is that expert systems effort is biased towards the descriptive at the expense of the normative -- an issue discussed by Stabell (1982) in the context of decision support systems. It may be the case that expertise in the domain is characterized by a propensity to operate outside existing rules and procedures or to operate in the absence of these items. Another aspect of this issue is that existing problem formulations are not necessarily relevant problem formulations. For example, one method of evaluating an expert system is to compare its decisions with decisions that were made manually. Such a comparison ignores a consideration of the ultimate impact or quality of the decision. It may be the case that experts are able to substitute new problem formulations for old problem formulations in order to achieve organizational objectives more effectively or efficiently.

There is some evidence that these assumptions are particularly problematic in management domains. A recent study of experience and expertise among corporate managers found that a) the experiential basis upon which expertise is formed is diverse and heterogeneous; b) there is little direct transfer of knowledge from highly-skilled practitioners to novices; and c) there is a wide diversity in the ways in which problems and objectives are formulated (McCall, Lombardo and Morrison, 1988). Similarly, entrepreneurial managers have heterogeneous backgrounds. There is a diverse collection of

relevant experiences that could conceivably lead to expertise and subsequent venture success (such as product/market experience, industry experience, general supervisory or management experience, and start-up experience), but studies which have attempted to find such relationships have failed to do so for the most part (Reuber, Dyke and Fischer, 1990). In addition, entrepreneurship is not a field of endeavour that requires articulation of judgment processes or decisions, nor do written procedures exist. Finally, the domain of cost management is particularly salient with respect to the third assumption discussed. There is much more homogeneity in this domain than in corporate management and entrepreneurship, due to the existence of professional designations and standard cost management techniques; however, this homogeneity must be considered somewhat dysfunctional in light of recent criticisms of the field. It has been argued that experienced practitioners often use inappropriate techniques to solve irrelevant problems (Johnson and Kaplan, 1987). With basic assumptions in the domain being challenged, it is difficult to determine who should be considered a cost management expert.

TACIT KNOWLEDGE

The nature of tacit knowledge was explored by Polanyi (1966) who described it as knowledge which is experientially acquired: "the outcome of active shaping of experience performed in the pursuit of knowledge" (p.6). Furthermore, tacit knowledge was considered to be both unconscious and unarticulated. Tacit knowledge has been referred to periodically in the expert systems and decision support systems literature. Writers largely come to the same conclusion: it is desirable to capture tacit knowledge in intelligent systems, but it is extremely difficult to do so (Gruber, 1989; Klein and Hirschheim, 1985; Slatter 1987). However, it is possible to use the concept of tacit knowledge to address the nature of domain-specific expertise in a way that avoids the assumptions discussed above.

Tacit knowledge has been investigated systematically in the psychology literature in examinations of practical intelligence (Wagner and Sternberg, 1985; Wagner, 1987; Sternberg and Wagner, 1989). A recognition that formal reasoning ability and intelligence, as measured by standard psychometric instruments, poorly predict performance in real-world pursuits (Galotti, 1989; Perkins, 1985; Wagner and Sternberg, 1985) has led researchers to focus on the experientially-based, practical knowledge that is predictive of real-world success. Wagner and Sternberg (1985) call this knowledge "tacit knowledge" and have developed a methodology

to capture and measure it. Consistent with Polanyi (1966), they define tacit knowledge as a) practical rather than academic in nature and orientation; b) informal rather than formal; and c) experientially-acquired rather than directly taught. Tacit knowledge has been found to be predictive of success in a variety of domains, including sales (Sternberg, 1988), corporate management (Wagner and Sternberg, 1985), academic psychology (Wagner and Sternberg, 1985), and even school performance (Sternberg and Wagner, 1989). The conclusion is that "differences in tacit knowledge were consequential for career performance in professional and managerial career pursuits" (Wagner and Sternberg, 1985, p. 452).

The focus in tacit knowledge studies is on identifying the knowledge that distinguishes experienced individuals in a domain from those that are less experienced, and further, on showing that this knowledge is correlated with job performance within experiential level. In order to investigate tacit knowledge within a domain, it is necessary to define a tacit knowledge instrument for that domain. The instrument consists of a series of work related situations (called scenarios). Each scenario has a number of possible actions (response items) associated with it. Individuals of varying experience levels in the domain are asked to examine the scenarios and to rate the relative importance of each response item. Using statistical discrimination procedures, the response items that differentiate between individuals of different experience levels are identified as the items of the tacit knowledge scale. The next step is to examine whether tacit knowledge is associated with success within experience levels. Individuals are also asked to provide data on a variety of performance measures. The effects of experience are partialled out of the success measures and these residualized success measures (net of experience) are correlated with tacit knowledge scale scores.

Thus, the tacit knowledge concept and methodology allows us to explore the nature of expertise in a domain without making the assumptions discussed above. There is an explicit recognition of individual variation in the ability to learn from experience; experience and expertise are not considered to be equivalent. The methodology does not require that individuals articulate their decision processes; it only requires that they rate possible actions to scenarios. In addition, the methodology makes no assumptions about the activities on which experts and non-experts differ. This is left as an empirical question.

Despite these advantages, this methodology is not a replacement for existing knowledge elicitation techniques.

Much more detail about decision processes needs to be collected in the construction of expert systems than is possible using a tacit knowledge instrument. However, an examination of tacit knowledge is useful as a pre-knowledge acquisition activity. It permits an identification of relevant experts in a domain and a delineation of the knowledge that distinguishes experts from non-experts. The way in which the methodology is being applied to the domain of entrepreneurship is outlined below.

APPLYING THE TACIT KNOWLEDGE METHODOLOGY TO ENTREPRENEURSHIP

Wagner and Sternberg's (1985) tacit knowledge methodology was adapted in order to apply it to the elicitation and delineation of expertise in the domain of entrepreneurship. The adaptation resulted in a methodology with three distinct phases.

1. Interviews

Wagner and Sternberg (1985) used the critical incident technique of Flanagan (1954) and McClelland (1976) in order to identify work-related situations to use as scenarios. Our interview phase was much the same, and is discussed more fully in Dyke, Fischer and Reuber (1989). Interviews followed a semi-structured schedule. Experienced entrepreneurs were asked to describe major decisions they had faced in the past, the options they had considered and how they had reached their decision. They were also asked to consider how they might have endangered the business had they chosen other alternatives. Analysis of the interview transcripts revealed several critical incidents with overlapping themes for each of the ventures studied. These incidents form the basis for the eight scenarios in the tacit knowledge instrument. Each scenario describes a different entrepreneurial venture.

We conducted more interviews than did Wagner and Sternberg, with more heterogeneous subjects. Four times as many interviews were conducted (19 rather than 5), and rather than limiting subjects to one organization, we interviewed subjects from different business sectors and at different business stages. This broader scope was necessary in order to capture the richness of the domain.

2. Open-Ended Instrument

The second phase of our study was an addition to the Wagner and Sternberg methodology. They used the interviews

as a basis for both scenario construction and response item generation. We used the interviews only for scenario construction; response items were generated by administering the open-ended scenarios to individuals with different levels and types of entrepreneurial experience. This added step was performed for two reasons: a) it gave us a much richer set of response items that might be selected by either experts or novices; and b) it allowed us to analyze qualitatively the responses that individuals of different backgrounds made in the absence of any prompting.

At the end of each scenario, respondents were asked to nominate at least five actions that the entrepreneur should perform in order to ensure the success of the business. The scenarios were administered to approximately 300 individuals, clustered into four experiential groups. There were two groups of students -- undergraduate Commerce students, constituting the least experienced group, and part-time MBA students. The MBA students were included because they all have a minimum of five years of work experience but no entrepreneurial experience. Thus, any differences between the MBAs and the non-student groups can be attributed to entrepreneurial experience per se, rather than to general experience in the work force.

The non-student respondents all had experience with entrepreneurship, but the nature of this experience was very different. Approximately half of these individuals were business owners, while the other half (called the "observers") were individuals who work with entrepreneurs, such as bank lenders, venture capitalists and consultants. Including both kinds of individuals allowed us to investigate differences in responses due to the nature of experience: direct and specific (owners) vs. indirect and generalized (observers). Both groups were highly educated (72.7% of the owners and 77.8% of the observers had some graduate education) and experienced (the average number of years of experience in their current line of work was 9.1 years for owners and 8.7 years for observers).

A total of 4,054 responses (actions) were nominated by the 299 subjects for the eight scenarios. Two of the authors classified each response by content and by the experiential group of the respondent. Prototypical responses which were characteristic of certain experiential groups were selected as response items for the close-ended instrument to be administered in the third phase of the study. This analysis caused one of the scenarios to be removed from final instrument because responses exhibited little variety.

In addition, the responses were content analyzed

qualitatively and quantitatively (using a textual analysis software package) to investigate three cognitive characteristics often associated with expert-novice differences (Galotti, 1989): differences in the volume of information provided by the subjects, differences in the kinds of information provided by the subjects, and differences in the extent to which subjects actively seek out further information in solving problems. This provided a fairly loose validity check for the method. There were significant differences among the experiential groups for each of these characteristics.

With respect to the volume of information provided by subjects, we found that experienced subjects were able to formulate more responses to scenarios than were inexperienced subjects and were also able to discuss their responses more thoroughly. The types of responses nominated also varied, with the two student groups being more similar to each other and the two non-student groups being more similar to each other, as predicted. A particularly interesting finding in the quantitative analysis of word frequencies was that experienced individuals in this domain use a more heterogeneous vocabulary than do students. This finding is consistent with the heterogeneity of the backgrounds of these individuals, whereas it is to be expected that students will use a more narrow vocabulary when solving business cases, based on their shared educational background. However, the finding is at odds with knowledge elicitation techniques that focus on the delineation of a shared vocabulary as a stage in the elicitation process (for example, Breuker and Wielinga, 1987; Gammack, 1987).

Finally, there were significant differences among the four groups with respect to the extent to which search for further information was prescribed. Observers and MBA students prescribed further search the most, followed by business owners, and then undergraduates. These results are consistent with studies which show that type of experience, as well as amount, impacts cognitive attention (for example, Boritz, 1989; Melone, 1988). Searching for additional information in order to evaluate businesses is a major job-related activity of observers and is stressed in MBA programs. Therefore, it is not surprising that individuals in these two groups are more interested in obtaining additional information in order to make judgments.

3. Close-Ended Instrument

Once the response items were generated from the open-ended responses in phase two of the study, close-ended

instruments were administered to entrepreneurs in a variety of ventures in May 1990. This phase was comparable to Wagner and Sternberg's administration of the tacit knowledge instrument, although there were minor changes.

First, Wagner and Sternberg used discrete groups to delineate experiential levels, as we did in the second phase. However, career progression in entrepreneurship is very different from the two domains they studied. Accordingly, we used number of years of business ownership to distinguish novice and expert entrepreneurs. Second, the success measures they used were individual performance criteria such as salary and number of employees supervised. In entrepreneurship, however, separating the success of the individual and the success of the business makes no sense. Therefore, multiple measures of business success were collected from respondents, including total sales, sales growth, and number of employees. Collecting business performance measures is also desirable in light of the third assumption regarding expertise discussed in this paper. It allows conclusions regarding the association between knowledge and ultimate business objectives to be made, rather than conclusions regarding the association between knowledge and career performance. The former is a stronger formulation of organizationally-relevant expertise.

Completed questionnaires were received from approximately 600 entrepreneurs in a variety of sectors and industries. A significant number of response items correlate with experience and form the tacit knowledge scale. Data analysis is still on-going since it is necessary to normalize success measures across sectors and industries before correlating success with tacit knowledge within experience levels.

IMPLICATIONS OF THE STUDY

This paper has presented a methodology that has been used to define expertise in entrepreneurship, a domain where experts are heterogeneous . The methodology has been adapted from the tacit knowledge methodology of Wagner and Sternberg (1985) and has been applied to the domain of entrepreneurship.

The methodology only addresses preliminary questions that are relevant to expert system development in this domain. However, its application yields a number of insights that are significant for subsequent work. First, the tacit knowledge instrument can be used to define and identify experts who would participate more intensely in detailed development work. Second, and related, it is important to specify the nature of the activity performed by the system in choosing experts. If

an important aspect of the system is prescribing additional information that might be collected (for example, a system that aids in business plan preparation), then individuals who are expert in search (such as bank lenders or consultants) are more appropriate experts than business owners. In this case, the third phase of the study would have to be redone using the former group of individuals so that a valid measure of expertise could be formulated. Third, the scenarios constitute a body of material that can be analyzed in more detail. Since it is known where and how experts and novices respond differently to each scenario, it would be worthwhile to focus on the rationales behind these responses when eliciting more detailed procedural expertise. Finally, the lack of a shared vocabulary that was found among experienced entrepreneurs suggests that detailed knowledge elicitation in this domain should be focused at the conceptual and epistemological levels of representation and interpretation, rather than at the linguistic level, as defined by Brachman (1979). Knowledge elicitation techniques aimed at delineating a shared vocabulary are unlikely to be effective.

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