Discovery and Change: Themes of Mental Model Development Among Successful New Farmers

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Abstract: This study explored how a group of farmers developed their mental models of farming. Two themes emerged from the data: (a) Discovery learning plays an important role in model development; (b) When a mental model serves as a barrier to learning an activating event may be necessary for model transformation.

Purpose

In the U.S., demographic, technological, and business practice changes pose new challenges for adult learners in workplace settings. One profession that has experienced dramatic changes, particularly over the past few decades, is the farming profession. Farmland has been consumed by residential and commercial development, family farms have lost their next generation, and immigrant populations have assumed a larger role in farming production and markets (U.S. Department of Agriculture, 1998). As in other workplace settings (Sternberg & Horvath, 1999), farmers who are able to creatively adapt to external pressures are more likely to succeed in times of change.

Researchers (e.g., Stokes, Kemper, & Kite, 1997; Di Bello, 1997) have show that in work contexts, the ability to effectively problem solve and adapt to change is impacted by prior learning experience. In turn, learning experience is related to the mental models one constructs of the task at hand as well as the nature of one's work as a whole (Daley, 2001; Epstein, 1999). For example, Coughlin and Patel (1987) found that the content and complexity of physicians' mental models was directly impacted by prior experience, and physicians applied their models to frame and resolve patient cases. Artzr and Armour-Thomas (1998) demonstrated that mathematics teachers' overarching conceptions of pedagogy and the roles of student and teacher directly impacted their instructional practices and the effectiveness of their practices on a day-to-day as well as long-term basis.

Facilitators of workplace learning can effectively create opportunities for learners to articulate, examine, and modify, if needed, their mental models (Feltovich, Coulson, Spiro, & Dawson-Saunders, 1992; Tuovinen & Sweller, 1999). These activities can open individuals to new learning and ways of solving problems, which may result in enhanced professional performance and success. Unfortunately, little is known about how farmers develop their mental models of farming and how the models may change in relation to external challenges (Eckert, 2003; Raedeke & Rikoon, 1997). With a better understanding of how farmers develop mental models, educators and service providers will be better equip to design and support learning experiences that enable farmers to successfully adapt to changes impacting the profession (Eckert & Bell, 2005). The purpose of this qualitative study was to explore how farmers developed and changed their mental models of farming. The study was conducted with a sample of small farm operators in the northeastern United States, where pressures on small farms are especially intense.

Theoretical Framework

A synthesis of the works of Johnson-Laird and colleagues (e.g., Johnson-Laird, 1983; Legrenzi & Girotto, 1996) and Gentner and colleagues (e.g., Collins & Gentner, 1987; Gentner & Stevens, 1983) were used as the theoretical framework for this study. Both groups of researchers have made complementary contributions to understanding the nature of mental models, their construction, and the role they play in learning, problem solving, and decision-making applicable to both work and non-work settings.

Johnson-Laird (1983) defined mental models as "representations in the mind of real or imaginary situations" (p. 397) and proposed that "mental models play a central and unifying role in representing objects, states of affairs, sequences of events, the way the world is, and the social and psychological actions of daily life" (p. 397). Gentner (2002) elaborated, stating that mental models function to support "understanding, reasoning, and prediction" (p. 9683).

Johnson-Laird and colleagues emphasized the role of mental models in reasoning and performance. They offered two propositions: (a) A mental model represents one possibility, capturing what is common to all the different ways in which the possibility may occur. Mental models represent explicitly what is true, but not what is false; and (b) Complex tasks tend to elicit multiple models. Reasoning is easier from one model than from multiple models (Johnson-Laird & Byrne, 2000b, ¶ 1).

Gentner and colleagues contributed to understanding how individuals construct mental models using analogical mappings across domains. Individuals use analogies to apply knowledge from a familiar domain (the base) to the new domain (the target). The structure and content of the base domain appears to be influenced by both prior experience and by "cultural transmission" (Collins & Gentner, 1987, p. 264).

Both sets of researchers highlighted the potential fallibility of individual mental models, and offered considerations for the facilitation of learning. Individuals, particularly novices in a domain, tend to focus on a single possibility in multiple-model problems and form erroneous conclusions (Johnson-Laird & Byrne, 2000b, ¶ 1). Instructors can identify errors in incorrect models as indicators of gaps in learning, and "if typical incorrect models are understood, then instructors and designers can create materials that minimize the chances of triggering errors" (Gentner, 2002, p. 9683). This framework provided theoretical and empirical support for exploring both the nature of farmers' mental model development as well as implications for supporting farmers in adapting to changes that affect their work.

Research Design

Ten operators of small farms in the northeastern United States comprised the sample for this study. Purposive sampling strategies were used to ensure that participants represented a variety of approaches to farming (organic and conventional), farm types (vegetable, dairy, poultry, and livestock), and range of marketing practices (wholesale, direct marketing, and community-supported agriculture). The researchers identified participants through referrals by providers of educational and other services to farmers, through referrals by farmers participating in the study, and through websites and newspaper profiles of successful farmers. Each participant met the operational definition of successful new farmer, having completed re-strategizing efforts and on the way to becoming established farmers (Sheils, 2004). Average age for the sample was 42 years

(range 27-56 years), and average number of years in the current operation was 8 (range 1-15 years).

The 10 farmers who participated in the study were interviewed on site at their farms over a 6-month period between February and August of 2002. The semi-structured interviews lasted 60 to 90 minutes each, with two couples interviewed together. The interviews were tape-recorded and transcribed. The interview protocol focused on farmers' perceptions of significant experiences in the course of their learning how to farm and the meanings they attributed to being a "successful" farmer. The protocol was revised on an ongoing basis to elicit more focused responses from participants and to accommodate themes that emerged in early data analysis. Data analysis began with transcription of the first interviews and continued throughout the study. The process entailed alternating between beginning with open coding or thematic coding using themes suggested by the literature on mental models (e.g., Collins & Gentner, 1987; Johnson-Laird, 1983; Seel, 2001) and verifying or revising themes based on the data (Miles & Huberman, 1994). Trustworthiness of data collection and analysis were maximized using a variety of strategies including data triangulation, member checking, peer debriefing, review of transcripts and interpretations by a farmer advisor, and review of current literature. Relevant information about the participants is incorporated into the following discussion of results. (The names of interview participants have been replaced with pseudonyms.)

Findings and Conclusions

Every farmer interviewed described his or her practice of farming in ways that reflected an underlying mental model. Leon, a grass-based livestock farmer, was most explicit, saying, "When you start thinking about it, we've tried to in conventional agriculture apply an industrial model to a biological system, and we just have to keep working harder to make it work."

Two themes emerged in the data regarding how farmers developed their mental models of farming:

1. Discovery— Through discovery learning and problem-solving farmers built upon and reinforced their existing mental models of farming.
2. Change—In some cases, farmers transformed their mental models as a result of an *activating event* (Cranton, 2002) that triggered articulation, questioning, and revision of their values, beliefs, knowledge, and skills.

For the first theme, farmers spoke of trial-and-error and of learning without necessarily knowing the outcome in advance—in short, of learning through discoveries and problem solving. For example, Ken, who operated a goat dairy and grew vegetable crops, discovered that chickens that found their way into the greenhouse ate many of the harmful insects. This turned out to be so effective that Ken refined his organic mental model of pest control to include the use of beneficial predators such as chickens and praying mantis. In Ken's words, this was "accidental learning."

Tuovinen and Sweller (1999) characterized discovery learning as learning that takes place outside of direct instruction where learners on their own or with other learners discover concepts, relationships, and procedures. According to Seel (2001), both self-guided and other-guided discovery learning and problem solving are essential to metal model development. In this study, farmers described engaging in both self- and other-guided discovery learning experiences.

The second theme addressed the impact of activating events on farmers' mental model development and transformation. While many of the learning activities described by farmers in the sample served to maintain the continuity of an existing mental model, some experiences were activating events that triggered articulation, questioning, and sometimes transformation of the farmer's mental model. Cranton (2002) defined an activating event as one that "typically exposes a discrepancy between what a person has always assumed to be true and what has just been experienced, heard, or read" (p. 66). Among the farmers interviewed for this study, half described experiences that were indicative of activating events.

For example, prior to an activating event, Leon's mental model of farming was best described as an "industrial model" where farming was conducted on a large-scale basis and required a great deal of resources and initial investment. For Leon, this mental model framed most of his college instruction and his early years as a farmer. His mental model of farming was transformed after an experience while working on a hog farm when disease decimated the livestock population, "There was periods of time when we lost every pig in the whole room, and you just, you know, pitching 'em out the door for hours, piles this high outside the . . . it's pretty discouraging." Leon described this as an "aha" experience that "totally changed my thinking, which also changed whether I could start farming on my own." Because of the change in his mental model triggered by the activating event, Leon was able to establish his own small-scale livestock operation a way that was not resource-intensive.

In conclusion, understanding how farmers develop mental models can help educators design learning programs and services that enable farmers to succeed. For example, educators can (a) demonstrate to farmers that they recognize the knowledge, skills, and values farmers have developed through discovery learning, problem solving, and activating events; (b) offer opportunities for discovery learning and problem solving within structured educational programs; (c) create conditions that support self-directed discovery learning for individual farmers at their worksites; and (d) recognize that when a component of a farmer's current mental model poses a barrier to change that would lead to improved viability or profitability, a purely cognitive, reason-based approach by is probably not enough to trigger such transformation.

Implications for Adult Learning Theory and Practice

The findings of this study have implications for adult learning theory and practice in three ways: First, they document the nature of mental models of farming held by successful new farmers, how they develop, and the circumstances under which they can change. Second, the study supports much of the prior research on mental model development. It offers a deeper insight into the role of activating events in transforming mental models that may be based on erroneous assumptions. Lastly, the study can serve as a model for the exploration of mental models among professionals in other workplace settings, particularly in settings where workers are more autonomous. When educators and trainers consider the mental models held by learners in professions, they can maximize the impact of their interventions and services and promote professional success.

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Acknowledgement

The project on which this paper is based was conducted by the author and colleague, Eileen Eckert. The author would like to thank Eileen Eckert for her contributions to an earlier version of this paper. This study was supported by a USDA grant to the New England Small Farm Institute for the *Growing New Farmers* project.