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EFFECTS, MEANING AND LEARNING PROCESSES REGARDING EXPERTS' STORIES AND NOVICE PROBLEM SOLVING IN AN ILL-STRUCTURED PROBLEM-SOLVING ENVIRONMENT

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ABSTRACT

The situations that practitioners typically have to face in the workplace are filled with ill-structured problems. A case library, a systematic collection and organization of a number of experts' experiences, encoded as cases, and presented in the form of stories to learners while interacting with a task environment, is considered by many scholars as a way to increase ill-structured problem-solving skill in novices. Despite the acknowledged potential of case libraries, no prior studies have been conducted that clearly isolate the effect that a case library may have on the acquisition of ill-structured problem-solving skills on novices. For this reason, this mixed-model design study, quantitative and qualitative, attempts to shed some light into the effects, meaning and learning processes regarding experts' stories and novice problem solving. Forty-four undergraduates were subjected to the following: a pretest, random assignment to one of three groups (experimental or case library with stories, comparable or fact sheet with material comparable to the stories but presented as facts, and control or text randomly selected from a textbook unrelated to the material), and post test. The tests, divided in two parts, attempted to measure whether the experimental group incorporated the lessons to be learned from the stories in the case library. The results on one part seemed to indicate that indeed the case library supported ill-structured problem-solving skills when compared to fact sheets or random text, whereas on the other part the results were inconclusive. For the qualitative part, six students, two from each experimental situation, were engaged in separate in-depth interviews to learn about how they went about solving problems in school and how stories could form part of this process. In addition, three novice practitioners were engaged for a 7-month period through two in-depth interviews and two problem-solving sessions in order to learn about problem-solving processes in a work setting and to determine whether stories were an important component of these processes. Based on this research, a model representing how stories form part of the process of problem solving is presented and discussed in terms of the data collected and in terms of other theories. Implications for instructional designers and educators in general are also provided.

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CHAPTER 1

INTRODUCTION

Let me begin by telling you a story:

Manufacturing Products Around the World

The Case of Reese's Peanut Butter Cups

There are many important reasons why food products are very difficult to export. Tariffs, local subsidies to native companies and agricultural products, inconsistent quality of local ingredients, and other similar reasons can make it difficult for a company to manufacture and market its products in another country.

For example, in the mid-80's, Hershey, as part of its European export strategy, started buying European companies with production capacity; the goal was to have five to eight plants in Europe with excess capacity. A large Dutch plant was acquired to be used for making Reese's Peanut Butter Cups. Hershey immediately set up a miniature peanut butter cup operation in this plant. However, many problems were immediately encountered with the quality of peanuts. Hershey's original strategy was to source the peanuts locally, but this strategy proved to be a disaster. Many varieties of peanuts go through the port of Amsterdam from places like India, China and the rest of the world. Hershey was unable to get the correct flavor profile, which is based on the unique flavor of U.S. peanuts.

In a desperate attempt to make the plan work, Hershey decided to buy the peanuts in the U.S. and ship them to The Netherlands. The plan failed and Hershey was forced to abandon its European export strategy for peanut butter cups.

The story presented above was related to me by a man who recently retired from a large U.S. food processing company. Gary[1] had spent the last 28 years working for this company, starting at the food science laboratory level, then through the years managing myriad projects while holding a number of positions of increasing responsibility. Finally, he rose to the top to become a senior vice president overseeing the yearly investment of hundreds of millions of dollars in the development of new food products around the world. Given his depth and breadth of knowledge in all the facets of the food product development process, Gary is what we would casually refer to as "an expert." Gary is particularly interesting to talk to because when he is asked to work on a problem, he takes a deep breath, stares for a few seconds at the ceiling, a wall or an empty chair, and invariably contextualizes the problem by telling a story about a situation that he or

[1] All personal, company, project, or product names as reported in this study have been disguised as requested to protect identities and other information deemed sensitive by the people and organizations involved.

someone he knows went through in the past. He always reminisces about experiences that shed light on the problem at hand. His solution to the problem is usually intertwined with the "lesson" contained in the brief story. For example, Gary clearly forewarns us about *what not to do* when considering manufacturing products in other countries: that is, solely basing an export strategy on sourcing locally. Gary is a good storyteller, an open book filled with amazing food product development stories of struggle, successes, failures (such as the case above), conflicts, and many other elements. He embodies the knowledge base typically found within companies that have been around for a long time—a sort of corporate "collective wisdom" database. Persons like Gary command our attention because they have "been there, done that," and their stories more often than not have a lasting impression on our memories.

This study is about the stories[2] that experts like Gary love to share when engaged in problem solving. It is also about the influence these stories have on the problem-solving ability of other people very much *unlike* Gary; they are much younger, are still fulltime students, have less than one year or two of food product development experience in the business world, are in their early 20's, and rely primarily on "school knowledge" when wrestling with food product development problems. They are what we typically refer to as "novices." In addition, this study deals with another type of novice, those that are presently gaining work experience as full-time employees in the U.S. food industry, and who are facing complex problem-solving situations on a day-to-day basis. For these novices, it is expected that "school knowledge" is still fresh in their minds as they struggle to gain expertise by continuing to "learn the ropes" in their work context. For this study, the term *novice learner* will be used for the former type of novice (full-time students)

[2] For this study, please refer to Appendix A for a definition of the following terms: **story**, **experience**, **case**, **Case Library**, **task environment**, **personal Case Library**, **expert**, **novice learner**, and **novice practitioner**.

and *novice practitioner* for the latter type (formerly undergraduate students and just recently full-time employees).

Novices nowadays must face a workplace filled with complex problem-solving situations. For a professional to be successful, he must learn to deal with unique situations that were not part of her past academic preparation. Some researchers warn that schools are not preparing professionals with the necessary expertise to deal with these problems (Lave, 1988; Schön, 1993). For too long learners have been prepared in schools to deal with exercises and problems that are decontextualized and removed from reality (Lave, 1988). However, acquiring appropriate problem-solving skills is critical for novices since, in general, employers place high value on experts like Gary who can solve complex problems. After all, employees in the workplace are paid to solve problems and to think; they are not paid to memorize or recall random facts about general subject matter. For these reasons, problem solving is considered to be the most important goal of formal education (Gagné, 1980).

Teaching problem-solving skills is not a straightforward proposition due to its inherent complexity (Jonassen, 1997). Yet industry employers expect recent graduates to possess these skills. Moreover, problems in industry are all ill structured (Schön, 1993), that is, problems do not have a single solution, are open-ended, are composed of many sub-problems, frequently have many possible solutions paths, and possess no clear beginning or end (Jonassen, 1997; Kolodner, Hmelo & Narayanan, 1996; Sinnott, 1989). By contrast, well-structured problems usually have a correct and convergent answer or solution, well-constrained parameters involving a limited number of rules and concepts, and have a knowable process for arriving at a preferred solution; these are the "canned" problems typically found at the end of textbook chapters (Jonassen, 1997). Again, teaching ill-structured problem solving, difficult as it seems, becomes critical at

the undergraduate level since we would expect that these skills will be the primary resource novice learners will depend on as they make the transition from novice learners to novice practitioners once they leave school.

Many researchers have proposed approaches for teaching ill-structured problem-solving skills in schools. Presenting problem-solving stories as cases—similar to the one shown above—and systematically building up a library of such cases[3] is claimed to be a viable strategy holding great promise for supporting problem-solving skill development in novices (Collins, 1991; Ferguson et al., 1991; Jonassen, 1997; Kass et al., 1993/1994; Kolodner, 1993; Kolodner et al., 1996; Schank, 1990; Schank et al.,1993; Schank, 1999). We are able to learn from stories because they depict human experience in forms that are meaningful (Polkinghorne, 1988). Through the process of sharing stories, we negotiate meanings (Bruner, 1990; Lodge, 1990; Witherell, 1995), learn to explicate (Bruner, 1990), to interpret (Gudmundsdottir, 1995), as well as to construct persuasive arguments (Bruner, 1990). Furthermore, stories allow us to articulate our identity and appreciate different perspectives (Jackson, 1995; McEwan & Egan, 1995). Most importantly, stories have been found to be critical for solving problems in the workplace (Lave & Wenger, 1991; Orr, 1996; Schön, 1993).

Case Libraries can play an important role in promoting problem-solving skills. As novice learners come in contact with the experiences of experts through a Case Library, it is expected that they will be in a better position to predict the consequences of actions, provide solutions to problems, reflect on the lessons learned by other experts or people who have had experiences relevant to the problem at hand, avoid pitfalls from faulty thinking, and, overall, better assess the complexity of a situation and identify the important issues of a problem (Kolodner, 1997). By

[3] From here on referred to as a "Case Library."

being exposed to many cases depicting experts' perspectives arising from a complex situation—divergent views on a problem and its solution, conflicting goals among stakeholders, etc.—novice learners' cognitive flexibility will be supported, thus developing more sophisticated thinking strategies that can be put to work in real-world complex problems (Spiro et al., 1992). It is expected that a Case Library will help novice learners expand their personal Case Library and thus expand their repertoire of experiences necessary to eventually become expert problem solvers (Kolodner, 1993). After novice learners are familiar with a number of stories related to the problem at hand it is expected they will better analyze the causes of *their* ill-structured problem and identify situational constraints (Jonassen, 1997).

Supporters of Case Libraries propose that humans learn through indirect experience with stories by generating indexes based on the stories and related situational features, committing those stories as cases into memory (into a personal Case Library). This learning is subsequently applied by recalling and successfully adapting already existing cases to new problem situations and committing the new situation into memory with new indexes (Kolodner, 1993; Schank, 1999).

This study will focus on the role that stories and Case Libraries may play on ill-structured problem solving. In general, it is expected that a Case Library will support ill-structured problem solving by making novices more sophisticated thinkers (thinking more like experts do), and this should translate into the kinds of decisions they make while problem solving when working on ill-structured problems. Specifically, this study is relying on the assumption that when a novice learner is wrestling with an ill-structured problem, if he is shown a number of stories that highlight the complexity of the issues he is currently wrestling with, he will be motivated to read or listen and interpret the story, reflect on its outcome, apply its lessons to the

issue at hand, and commit this story as a case into his personal Case Library. Finally, when asked to do so, he will be able to apply this story and its lesson to future problem-solving situations.

In summary, problem-solving skills are one of the most distinctive elements separating experts from novices (Simon & Simon, 1978). For that reason, these skills are the most sought after in the workplace. It is imperative that universities explore innovative ways to provide novice learners with the necessary school experiences that will enable them to solve ill-structured problems before they enter the workforce. Exposing novice learners to the problem-solving experiences that experts have gone through is being proposed by many as an option to be considered for this purpose. Systematically eliciting, compiling and making available to novice learners these stories in a Case Library while they are problem solving promises to produce a positive impact on problem-solving skills. In addition, understanding the process of how novice practitioners apply stories in their work settings as they wrestle with ill-structured problems can throw light on this skill acquisition process.

Previous studies have shown that the use of stories in problem-solving education increases problem-solving skills, helps address misconceptions, and contributes to the changing of attitudes (Brown, 1992; Kearny & De Young, 1995). But these studies were either primarily concerned with well-structured forms of problem solving (e.g., physics problems) or concerned with attitudinal change (e.g., whether or not to carpool as a way to help the environment). Other research related to cases or stories (Edelson, 1993, Kass et al., 1993/1994; Schank et al., 1993) has been primarily concerned with interface issues or complex learning environments such as Goal-Based Scenarios (Schank, et al., 1993), not effectively isolating the potential effect that stories may have on learning and instead concentrating on affective matters. On the other hand,

research on the application of cases or stories to problem solving in a work setting, although unquestionably showing their importance, has been exploratory and has not led to attempts to systematically apply research results into a school setting (Klein & Calderwood, 1988; Kopeikina et al., 1988; Orr, 1996; Ross, 1986, 1989; Schön, 1993). Although the case-based reasoning literature abounds with research on case libraries (Kolodner, 1993), this research has been strong on content and development but weak on systematic evaluation, particularly as it pertains to a school setting. There are no studies showing whether novices being exposed to a collection of experts' stories while problem solving—that is, having controlled access to a Case Library—will demonstrate increased problem-solving skills when working within an ill-structured problem-solving environment. What's more, there are no studies that corroborate the explanations currently being put forth regarding the process that ensues when novices attempt to solve ill-structured problems while having access to a Case Library.

Considering the state of research regarding problem solving and the role that stories and storytelling play in the process, a study that simultaneously inquires into learning effects and processes—in school and in the work place—has the potential for impacting the design of Case Libraries and their incorporation into instruction. Considering the dearth of studies conducted with this purpose in mind, systematic inquiry and exploration in this area is warranted.

Purpose of Research

The purpose of this mixed-model design study—quantitative (control/comparable/experimental group design) and qualitative (Grounded Theory tradition)—is to demonstrate the effectiveness of, explore the meaning learners construe from, and potentially lay a basic foundation for the development of a theory or model of the learning process when novice learners read or are exposed to experts' stories related to ill-structured problem solving in a particular domain. The main goal of the quantitative approach will be to determine the effect that experts' stories have on novices' problem-solving skills. The main goal of the qualitative approach will be to explore the possibility of "discovering paradoxes, contradictions, fresh perspectives" (Tashakkori & Teddlie, 1998, p. 43) in the claims currently being made on how and why novices learn from experts' stories.

This study is an attempt to understand truly the problem-solving learning processes behind stories and Case Libraries. By capturing and presenting stories based on expert problem-solvers' experiences as they worked on problems similar in context to the problem that a novice learner is currently wrestling with, it is expected that through careful analysis of data qualitatively collected from the novice learners, the nature of the influence that they experience while problem solving should be revealed. In addition, by closely examining novice practitioners' activities as they problem solve during a typical daily work experience, it is expected that the role of stories and storytelling may emerge (if at all) within a highly situated and out-of-school context.

In summary, this study should provide insights into the novices' meaning-making process in situations that require problem-solving skills they may not possess, but which a Case Library can support. This study will attempt to measure quantitatively the effect these stories have on novice learners' problem-solving skills. Furthermore, this study will attempt to find out how prevalent

is the use of stories in a work setting, the role of context during the moments they are used, and the level of importance associated to storytelling when practitioners work on ill-structured problems.

Potential Significance

In general, the present study attempts to add to the understanding and ongoing discussion of the phenomena of supporting ill-structured problem-solving skills through experts' stories which has been amply explored in the disciplines of computer science and educational psychology (Bruner, 1990) but whose impact has hardly been studied from an instructional design perspective. More specifically, by attempting to generate a theoretical framework or model, this study could challenge or support the numerous claims that have been made about the usefulness of experts' stories in learning primarily stemming from the literature on goal-based scenarios (Schank & Cleary, 1995; Schank, Fano, Jona & Bell, 1993) and case-based reasoning (Kolodner, 1993; Kolodner, Hmelo & Narayanan, 1996). This study could provide qualitative support to better understand these claims by reexamining the cognitive processes, or it could provide grounds for pursuing alternative forms of explanation.

In addition, after conducting the appropriate quantitative analysis on some of the data results that show statistical significance, evidence will be provided in support of the claim that a Case Library can increase novice learners' problem-solving skills through the use of experts' stories. In so doing, the present study can empower instructional designers and educators in general to make recommendations on the design of innovative instructional materials and methods that could have a positive impact on learning in knowledge domains that are by nature ill structured.

Research Questions

Answers to the following questions are sought:

1. Would a Case Library have any effect on the problem-solving skills of undergraduates (junior/seniors) specializing in some aspect of the food product development process when working on ill-structured food product development problems? This aspect of the study will be geared toward testing the following hypothesis:

   A group of junior/senior food product marketing/retail students (novice learners), who had access to a number of stories contained in a Case Library, will

   - obtain higher scores on a multiple-choice test that assesses high-order cognitive skills than comparable and control groups which will not have access to the Case Library;
   - obtain higher scores on a short-answer test that assesses various problem-solving skill components as they provide arguments in response to the issues and problems faced on given situations that are more reasonable, persuasive, realistic and feasible than comparable and control groups, which will not have access to the Case Library.

2. How do novice learners and novice practitioners obtain meaning from experts' stories when problem solving? How is the pedagogical value of these stories developed by the novices? What is the role of context in school or workplace for this meaning-making experience to occur?

3. What process is at work when novices listen to, read, recall, or use experts' stories while problem solving? Specifically,
    - What is the novices' thinking and meaning-making process as they progress through the following sequence of events:
        - The moment a novice learner comes in contact with a problem situation in school or a novice practitioner wrestles with an ongoing problem at work?
        - When a novice learner reads a story from a Case Library or a novice practitioner listens to a story that contributes to an ongoing problem-solving situation?
        - Right after they have experienced the stories?
        - Right after they attempt to make decisions regarding a related problem situation?
        - Sometime later (say weeks, months, years), when they are confronted with a new problem situation and are required to work on a new set of problems?
        - Right after they provide decisions regarding this new set of problems?
    - How do novices incorporate the lessons to be learned from the stories in a new problem situation?
    - What are the overarching themes emerging from the novices' introspection regarding the impact the stories have had on their learning and meaning-making processes?

CHAPTER 2

REVIEW OF RELATED LITERATURE

When we talk about stories and storytelling, thoughts of gossip, jokes, horror stories, and similar ideas come to mind. In reality, much has been written, particularly in the past two decades, which has instated (or should we say reinstated?) stories as a powerful means of acculturation, thinking, meaning making, interpretation, explanation, identity building, and human development. It is necessary to review this literature to understand the interest generated in the past two decades in narrative and the phenomena that some call "a return to narrative . . . an effort, that is, to recover and perhaps retell the narratives that form the basis of a particular disciplinary practice" (McEwan, 1995, p. 167). This review will highlight the importance that many scholars are attributing to stories and storytelling in our personal lives, at work, and in the learning process, in general, and problem solving, in particular. Finally, a specific approach for harnessing the power of stories and storytelling for use in problem solving will be described. This approach will provide the theoretical and instructional design basis for this study.

Stories, Narrative Description and Logical Explication

Narrative has always been a part of humankind. By narrative we mean the "scheme by means of which human beings give meaning to their experience of temporality and personal actions" (Polkinghorne, 1988, p. 11). Cultures have maintained "collections of typical narrative meanings in their myths, fairy tales, histories, and stories" (p. 6). Modern storytelling is simply the continuation and confirmation of this most ancient tradition (Bruner, 1990; White, 1981). We seem to have an innate ability and predisposition—we could even call it an "urge"—to organize and represent our experiences in the form of stories. Thus we seem to feel a need to share stories of our daily or unusual experiences with our children, spouses, friends, coworkers, students, bosses and even with strangers (Jackson, 1995). And we hardly have to think about this since "the typical form of framing experience (and our memory of it) is in narrative form" (Bruner, 1990, p. 56). Some even argue that to be part of a certain culture it is necessary to be connected to the stories that abound in that culture (Bruner, 1990). Culture in this sense is not simply the sharing of stories, myths, fairy tales, and various genres of literature that we study in formal school settings, but also the everyday individual stories and histories we tell each other at the water cooler, during staff meetings, over dinner at home, in a restaurant with an important customer, or even the stories we witness as we watch TV commercials, a favorite sitcom or movie in the comfort of our living rooms. We seem to be surrounded by stories during most of everyday life, and the subject of these stories is life itself.

According to Polkinghorne (1988), narrative is "the primary form by which human experience is made meaningful" (p. 1). For this reason, stories and storytelling play an important role in all societies. The act of narrating stories has many functions:

- it is a method of negotiating and renegotiating meanings (Bruner, 1990; Lodge, 1990; Witherell, 1995) that allows us to enter into others' realms of meaning through the messages they utter in their stories (Polkinghorne, 1988);
- it helps us find our place in a culture (Bruner, 1990; White, 1981);
- it assists us in the sharing of our human diversity (Bruner, 1990);
- it helps us to learn, to conserve memory, or to alter the past (Bruner, 1990);
- it allows us to explicate (Bruner, 1990) and to interpret (Gudmundsdottir, 1995);
- it assists us in understanding human action, intentionality and temporality (Bruner, 1990; Huberman, 1995) by facilitating the understanding of the past events of one's life and the planning of future actions (Polkinghorne, 1988);
- it permits us to remember the unusual (as when we recount a fender bender incident) (Bruner, 1990; Schank, 1999);
- it aids us in the building of persuasive arguments (Bruner, 1990);
- it facilitates the attainment of vicarious experience (Bruner, 1990; Sutton-Smith, 1995) by helping us to distinguish the positive models to emulate from the negative models to avoid (Polkinghorne, 1988), offering us "other eyes through which we might see, other ears with which we might make soundings" (Coles, 1989, p. 159); helping us to cast "ourselves as agents in a struggle and relate our actions to some higher goal [and thus] give meaning to what we do" (McEwan, 1995, p. 169);
- it mediates in the process of articulating our identity so that we can explain to others who we are with a series of interconnected stories (Polkinghorne, 1988; Schafer, 1981);
- and it allows us to embark on the "authentic exploration of experience from a particular perspective" (McEwan & Egan, 1995, p. xii; also Jackson, 1995).

Children seem to have a certain readiness for storytelling from the moment they get started in the process of language acquisition (Bruner, 1990; Polkinghorne, 1988). And this predisposition is invariably reinforced as they are initiated into traditions of storytelling and interpretation. Storytelling, in fact, is considered instrumental in bringing children into a culture as they learn to interpret or construct meaning and negotiate their way into the world of those they love and depend on (Bruner, 1990). This is reinforced as the people around the child prompt, teach and even demand that the child articulate thoughts within the constraints of a certain narrative structure (Bruner, 1990). Children are able to understand and tell stories long before they are able to articulate any logical propositions. In fact, children understand logical propositions better when they are "couched" in story form (Bruner, 1990). Furthermore, some even argue that "the capacity to narrate is a condition of learning the more developed forms of thought and writing" (McEwan & Egan, 1995, p. xi). By contrast, depriving children of stories is equivalent to shutting them away from their actions and their worlds (Gudmundsdottir, 1995).

Considering that narrative is so ubiquitous (Bruner, 1990), we must ask the following question: why is narrative not the dominant form—even further not even considered a *legitimate* form—of teaching and learning along with logical exposition? As Polkinghorne states (1988), "despite its centrality for human affairs and cognition, the role of the narrative scheme has only recently come under study in cognitive science" (p. 9). Bruner (1986) proposes an explanation:

> There are two modes of cognitive functioning, two modes of thought, each providing distinctive ways of ordering experience, of constructing reality. The two (though complementary) are irreducible to one another . . . Each of the ways of knowing, moreover, has operating principles of its own and its own criteria of well-formedness. They differ radically in their procedures for verification (p. 11).

He states that these two modes of cognitive functioning are the logical explication ("a well-formed argument") and the narrative description ("a good story"), both requiring, for certain situations even demanding, different forms of articulation (p. 11). A logical explication convinces by producing procedures for establishing formal and empirical proofs, whereas the narrative description convinces through verisimilitude (Bruner, 1986). Education, however, has been traditionally dominated by the desire to appear "scientific" in its discourse within and outside the discipline by opting for the former and not the latter, proceeding to develop its discourse in the most rigorous logical form.

Bruner (1990) argues that despite the dominance of the logical form of exposition in academic disciplines, it is the narrative form of explanation that "jpf's", that is, "just plain folks" (Lave, 1988, p. 191), use in their day-to-day negotiations of meaning. Being that narrative is so infused with the stuff of humanity—from humans, to humans, about humans—it seems to convey its message in an inherently human dimension, a dimension that is inexorably lost in a logical exposition (Coles, 1989; McEwan & Egan, 1995; Polkinghorne, 1988). Bruner (1986) and Huberman (1995) argue that in spite of these two forms of explanation appearing to be very different, they are actually closely intertwined. Both scholars seem to insist that all discourse, scientific as well as everyday, is impoverished if either form of explanation is excluded.

Rather than being occupied with the elaboration of methodical scientific explanations, the narrative form has been almost exclusively applied to the more rudimentary task of explaining human actions and events as they affect human beings (Polkinghorne, 1988). However, we are reminded that scientific explanations—what Polkinghorne calls "the paradigmatic mode"—search for universal truth conditions, whereas the narrative mode looks for particular connections between events (p. 17). The discourse of natural science is a case in point. The power of the

logico-mathematic reasoning employed in the natural sciences is directed toward generating abstractions, categorizing, and decontextualizing the phenomena under study (Bruner, 1990; Polkinghorne, 1988). Time and context become irrelevant in this form of explanation. On the other hand, narrative description is infused with contextual elements, driven by time sequences and directed to form "an expression of global meaningfulness" (Polkinghorne, 1988, p. 34). The former is concerned with extrinsic references, the latter with the storyteller's experience of unity. Because of this Polkinghorne (1988) argues that logical exposition, as it is used in formal scientific discourse, and narrative description "each communicates a different kind of truth" (p. 36).

Given these profound differences, compounded by the inexorable pace and success of the natural sciences in explaining phenomena since the inception of modern science, narrative description gradually took the back seat to logical exposition and scientific explanations in academic discourse (Bruner, 1990; Polkinghorne, 1988) albeit with some notable exceptions (e.g., history, anthropology and qualitative sociology). Narrative slowly acquired a quality of "entertainment value" (McEwan & Egan, 1995, p. xii) and was thus not seriously considered as an alternative—certainly not an equal—form of explanation in most social disciplines. In the natural sciences, narrative was not considered a form of explanation at all. Narrative was considered to be "simply too elementary a form of discourse even to pretend to satisfy the requirements for scientific deductive-nomological explanation" (Polkinghorne, 1988, p. 45). In addition, since narrative expression is highly dependent on context and voice, traditionally it has been suppressed in scholarly writing in an attempt to meet "the scientific ideal that identifies objectivity with the scientist's detachment from the object of study" (McEwan, 1995, p. 167).

However, as mentioned earlier, there has been a recent movement to reinstate narrative in a more important role at least within the social disciplines. This has come about as a result of a move within the social disciplines in recent years away from objectivism, which has traditionally been behind the thrust to emulate the natural sciences in their rigorously rational exploration of social phenomena. Starting with debates on history in the 1960's, literary criticism in the 1970's, and psychology in the 1980's (Polkinghorne, 1988), this move has brought most social disciplines—such as cognitive psychology, linguistics, philosophy, literary theory, education, humanities, anthropology, history, and others—to revisit or accept interpretative approaches of research as legitimate means of understanding (Bruner, 1990). This in part explains the enormous interest that now exists in narratology (Huberman, 1995). Rather than finding scientific and rigorously rational explanations of phenomena, the new concern of these disciplines now seems to be with "meaning-making" (Bruner, 1990, p.2). With renewed interest in finding ways to explain how people—particularly jpf's—construct and negotiate meaning in a community, these disciplines are concentrating on the role that language plays in the process of creation and negotiation of meaning, and the role that narrative plays in this process. According to Polkinghorne (1988), only narrative can play this important role because it "functions to organize elements of awareness into meaningful episodes" (p. 1). Some observers have characterized this movement toward interpretation and narrative as nothing less than "a revolution" (Bruner, 1990, p. 33).

However, despite this movement to "return to narrative," there is much reason to agree with Egan (1995) when she says that "there seems to be some lag between acceptance of a significant narrative component in our mental lives, and elaboration of ideas about learning which clearly reflect that narrative component" (p. 116). This is particularly telling in formal education where

narrative can be a natural ally, but where it has not yet been allowed to exploit its potential and, as eloquently stated by McEwan & Egan (1995), “where a pervasive nonnarrative and behaviorist chill has prevailed” (p. xii). As Paley (1995) is quick to remind us, “Storytelling, hard work that it may be, seems too much like play” (p. 92).

In the next section we will see that despite having being ignored and misunderstood for so long, narrative has been found to play a critical role in the workplace—and not just for teaching and learning.

Stories in the Workplace

While we may expect that any practitioner will be able to provide logical answers to any inquiries regarding what they do in their jobs, Polkinghorne (1988) found in his research that practitioners primarily prefer to work with narrative knowledge when asked to provide explanations. They seem to be most concerned with people's stories: "they work with case histories and use narrative explanations to understand why the people they work with behave the way they do" (p. x). In this environment where storytelling figures prominently, an invisible structure is built that imparts organizational unity, continuity and meaning in the form of organizational myths, stories, sagas, and legends (Polkinghorne, 1988). Polkinghorne found that this "group narrative" (p. 122) serves many aims in the organization: to interpret and signify the purpose of the organization and the role of its individual members, to provide information about norms and values, to reduce tension (as with jokes), to conceal power plays, to mediate contradictions between theory and practice and between group and individual needs, and to build bridges between the past and the present. To sum up, narrative contributes to establishing the organization's basic theme or identity.

Schön's (1993) research reveals that the subjects he studied—architects, engineers and psychotherapists—most often encoded their experiences in narrative form by using case histories and narrative explanations. This was particularly true of psychotherapists whose work primarily involves people. These practitioners offered stories to explain and justify their thinking and actions drawing from "a *repertoire* of examples, images, understandings, and actions" (p. 138, emphasis in the original). The world of these practitioners revolves around a "virtual world of talk" in which "storytelling represents and substitutes for firsthand experience" (p. 160). Furthermore, Schön found that intuitive understanding with these practitioners was supported not

so much by technical and logical expositions as they were by "their repertoire of familiar examples and themes" (p. 166) as articulated in "stories of past experience which served as exemplars for future action" (p. 242).

Henning (1996), in conducting his ethnographic study of refrigeration service technicians, found that stories served as a mechanism for promoting an ongoing discourse between technician, machines, products and people. Stories afforded technicians a means to form and express their identity as technicians and to assist others in their initiation. By being able to tell stories to their coworkers, technicians, particularly the newer ones, were able to form and strengthen the bonds that give cohesiveness to their community of practice (p. 162). Technicians shared stories about initiation (p. 140), identity formation (p. 160), their sense of pride (p. 141), and in general about the drama of facing responsibility and unusual and difficult situations (pp. 141-2). These stories reinforced the technician's identity, which contributed to their further participation in the community they were continuously building.

Orr (1996) found in his research with photocopy technicians that "narrative forms a primary element of this practice" (p. 2). He found that diagnosis happens through a narrative process, it formed the basis of the technician's discourse, and it provided "the means for the social distribution of experiential knowledge through community interaction" (p. 2). Contrary to common beliefs, their stories were not so much meant to amuse as they were meant to enlighten. Like Henning (1996), Orr (1996) found that "stories also celebrate the technicians' mastery of the complex and sometimes obscure interaction between technicians, customers, and machines" (p. 5-6). He found that stories served the purpose of making sense "of their [the technician's] world and the process of making that sense" (p. 13). Through stories technicians reinforced their identity and the roles they played in their world; projected their careers into the future; shared

work practices, values and models of behavior; and shared friendship and certainly some needed laughs. Most importantly, Orr found, as did Schön (1993), that these practitioners employed storytelling for framing and dealing with problems. Narrative was used for explaining "catastrophes" (p. 98); for understanding, explaining and arriving at diagnoses; for teaching and learning new methods; for dealing with uncertainty; for changing perspectives on problems; for warning about failures; for providing solutions; for expanding the problem space; for finding causes to problems; for illustrating a point; for challenging a fellow technician; for building confidence as problem solvers; and for anticipating future problems (Orr, 1996). To sum up, for these photocopy technicians stories are an important source of information that serves as the "community memory of the technicians, in which they preserve and circulate their hard-won knowledge of machine arcane, usually in the form of war stories" (p. 117). When called out on a difficult problem, a technician was invariably expected to bring good recollections to bear to the problem situation by producing a good diagnostic story. A good memory of stories of this sort would make a technician "a popular resource" (p. 117).

Like Henning (1996) and Orr (1996), Lave & Wenger (1991) found stories to be critical for initiating new members into a practice. While studying apprentices in their work setting, they found that "apprenticeship learning is supported by conversations and stories about problematic and especially difficult cases" (p. 108). In these settings, stories are used as "communal forms of memory and reflection" (p. 109).

To summarize, these studies show that the narrative form enables the construction of an identity by allowing practitioners to "construe what they are and where they are headed," giving cohesion to shared beliefs and transmitting values (Polkinghorne, 1988, p. 14). A set of well-known stories creates a "sense of being part of a community" (Jackson, 1995, p. 5), a culture

knowledgeable and practiced in the use of “accumulated and shared meanings” (Gudmundsdottir, 1995, p. 27). The narrative dialogue of reflection and interpretation sustained by these practitioners is how “experience is transformed into pedagogical content knowledge” (p. 30). It is what allows “us to understand the world in new ways and help us to communicate new ideas to others . . . in order to give . . . experiences meaning” (p. 34). It is how we extend or restructure “the stock of knowledge which will be available for future inquiry” (Schön, 1993, p. 242).

Having reviewed how stories play such an important role in the workplace in general, now we turn to the next section where we will review how stories play an important role in learning and problem-solving specifically.

Stories, Learning and Problem Solving

In this section, we will see that many scholars agree that one solution for developing professionals equipped to deal with the complexity of workplace situations—that is, to deal with ill-structured problems—is to expose them to stories generated at the workplace itself. One way to do this is by exposing them to narratives or stories or cases that have been compiled into a Case Library.

Schön (1993) forewarns us that practitioners must face a workplace filled with "complexity, uncertainty, instability, uniqueness, and value conflict" (p. 18). The workplace is perpetually overflowing with "situations of practice [that] are inherently unstable" (p. 15) and "are characterized by unique events" (p. 16). In professional practice, situations abound with indeterminacy and value conflict, with conflicting views, in the midst of which the successful practitioner must be able to "choose among multiple approaches to practice or devise his own way of combining them" (p. 17).

To complicate matters further, formal schooling is not providing the appropriate support to these practitioners. The skills and techniques of traditional expertise, particularly as they are being taught nowadays, seem hardly to be a match for the complexity found in the fields of medicine, management, engineering and many other professions. Lave (1988) forewarns us that novices in school are only trained to work on problems that are by nature decontextualized and well-structured while problems in life outside of school are always remarkably complex, requiring inventive ways for restructuring resources in what she calls "gap-closing, sense-making processes" (p. 176). In other words, all real-life problems are ill structured. As mentioned earlier, well-structured problems usually have a correct and convergent answer or solution, well-constrained parameters involving a limited number of rules and concepts, and have a knowable

process for arriving at a preferred solution; these are the problems similar to the exercises and problems typically found at the end of textbook chapters (Jonassen, 1997). On the other hand, ill-structured problems by nature do not have a single solution, are open-ended, are composed of many sub-problems, frequently have many possible solutions paths, and possess no clear beginning or end (Jonassen, 1997; Kolodner, Hmelo & Narayanan, 1996; Sinnott, 1989).

Schön (1993) recommends conducting a "carefully guided analysis of innumerable cases drawn from real-world business contexts in order to help students develop the generic problem-solving skills essential to effective management" (p. 30). More specifically, he states, "Seeing *this* situation as *that* one, one may also *do* in this situation *as* in that one" (p. 139, emphasis in the original). It is expected that "the inquirer may reflect on the similarities and differences he has perceived or enacted. He may do this by consciously comparing the two situations [that is, the problem situation and the given case or story], or by describing *this* situation in the light of a tacit reference to the other" (p. 139, emphasis in the original). By being exposed to numerous cases or stories while wrestling with a problem situation, the practitioner will be expected to reflect-in-action, that is, "on-the-spot surfacing, criticizing, restructuring, and testing of intuitive understandings of experienced phenomena . . . [engaging in] . . . a reflective conversation with the situation" (p. 241). These cases may be generalized to other cases "not by giving rise to general principles, but by contributing to the practitioner's repertoire of exemplary themes from which, in the subsequent cases of his practice, he may compose new variations" (p. 140). Lave and Wegner (1991) found this to be precisely the case in their research, where "apprenticeship learning is supported by conversations and stories about problematic and especially difficult cases" (p. 108). For these reasons, Schön (1993) urges educators and trainers to engage in what

he calls “repertoire-building research” (p. 315), that is, accumulating and describing such exemplars—cases or stories—in ways useful to reflection-in-action for all professions.

Schank (1990, 1999), one of the early proponents of using stories for promoting problem-solving skills, believes that relating and listening to stories is an important element in learning. Likewise, Bruner (1990), Randall (1999) and Polkinghorne (1988) also argue that since the sharing of stories through our lives is so important, we must possess some kind of “narrative intelligence” that allows us to formulate or follow a story (Polkinghorne, 1988, p. 51; Randall, 1999, p. 13). They all recognize stories as being part of our cognitive system for thinking, explaining, understanding, remembering and memorizing.

Furthermore, others go as far as hypothesizing that by acquiring an experience indirectly, by listening to and understanding a story of what other people went through while performing a task, is tantamount to going through the experience oneself (Ferguson et al., 1991). In other words, the memory structures used for understanding the story are the same as those used to carry out the task. Stated in other words, “Acting [that is, just doing what we do in day-to-day life] is like writing a story, and the understanding of [our or someone else’s] action is like arriving at an interpretation of a story” (Polkinghorne, 1988, p. 142). Therefore, presenting the experiences of expert problem solvers in any field to novice problem solvers in that field can prove to be beneficial to the novices (Ferguson et al., 1991). It follows that making a Case Library composed of experts’ experiences available to novices while they problem solve can have the effect of making them better problem solvers.

Additional support for the idea that novices can become better problem solvers through stories also finds support in the case-based reasoning (CBR) literature. CBR is primarily founded on the assumption that cases and examples are as useful for supporting problem solving

through analogical reasoning by focusing the novice's attention on what is important, making available ideas on how to move forward, and giving grounds for pre-assessing the consequences of their decisions or actions (Kolodner, 1997). Given the lack of previous experiences by novices, experiences available through a Case Library are expected to augment their repertoire of experiences by connecting with those of others (experts). Since CBR focuses on prior experiences (ours and others'), these prior experiences serve as a basis for interpreting a future situation, forewarning us of potential problems, realizing what to avoid, and foreseeing the consequences of decisions or actions. It is suggested that this kind of reasoning—that is, reasoning from stories or cases—provides support to "inferences necessary for addressing the kinds of ill-defined or complex problems that come our way in the workplace, at school, and at home" (Kolodner, 1997, p. 58). As stated by Bruner (1990), cognitive science made great contributions to our understanding of how information is moved about and processed. These explanation efforts, particularly those associated with Artificial Intelligence (AI), in general, and natural language processing, in particular, fueled substantial discussions on the description of the process of learning with stories and cases. Upon these discussions is that the CBR literature rests. This merits a detailed examination of the CBR perspective on learning and related assumptions in the next section.

Jonassen (1997) proposes that instructional materials geared toward supporting ill-structured problem-solving skills should incorporate "cases that represent probable real-world problems in the domain, that is, that are authentic. The obvious source of these cases is practitioners who can be interviewed" (p. 84). Schank et al (1993) propose that learning environments (specifically Goal-Based Scenarios) promoting problem solving ought to have cases as a "means by which the nature, applicability, and consequences of skills are conveyed to the student" (p. 48). Collins

(1991) proposes that learning environments (specifically those that follow cognitive apprenticeship prescriptions) ought to have ways to incorporate demonstrations on how experts solve problems. He laments that in textbooks students only see worked-out solutions that do not show the false starts or dead ends that characterize real-world problem solving. Furthermore he states that by having an expert reflect on how he solves problems, learners can benefit greatly by "seeing" this otherwise covert problem-solving process at work. Kolodner et al. (1996) propose that one of the most effective ways to build learning environments (specifically with Case-Based learning aids) with support for novices on their design problems is by allowing novices to peruse the experiences of experts as they in the past worked on similar problems. Kolodner et al. see cases or experiences of others as contributing to reasoning about new situations as contained in a Case Library. Similarly, Kass et al. (1993/1994) propose that "for teaching ill-defined skills . . . in which hard-and-fast principles are lacking and heuristic rules of thumb must be relied on, the best form of guidance is to expose students to the real-world experiences of experts. Through real-world experiences, students can see how heuristics are applied in context" (p. 388).

Having laid out thus far the teaching and learning potential attributed to stories in the cognitive domain, let us sum up some of the major reasons these scholars suggest that exposing novices to stories will promote problem-solving skills:

- stories embody the language of diagnosis and its processes (Orr, 1996, p. 104);
- stories are one of the principal human gifts for presenting, dramatizing, and explicating conflicts (Bruner, 1990, p. 95);
- because they are being based on personal experience, stories have the advantage of credibility (Orr, 1996, p. 127);
- stories are the most natural form for sharing work experience (Orr, 1996, p. 140);

- stories are packages of situated knowledge (Lave & Wenger, 1991, p. 108);
- the narrative form and storytelling allow us to construct imaginative "what if" scenarios (Polkinghorne, 1988, p. 14);
- stories are embodied in a structure most natural for committing experiences to memory for "longer than a few hours" (Coles, 1989, p. 189);
- stories draw together into a whole interpretative "package" the laws, personal dispositions, questions of character, actions, and processes used when deliberating prior to reaching decisions (Polkinghorne, 1988, p. 19) by showing "the interconnectedness and significance of seemingly random activities" (p. 36).

And finally,

- with stories, problem situations do not appear to us "as impersonal and unhinged as the math and social studies workbooks" (Paley, 1995, p. 94).

With these in mind, the following are the problem-solving behaviors that I believe a collection of stories in a Case Library would contribute most positively to novices' problem-solving skills in a learning environment:

1. Determine the source of the problem
2. Provide solutions
3. Provide explanations (for successes, failures, and unexpected outcomes)
4. Draw conclusions from experts' experiences
5. Predict the result of actions in given situations
6. Make inferences
7. Generate implications
8. Identify alternative actions

9. Articulate an argument in favor of a decision
10. State hypotheses
11. Given a design problem, propose a design that partially or wholly addresses that problem.

If it is true, as White (1981) says, that "narrative might well be considered a solution to a problem of general human concern, namely, the problem of how to translate *knowing* into *telling*, the problem of fashioning human experience into a form assimilable to structures of meaning" (p. 1, emphasis in the original), the most natural quest now should be to find the methods for delivering on the promise of narrative. The next section will attempt to do just that.

Case-Based Reasoning, Stories and Learning

As mentioned in the previous section, CBR depends on analogical problem solving for its effectiveness. "Analogical problem solving consists of transferring knowledge from past problem-solving episodes to new problems that share significant aspects with corresponding past experience and using the transferred knowledge to construct solutions to the new problem" (as cited by Reimann & Schult, 1996, p. 123). This capacity to see analogies in problem solving is considered basic to human communication and language (Polkinghorne, 1988). Through analogy, "The familiar situation functions as precedent, or a metaphor . . . and exemplar for the unfamiliar one" (Schön, 1993, p. 138). "It is our capacity to see unfamiliar situations as familiar ones, and to do in the former as we have done in the latter, that enables us to bring our past experience to bear on the unique case" (p. 140). Prior experience is expected to help us with a new puzzling problem, making CBR possible by prompting us to "model" (p. 186) what we *do not* know onto what we *do* know.

There is some reason to believe that people will naturally reason using "analogs," or cases, when solving problems, particularly when facing uncertain situations (Kolodner, 1993, 1997). Since analogical reasoning is a natural method people use to solve problems in the world, it follows that CBR too should be a natural way of solving problems in context (Kolodner, 1997). By assuming that real-world examples are stored in memory as cases (Kolodner, 1993), it would be expected that a Case Library will stimulate analogical reasoning processes by serving as the repository of experts' real-world problem-solving skills made available to others for enhancing their problem-solving skills. Because of this obvious connection with analogical reasoning, important CBR developments in the 1980's motivated much research in this area (Kolodner, 1997).

Besides the evidence for the use of cases in the form of stories found by Schön (1993) and Orr (1996) as discussed earlier, Brown (1992) and Kearny & De Young (1995) found that stories increase problem-solving skills, help address misconceptions, and contribute to the changing of attitudes. In addition, Klein & Calderwood (1988) found that experts they studied relied more heavily on cases based on past experience than on abstract principles when making decisions with a high degree of uncertainty. Ross (1986, 1989) found that people learning a new skill will naturally use what they have learned in a previous problem and apply it to a new problem. Lancaster & Kolodner (1988) found that car mechanics frequently use their experiences and those of others when wrestling with new problems, while Kopeikina et al. (1988) found similar evidence with GTE engineers trouble-shooting phone switching networks. Problem solving with cases seems to be the most natural approach for these problem-solvers when facing uncertainty or some new or particularly difficult problem.

While many analogical problem-solving researchers concentrated on the problem of matching, transfer and other related issues, CBR research broadened its scope by concentrating on exploring the link between memory, reasoning, and learning processes by specifically focusing on encoding, retrieval, and use of analogs, that is, cases, within the same domain (Kolodner, 1997). Though CBR was originally developed as a model for incorporating intelligence into computer systems (Kolodner, 1993), it has provided cognitive psychologists and educators with new perspectives on teaching and learning[4] (Kolodner & Guzdial, 2000). The main idea behind these computers that can solve problems (also known as automated reasoners) is that they will apply, through analogical reasoning, the lessons learned from "past experiences"

[4] It is important to note at this point that because CBR originated from the idea of using stories for teaching *computers* to be better problem solvers (Kolodner & Guzdial, 2000), its explanations about learning, and even its terminology, have been primarily influenced by information processing theory.

to a new problem-solving activity. So equipped, they are primarily employed as aids to human.

It is important to review the main processes at work in an automated reasoner to understand the assumptions commonly being made about how *people* learn from stories. An automated reasoner, also called automated problem solver, is a computer program usually developed by a knowledge engineer that when presented with a problem description will go through the steps of finding a solution frequently asking a human user to make decisions about preferences when it is in doubt. A well-built automated reasoner will ideally have all the necessary "knowledge" to solve problems within a given domain (e.g., designing a menu) as well as the set of steps it must follow to derive solutions. In effect, they "judge" similarities, "adapt" heuristics, "incorporate" common sense and causal knowledge, etc. (Kolodner, 1993). When an automated reasoner is confronted with a problem situation, it looks into the contextual factors to determine the problem's important features. For example, the contextual factors for an automated reasoner concerned with laying out composite airplane parts for curing may be such things as type of material, type of mold, groupings of parts, where in the oven is the table, size of parts, etc. (Kolodner, 1993). Then, in a process analogous to remembering, it builds indexes for searching in its Case Library for cases similar to this situation (see below for an elaboration on indexing). The idea is to retrieve a case that would enable it to propose a "ballpark" solution to the problem (Kolodner, 1992, p. 22). If there are significant differences between the problem situation and the retrieved case—as is often true—the reasoner goes into a process of adapting the retrieved case to the current situation. After proposing the solution based on the adapted case, the reasoner must get feedback from the human user about the adequacy of the solution; if is told that the solution is deemed adequate, then, in a process analogous to committing to memory, it will re-insert the adapted case into its Case Library with new indexes for later reuse. Indexing is the

process " of assigning labels to cases at the time that they are entered into the case library to ensure that they can be retrieved at appropriate times" (Kolodner, 1993, p. 193). Similarly, these indexes are reconstructed at the time the cases are needed thus completing one full indexing circle, that is, indexing to store into memory, and indexing to retrieve from memory. Therefore, learning for an automated reasoner is the process of acquiring stories in two ways: through direct input by the human user, who must appropriately index the stories so that the reasoner can insert (encode) them as cases into its Case Library; and by successfully adapting and re-indexing already existing cases to new situations (Kolodner & Guzdial, 2000; Kolodner, 1992). CBR research has generated a plethora of industrial, educational and experimental systems (see Appendix B). Some of these systems have been used for carrying out additional research into analogical reasoning as well (Kolodner, 1997).

A Case-Based Teaching (CBT[5]) architecture, developed for teaching *humans* through stories, is founded on CBR thinking. It is based on similar assumptions about the ways people learn through stories and experiences, and how they apply those stories and experiences to problem solving. That is, experiences are gained directly as part of the problem-solving activity, or vicariously by listening to other people's stories (Ferguson et al., 1991). One of the critical components of a CBT system is the Case Library, a systematic collection and organization of a number of these experiences that are presented in the form of stories to the learner while interacting with a task environment (Edelson, 1993). This repository of "collective wisdom" is based on experts' problem-solving experiences. (See Appendix C for a representation of the Case Library concept featuring various task environment and access possibilities, and database with related cases.) CBT proponents argue that when confronted with a problem, people will try

[5] Not to be confused with *Computer-Based Training.*

to remember a case in which they faced a similar situation (Schank, 1990, 1999). This remembering process would be analogous to people building indexes allowing them to retrieve a case from their memory (personal Case Library). Once a similar case is found—assuming that there are no cases identically applicable to the situation—they adapt it to the new situation and proceed to propose a solution. If they are told that the solution is adequate, they will re-index the adapted case and commit it to memory (re-index it) as a new story applicable to this particular situation. However, if they are told that the solution is inadequate, people face what is called an expectation failure[6] and are naturally challenged to find an explanation (Edelson, 1993; Read & Cesa, 1990; Schank, 1999). At moments such as these, it is believed that people will be most receptive to learning through listening to or reading stories that show how expert problem solvers have dealt with similar situations (Edelson, 1993; Schank, 1990, 1999). As mentioned earlier, it is argued that the memory structures employed while understanding these stories are the same as those employed if the learner had come up with the solution herself (Ferguson et al., 1991); in other words, understanding would be equivalent to experiencing. Therefore, learning for humans in this context is the process of acquiring indirect experiences through stories by generating indexes based on the stories and situational features, and committing those stories as cases into memory (into the personal Case Library) after experiencing an expectation failure. Furthermore, learning is recalling and successfully adapting already existing cases to new situations, re-indexing them and re-committing them to memory.

In a similar way, we learn from stories by simply speculating about the possible outcomes of a story (Schank, 1999). Unlike an expectation failure, where learning is stimulated by confusion, learning by speculating on outcomes is not based on error but simply on a desire to know more.

[6] An *expectation failure* arises when the learner is expecting his solution to be successful in solving the problem but what he finds is that the solution fails to solve the problem.

This happens naturally because humans are always highly motivated to find out "the rest of the story." Prompted thus by this inherently human motivation, we acquire new stories for our personal Case Library, stories that we can call forth in the future when facing similar dilemmas (Schank, 1999). People's thinking is influenced indirectly, that is without experiencing failure, by simply being in contact with a story that embodies a potential problem-solving lesson. The story will become even more memorable if it includes a powerful "index"—that which makes the story truly memorable—that relates a current situation, prior experience or story with the new story. According to Schank (1999), while hearing or reading a story, the person will concomitantly activate memory of the themes that most closely match the situation being depicted in the story. The situational features of the story will serve as stimuli for remembering another experience or story contained in the personal Case Library through the indexes generated from the evolving story theme and context. Then a similar story—if one exists—will be activated and retrieved. In a conversation, this may stimulate the subsequent recounting of another story starting with the all-too-familiar phrase "That reminds me of the time when . . . " (Read & Cesa, 1990). During problem solving, the retrieved story will stimulate speculations on the outcome of the problem in the story. Once the outcome of the story is known, the person will learn how to react to a future situation with contextual factors similar to those surrounding that story by generalizing from this example and figuring out why the situation turned out the way it did. As Schank (1999) says, while "watching plays this may be of little import, but in real-life situations, knowing how a similar set of circumstances turned out can be extremely significant" (p. 85). This is how a person will "create a new belief or conclusion that will better enable future understanding" (p. 86). This form of learning is referred to by Schank as an outcomes-based approach to learning. That is, it is assumed that the story has the potential for teaching us

something “by clarifying the significance of events that have occurred on the basis of the outcome that has followed” (Polkinghorne, 1988, p. 21).

It follows from the above that when the person who listened to or read a story and later on is forced to deal with a problem with similar contextual elements, he is expected to remember the outcome of the story (or stories) and will be better prepared to face the new challenge. This will allow the person to modify his plans for successfully achieving some goal, be attentive to particular obstacles, articulate problem-solving methods, recognize the merits of different methods, avoid failures, and in general engage in problem-solving behavior that is guided and prompted by the stories he has come in contact with in the past. By presenting the “lesson” to be learned from the story in a logical form, or what from now on will be referred to as a fact sheet, Schank (1999) argues, the lesson will be “difficult to evaluate and difficult to remember, making it virtually useless” (p. 90). He adds, “People who fail to couch what they have to say in memorable stories will have their rules fall on deaf ears despite their best intentions and despite the best intentions of their listeners” (p. 90; also Gudmundsdottir, 1995).

In summary, even though we find that stories do not currently play an important role in education, we also find that stories are important for acculturation, thinking, meaning making, interpretation, explanation, identity building, and human development. In addition, stories abound in the workplace, particularly in teaching and learning problem-solving skills. Learning environments can be supported by stories collected into a Case Library in such a way that learning is promoted through expectation failures (Edelson, 1993), outcomes-based learning (Schank, 1999), or simply as case-based aids (Kolodner & Guzdial, 2000).

The Current Study

Since this study is about promoting ill-structured problem-solving skills where there is not one "correct" solution to any problem, it would be impractical to determine whether the learner will eventually select "correct" solutions to problems. This means that the task environment can never reach the expectation failure stage that would allow it to provide stories. Given this limitation, for this study an outcomes-based approach to learning from stories will be employed. This study is based on the following assumption: If we engage learners in a task environment that is composed of a case (which is itself a long story), provide learners with strategically placed links to numerous stories elaborating on the particular issues being presented in the case, we would expect the learners to obtain from these stories problem-solving skills otherwise not obtainable by merely having access to the case alone or by having access to fact sheets extracted from the stories. When subsequently challenged to work on problems related to the case in the task environment, it is expected that learners will be able to apply what they learn from the stories to the new problems. These stories will feature solutions to problems; warnings as exemplified in failures; application of methods; revelation of unexpected obstacles; and situations where various approaches (methods), solutions or perspectives have to be weighed before arriving at a solution (see Appendix D). It is expected that these stories will promote in learners better skills for providing solutions to problems, planning activities, justifying solutions, making predictions regarding success or failure, anticipating problems, identifying unacceptable solutions, and evaluating multiple solutions, perspectives or methods (Kolodner, 1993). In the next chapter the implementation of these ideas to this study will be described in detail.

CHAPTER 3

DESIGN AND METHODOLOGY

This chapter describes the way this study was planned and conducted. It starts by laying out the rationale for its design. Then it goes into great detail describing such issues as sampling, learning environment used during the study, field entry issues, examples of instruments, data collection procedures and handling, and data organization and processing. It ends with a brief discussion on validity and trustworthiness issues.

Overall Approach and Rationale

Current explanations on how experts' stories support the ill-structured problem-solving skills of novices lack sufficient empirical support and therefore warrant a fresh look simultaneously from the qualitative and quantitative perspectives. This mixed-model design (Tashakkori & Teddlie, 1998) intends to fulfill two purposes:

1. To employ the existing theoretical basis on stories and CBR as presented in the prior chapter to guide the quantitative portion of the study. This theoretical basis will allow me to make specific inferential determinations on the effect of stories on learning within a school context.
2. To employ this same theoretical basis as a *tentative* model to guide the qualitative portion of the study with the objective of proposing refinements to the existing framework as deemed necessary after data collection and analysis through the use of a Grounded Theory tradition (Glaser & Strauss, 1967; Strauss & Corbin, 1990, 1998). Through this analysis, an attempt will be made to find further ground to support the existing theories, modify, or upon finding contradictions discard their explanations within the study's context and present a new perspective or even suggest a new model entirely grounded in the qualitative data emerging from within school *and* work contexts.

This study represents an innovative form of combining and using the strengths of two reputable forms of research (quantitative and qualitative) to demystify the process of learning under these very specific circumstances while demonstrating, as objectively as possible, the effects of a learning intervention using experts' stories contained in a Case Library (see Appendix E for an overview of the extent of the combination). A purely quantitative study oftentimes cannot throw light on the important questions of process and meaning making; it can

measure outcomes (a score on a multiple-choice test or a score on short-answer items graded with a rubric) and support inferences about generalization, but it provides little in the way of in-depth explanation due to its rigidly contrived experimental conditions. A qualitative study provides in-depth explanations but is limited in generalizability (Marshall & Rossman, 1999), and does not provide "objective" means to demonstrate the effectiveness of a learning intervention even for the small number of subjects involved. By combining these two research methods, the aim is to obtain results that will provide support for strong inferences and generalizations as well as in-depth explanations in specific school and workplace contexts.

In addition, using this mixed-model design allows me to cross-check the results through multiple data collection strategies (Tashakkori & Teddlie, 1998): multiple-choice tests, short-answer tests, and closed-ended questionnaires will provide the quantitative support; open-ended examinations will provide a source for document analysis; and field observations and subsequent in-depth interviews will provide vital qualitative support.

General Quantitative and Qualitative Design[7]

For the quantitative part of the study, a learning intervention was designed whereby three groups were set up: control, comparable and experimental (Gall, Borg & Gall, 1996). To achieve statistically sound results, all subjects were randomly assigned to the three groups. The three groups received treatments unique to their experimental situation: control received text selected at random from a textbook dealing with issues unrelated to the stories, comparable received fact sheets condensing the stories' content, and experimental received the experts' stories. These groups were assessed based on how much they benefited from the learning intervention as determined by predefined criteria.

For the qualitative part of the study in the school setting, two novice learners randomly selected from each of the three groups (control, comparable and experimental) were asked to participate in in-depth interviews (for a total of six). A Grounded Theory tradition (Strauss & Corbin, 1998) was employed in support of the construction of a problem-solving model emerging from novice learners in-depth interviews. All novice learners went through the same protocol during the in-depth interview process.

In addition, for the other qualitative part of the study in the work setting, three novice practitioners were interviewed and then video-recorded as they participated in two typical problem-solving sessions in the workplace. Subsequently, they were "de-briefed" during a second in-depth interview. Likewise, by employing a Grounded Theory tradition (Strauss & Corbin, 1998), data were collected on the phenomena of problem solving as it happens in the workplace and *how* stories and storytelling play a role.

[7] See Appendix F for an overall conceptual view of the study.

Population Selection and Study Sequence[8]

Novice Learners and Learning Intervention

For the learning intervention, fifty-one novice learners with junior/senior standing were asked to participate in the study from two sections of an undergraduate food product development course regularly offered at a mid-sized private, Catholic university located in the northeastern part of the U.S. This sample was selected for the following reasons[9]: 1) they all fit within the definition of novice learners as specified in this study (see Appendix A); 2) these novice learners had experience already with the use of cases and the case method, and some experience in providing solutions (orally, in writing, individually, and in groups) to ill-defined food product development problems; and 3) this sample is a fair representation of the undergraduate population who eventually are hired by food companies in sales, marketing, research, food product development, etc., and are most impacted by the study's conclusions and recommendations. Prior to the start of the study, all students were working on an ongoing case entitled "Nestlé Refrigerated Foods: Contadina Pasta & Pizza (A)" (Bell, 1996). This case was used as the task environment for the study.

The two faculty members who taught the two sections that were the object of the study regularly follow a very similar teaching format and method. Both faculty require a semester-long project, perform brief lectures at the beginning of class, constantly stimulate class discussion with probing questions on current events, use similar resources (textbook, marketing/retail databases, and other library resources), and incorporate industry presentations into their courses. Both course syllabi, prior to and through the study period, covered general

[8] See also Appendix G for the study timeline.

[9] Since I previously conducted a pilot study with similar students (Hernández-Serrano, 1999), the faculty already had an idea of what would be required in this study.

topics on new food product development (NPD) such as, NPD issues and forces driving NPD, role and importance of NPD to the firm, classification of NPD, strategic planning for NPD, new product organization, new product failures and successes, the NPD process, internal analysis and category assessment, ideation and concept development, sales volume estimates, research and development, and production and logistics. Most importantly, both had used the Contadina case in this and similar courses. In addition, both faculty co-taught some of these topics. The most important differences between these sections were four-fold: 1) One section met two times a week on Tuesdays, 1:00-1:50 PM, and Wednesdays 1:25-3:15 PM (day section) while the other section met once a week on Wednesdays from 6:15-8:55 PM (evening section); 2) The day section had 31 students while the evening section had 20 students. 3) The professor for the day section required students to work in teams, where the other professor required them to work individually; and 4) Both sections incorporated industry presentations from practitioners, but the day section saw them live and the evening session saw them on video. Due to the parallels between both sections, the decision was made to conduct the study with both instead of just one section. I was present during all the classes in both sections during the course of the study.

To gain the participation and cooperation of the novice learners, I approached them through the two faculty members who assisted me in articulating to them the importance of the study, why their participation was important, how their contribution could further the cause of the study and education, and other issues related to buy-in.

As mentioned earlier, the material needed for the study (the Contadina case) had been used in past courses taught by these two faculty members. This case was placed on the course web site as a portable document file (also known as a "pdf" file, currently a commonly used file format for sharing files across diverse computing systems developed by Adobe Systems Incorporated)

and distributed in hardcopy. This 26-page case (15-page narrative and 11 pages of exhibits) is about how the Nestlé Refrigerated Food Company introduced two refrigerated pasta products into the U.S. market. It provides background information about the company, the product development process as implemented by the company, the state of the refrigerated food business, the Contadina brand and related branding issues, market potential, positioning, manufacturing and distribution, sales, product launch, competition, and product extensions. After consulting with faculty, it was determined that the section "Market Potential" (about 2½ pages long) would best satisfy the objectives of this study since it laid out the largest number of ill-structured problems and issues in the entire case.

For the three-week period during which the study took place (see Appendix G for the timeline), I managed the study's administrative aspects (consent forms, specific questions participants raised, etc.), managed the website where the study materials were published, collected data, and in general, ensured a smooth study execution. The faculty members' role was primarily motivating novice learner's participation, making time available for the study activities, as well as carrying on with regular course activities in ways that would not interfere with the execution of the study. The faculty offered 10-points extra credit to students who chose to participate, effectively making the study part of the course activities. For those who did not want to participate, an alternate project was offered as a way to earn the 10 points. Forty-nine out of the fifty-one students registered in both sections chose to participate. All human subjects paperwork was completed and handled as required by the Institutional Review Board of The Pennsylvania State University (Penn State) as well as the research site's Institutional Review Board. See Appendix N for a sample consent form.

The learning intervention was carried out according to the experimental design as shown in Table 3.1.

Table 3.1
Experimental Design

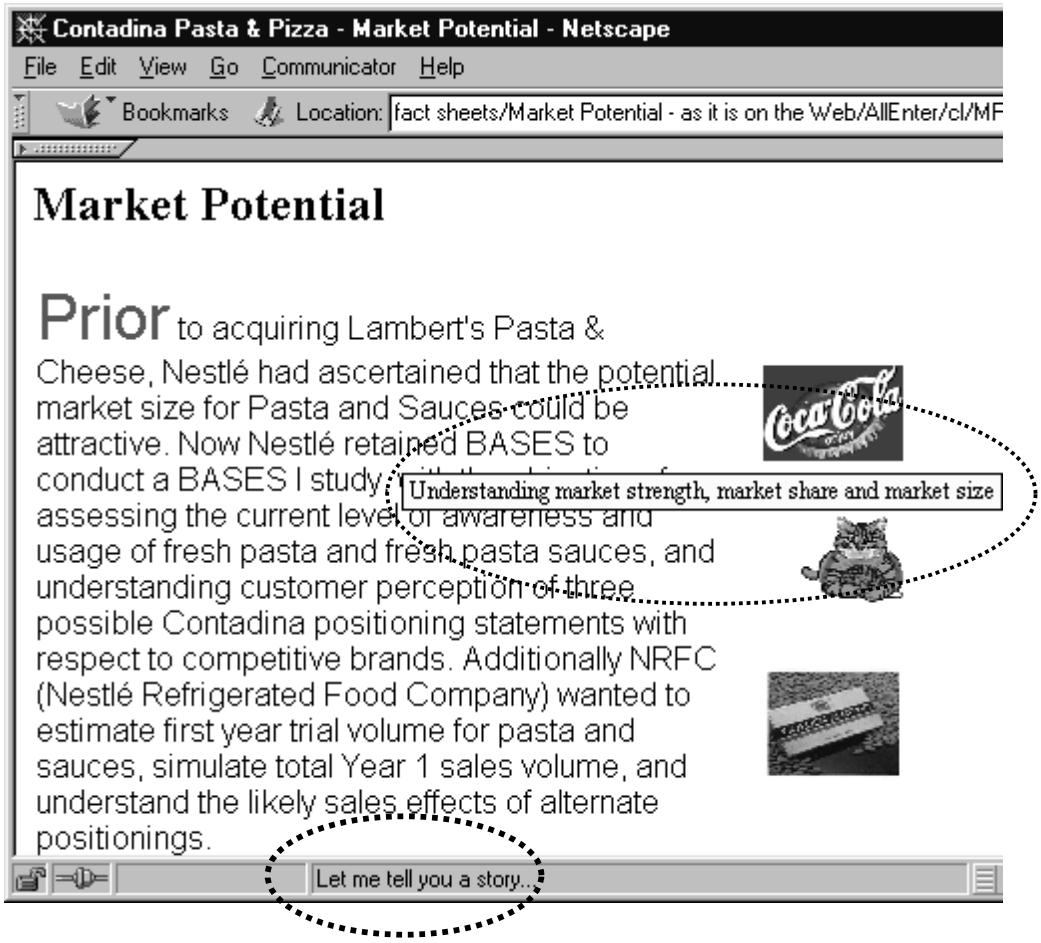
Experimental	R	O	X_1 (case library)	O
Comparable	R	O	X_2 (fact sheets)	O
Control	R	O	(random text on info unrelated to issues)	O

The execution of the study proceeded in six phases as follows (refer to Appendix G for the timeline):

Phase 1	All novice learners started working on the Contadina case. The whole case was read, briefly analyzed and discussed during class *except the section* "Market Potential." Prior to starting the study all learners were trained on how to use the environment. At this time I, with the help of the faculty, walked learners through 3 stories and 2 fact sheets pertaining to a two-paragraph section of the case during class called "Branding."
Phase 2	All novice learners were given a pretest to assess their pre-treatment problem-solving skills. The pretest consisted of two parts: 1) multiple-choice test, and 2) short-answer questions. In addition, they were asked to write an essay on a given "opportunity statement" (see below for a brief description of these study instruments). Exactly 62 minutes were allotted during the beginning of class to complete these activities.
Phase 3	Immediately after these pre-intervention activities, experimental, comparable and control groups were randomly formed from the pool of novice learners. Each learner in the experimental group was given a unique access code that gave her access to the Case Library and the task environment for the "Market Potential" section of the Contadina case. The comparable group was also given a unique access code, which gave them access to the same task environment but not to the Case Library. Instead, they had access to the same information contained in the Case Library, but presented as facts. The control group received access to the same task environment but instead of the Case Library or fact sheets, they just received additional general information about food product development not relevant to the issues being directly addressed by the Contadina case, the Case Library or facts sheets. See figure 3.1 to 3.4 for a screen shot of the environment, sample story, fact sheet and random text.
Phase 4	For the next three weeks, all three groups continued to work on previously scheduled class activities. All participants were asked and continuously prompted in class and through email to work individually on the "Market Potential" section of the case without sharing the assigned material with other students. Faculty refrained from discussing any aspect of this section of the case during this period, referring the learners instead to the study material.
Phase 5	After these three weeks, all novice learners were given post tests to assess their post-treatment problem-solving skills and an open-essay examination. These post-treatment instruments were identical in format to the pre-treatment ones but different in content. Exactly 62 minutes were allotted for these activities.
Phase 6	Immediately after these post-treatment assessments, *all* novice learners were debriefed using a questionnaire (see Appendix H). Also, 2 participants belonging to each of the groups (total of 6) were randomly selected for in-depth interviewing (see Appendix I for a description of interview protocol).

Figure 3.1

Partial Screen of Task Environment



This is a partial screen shot of the "Market Potential" section of the Contadina case (Bell, 1996) as presented in the study. The presentation of the training material ("Branding" section of the same case) was displayed the same way. The task environment was set up around eight web pages containing this segment of the Contadina case. Specific learning issues are raised on the case at key points in the text. For example, the first sentence as showed on the screen shot above raises the issue of ascertaining potential market size. At the right of this learning issue, the user finds an icon alluding to a story and its main theme. Upon sliding the mouse over it, a popup will flash the story's title that approximately corresponds to an "index" (Schank, 1999, p. 85) as articulated by the experts who recounted that story. This index is expected to help make the story memorable and assist in the future story retrieval process. Also, the phrase "Let me tell you a story…" will appear on the browser's status line at the same time. For example, the Coca-Cola story that corresponds to the learning issue "understanding market strength, market share and market size" is shown on the next page, followed by the corresponding fact sheet and the random text.

Figure 3.2

Sample Story

Understanding Market Strength, Market Share and Market Size
Coca-Cola's Share of the Stomach

In 1980, less than 15% of Coca-Cola's sales came from outside the U.S. Having been a dominant player in the U.S. for so long, the company was having a hard time finding opportunities for growth despite its enormous market strength. Coca-Cola's CEO, Roberto Crispulo Goizueta, challenged its employees to make the company a dominant player all over the world. Without changing the product, he drove Coca-Cola's marketing machine to push the product nationally and internationally by simply modifying Coca-Cola's definition of market strength, which up to that moment was defined as the company's share of the cola market.

His strategy was very simple. He called it "the share of the stomach." That is, if any person around the world drank liquids 20-25 times a day, Coca-Cola's target was that one of those drinks be a Coke. Mr. Goizueta's insight was that Coca-Cola was in the business of selling liquids and it had to compete with coffee, water, juice or any other liquid consumed by an average person around the world. He changed the thought process of the entire organization from the perception that the company was a dominant player in the cola market to a company that was measuring its potential market size by focusing on Coke's share of the stomach. This prompted Coca-Cola executives to venture into the business of juice, water and other liquids in order to increase Coca-Cola's share of the stomach.

In 1982, 80% of Coca-Cola's sales came from the U.S. and 20% from overseas. By 1997, Coca-Cola's sales were 20% from the U.S.—while still holding the dominant market position—and 80% from overseas. This had been one of the most successful growth strategies in recent times. Coca-Cola's success made many executives in other business rethink their definitions for market strength, market share and market size.

Figure 3.3

Sample Fact Sheet

Understanding Market Strength, Market Share and Market Size
Some Facts

Sometimes companies have a difficult time focusing on growth strategies simply because they do not really understand the nature of their markets. Typically companies define their market strength based on the share of the market they currently hold. But sometimes this definition can be restrictive and may prevent marketing personnel from considering great growth opportunities.

It is critical for companies to find innovative ways to define market strength, market share and market size. When companies develop a more appropriate definition of what their market is, they can transform themselves simply by acquiring a new perspective on the demand they are trying to satisfy. This in turn can prompt marketing personnel to venture into related business areas that otherwise may go unnoticed.

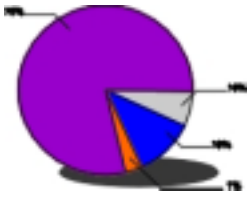


Figure 3.4

Random Text

Senior Management and Company Objectives
Some Facts

Senior management is an integral and important part of a product development team, if for no other reason than to see and be seen. Management serves many diverse purposes. It establishes clearly the interest of senior management in the project, which can play an important role in encouraging team spirit. Management can establish that the company's objectives are being strictly adhered to and divergent paths are not dissipating the energies of the team.

Senior management's presence can hold in check the rivalries, and sometimes abrasiveness, that can arise as pressures and deadlines take their toll on even the most integrated venture team. Management has an opportunity to assess the strengths and weaknesses of individuals possessing different skills as they work under pressure with other members of the team. This allows a just reward for good work—in itself a morale booster—and permits management to earmark a cadre of future leaders.

The students were put through a brief training session. Approximately a week before the release of the treatment material, a 2-paragraph section of the Contadina case called "Branding" was placed on the Web and supported with three stories and two fact sheets in a form similar to that shown in figure 3.1. *All* students were asked to review this material. For this training session, students were charged to find connections between the issues being raised in the "Branding" section of the case and the five icons with the five links leading to the stories and fact sheets. During class, I prompted students to articulate their experiences with the stories and fact sheets. A brief discussion ensued. No students raised any concerns about their ability to make the connection between the issues in the Contadina case and the elaborations contained in the treatment material.

Novice Practitioners and Field Experience

A faculty member from Penn State initially approached the senior vice president for science and technology of a large U.S. food company regarding my field research. I was interested in conducting this part of the research in this company since, as an instructional designer and material developer for a food product development course at Penn State for the past 2½ years, I had authored a case study regarding one of its products. Through that experience, I had already met and built up trust with the vice president of the company after having interviewed some of his employees.

After the initial contact, I presented the study proposal and its requirements to the vice president. After agreeing to support the research, he presented the research idea to his directors and managers who helped him identify the candidates with the required characteristics. From this meeting, four novice practitioners, two males and two females, between the ages of 24 to 27 years old, working for this food company were identified. Three participants were engaged and the fourth one was put on "stand-by" in case any of the other three participants became inaccessible (illness, transfer, etc.). These participants were deemed appropriate for this study for the following reasons: 1) all four possess academic backgrounds that qualified them to work for a food company (see Appendix A for a definition of what is considered a *novice practitioner*); 2) these novice practitioners work in areas in which problems are frequently ill-defined, requiring the talents of many other practitioners working on various aspects of the food product development process (basic or applied science, marketing, production, sales, etc.); and 3) being recent graduates, they were expected to have fresh memories of their undergraduate experiences.

Shortly after the participants were identified, I presented an overview of the study to the four participants and their supervisors. The vice president, in the presence of the participants and their supervisors, in a non-threatening manner urged the participants to express their opinions freely as required by the study. He portrayed the study as an opportunity for the company to learn more about problem solving within their organization. He selected the company's librarian as the person to serve as a contact between the participants, the company's legal department and me.

All four novice practitioners agreed to participate. The company, Penn State and I signed formal agreements and non-disclosure contracts for securing proper authorization to the site. These documents required that all data be made available for review by a company representative prior to removal from the company premises. This was requested to ensure that overly sensitive information on products be deleted.[10] All human subjects paperwork was completed and handled as required by Penn State's Institutional Review Board. See Appendix O for a sample consent form.

Immediately after agreeing to participate, dates and times were negotiated with each novice practitioner for conducting the first in-depth interview. During these individual interviews, agreement was reached on identifying a suitable ongoing problem for collecting data on two typical problem-solving sessions as required by the study. After I performed the analysis of these problem-solving sessions, each novice practitioner was contacted for scheduling and conducting the second in-depth interview. The interviews were audio taped while the problem-solving sessions were videotaped. Each interview was initially transcribed into an MS-Word file from audiotape with support from a third party. Each transcript attempts to represent the

[10] This never became necessary.

conversation as closely as possible to how it happened, not omitting the ubiquitous *uhum*, *but*, *you know*, etc., and fully representing the pauses and other communication subtleties (laughs, chuckles, etc.). In addition, I reviewed each video carefully numerous times to produce a log identifying all meaningful events as they occurred in the sessions (see Appendix M for a log of the most relevant problem-solving episodes). The episodes were classified according to concepts already identified in the in-depth interviews. The exact times (locations) in the tape where the episodes took place were noted.

Data were collected from *each* novice practitioner in the following sequence (refer to Appendix G for the actual timeline; refer to Appendix I for a description of the strategies used for collecting the data):

Phase 1 (interview)	Conducted in-depth interviews to obtain general information and background, her perspective on the company and related culture, and her perspective on problem solving and storytelling. It is important to note that at this time I informed the participants that the research was about problem solving without mentioning that it was also about storytelling. This was done so that the importance of storytelling would emerge naturally from the conversation. I was afraid that making them aware of this fact early in the study would consciously or unconsciously motivate them to overstress the importance of storytelling in problem solving thus skewing the data collection in favor of the phenomenon.
Phase 2 and 3 (two problem-solving sessions)	Observation and videotaping of the novice practitioner as he participated in a problem-solving session conducted during a meeting and a follow-up session in another meeting. The objective of the problem-solving sessions was to observe each novice practitioner as well as the overall dynamics of a food product development team in action as the team members wrestled with a series of current problems and moved toward possible solutions. From the perspective of the novice practitioner, I tracked and characterized these movements. The analysis of these sessions was used to confirm data obtained in the prior phase and to probe further into the problem-solving and storytelling phenomena during the next phase. It is important to note that these problem-solving sessions were scheduled by the participants and other team members as the needs of the situations they were wrestling with required. I did not have any influence on their scheduling or the related discussions. I was informed, usually a week in advance, when they were taking place and I presented myself with the video equipment and endeavored to become "a fly on the wall."
Phase 4 (interview)	Final in-depth interview to engage the participant in the analysis of the data collected so far and to clarify other points deemed outstanding. At this point participants were informed about the storytelling aspects of the research.

Task Environment Description and Quantitative Data-Gathering Methods

Task Environment for the Quantitative Study

As stated earlier, the task environment was built around the "Market Potential" section of the Contadina case. The learning issues contained in this section of the case were identified by me following an existing skills analysis regarding the development of a food product development plan. Details on the construction and elaboration of this skills analysis are presented in Appendix J. Details on the matching between learning issues identified in the Contadina case, the associated skills, and the title of the stories that supported those learning issues and skills are presented in brief form in Appendix K.

The 24 stories contained in the Case Library were elicited from four practitioners currently or formerly employed by four different major U.S. food companies. One practitioner was until recently employed as a regional sales manager responsible for all retail clients operating within the major metropolitan centers in the northeastern U.S. (15+ years experience as food sales representative). Another practitioner is currently employed as a vice president of marketing in a pet foods company (15+ years marketing experience). Another practitioner recently retired from the senior vice presidency of a major food product company (28+ years developing new food products). And the fourth practitioner had recently retired as CEO of a large U.S. food retail chain (28+ years food retail experience). I gained access to the practitioners through contacts made available to me by Penn State faculty and the faculty working in the university where the study was conducted. All story collection sessions took place on the university premises and lasted about 2-3 hours for each practitioner.

The story collection process proceeded as follows. First, I presented the practitioner with the "Market Potential" section of the Contadina case one paragraph at a time. A discussion with the

practitioner ensued regarding the learning issues apparent in each paragraph. Based on each learning issue identified by the practitioner, I proceeded to probe their memory for cases that reminded them of the issues being presented in each paragraph. Thus the storytelling would proceed. More than 40 stories were audio taped. Immediately after, I transcribed and reshaped the unstructured narrative into story form (see the definition of a story and related criteria in Appendix A). Finally a senior faculty member of another university who has also taught a similar course edited the stories for clarity and content. Minor suggestions were made that were incorporated into the stories.

Once the story collection process was completed, I coded all stories in Hypertext Markup Language (also known as HTML, currently the most commonly used method for formatting documents for the Internet) and loaded them onto a Penn State server. The "Market Potential" section of the Contadina case, which was to serve as the task environment (see Appendix C), was also coded in HTML and loaded onto the same server. Links between the task environment and the stories elaborating on the specific learning issues identified in the Contadina case were represented with icons that would lead to the stories upon clicking with the mouse. Similarly, two other websites were designed containing exactly the same material but with links that would lead to fact sheets and still another one to text randomly selected from a food product development textbook (see figure 3.1 to 3.4 for a screen shot of the environment, and an example of a story, a fact sheet and random text as shown in the study). A senior instructional design faculty member from another university and an instructional design Ph.D. candidate from Penn State reviewed the three learning environments. They were asked to judge whether the sample stories from the Case Library contained the attributes associated with a story as defined in this study, whether the task environment built around the Contadina case represented a valid

environment as defined in this study, and whether the procedure for presenting the stories was compatible with a case-based teaching system as described in this study. Minor suggestions were made that were incorporated into the environment. Access control was built into the three websites using the scripting language JavaScript, thus permitting access only to each of the sites based on unique alphanumeric codes prepared by me (e.g., 319ZK52), which were later randomly assigned to the students. Thus, control group participants could only access links to the random text, comparable group participants to fact sheets, and experimental group participants to the 24 stories. All students were told that they would be reviewing additional material to the case that was unique to their access code and were repeatedly asked to refrain from sharing the access codes or materials with fellow classmates.[11]

Quantitative Data-Gathering Methods

For the quantitative portion of the study, the independent variable is the presence of a Case Library in the task environment. The dependent variable is represented by the problem-solving skills as reflected in the pretest and post test scores. The quantitative scores were obtained from the results of the objective multiple-choice and short-answer tests. The test items in all tests specifically pertained to learning issues raised in the "Market Potential" section of the Contadina case, which were further elaborated in the related stories contained in the Case Library.

I developed all tests with the assistance of two Penn State faculty members who currently teach the course in which I currently work as an instructional designer. They provided appropriate content domain. A senior instructional design faculty member from another university was asked to perform a final review of the tests regarding test design. In addition, the tests were piloted for clarity and timing with two Penn State students who at that time were

[11] At the end of the study, only two students admitted that they showed the material to each other for "just a quick glance."

taking a food product development course. Finally, the tests were reviewed by the two professors of the sections that were object of the study for clarity, accuracy and fairness. Revisions were made incorporating the feedback from all these sources, after which 50 paper copies with related instructions were produced for both the pretest and post test.

Qualitative Data-Gathering Methods

In support of the quantitative study, six novice learners, one from each treatment group, were asked to describe their problem-solving process in general and in the context of the tests two weeks after taking the post test (see Appendix I for a description of the interview protocol). The objective was to reveal the process at work for the acquisition of problem-solving skills through the experts' stories (if any process is detectable) and to support an emergent model: a "school-setting" problem-solving model incorporating stories. Details on the processing and analysis of these interviews are discussed in the next chapter.

As mentioned earlier, additional qualitative data were obtained from the field through interviews with the three novice practitioners and observations as they participated in problem-solving sessions at work. The resulting interview and observation data was similarly analyzed using Grounded Theory (Strauss & Corbin, 1998) coding procedures and processes for developing the problem-solving model emerging from the data, that is, a "work-setting" problem-solving model. Finally, the "school-based" and "work-based" models were contrasted in all of their dimensions and merged into one model.

Procedures for Processing and Analyzing the Research Data

Factors Affecting the Data

For the quantitative portion of the study, five students' results were not included in the analysis for two reasons: 1) they reported to me that they did not consult the treatment material (two students) or 2) they were not able to complete the multiple-choice *and* the short-answer tests during pretest or post test (three students).[12] Therefore, from the initial sample of 49 participants, all statistical analysis regarding multiple-choice and short-answer tests was carried out only employing the results from the remaining 44. All these 44 participants completed the questionnaire.

For the qualitative portion of the study in support of the learning intervention, 41 students completed the open-ended pretest and 42 completed the open-ended post test. Since this material was not intended to draw statistical inferences but to be used for materials analysis, all open-ended tests were subjected to qualitative analysis. However, close examination revealed that students' responses were too incomplete, oftentimes only showing bulleted items, partial phrases, or expedient general comment (such as, "They need to do market research."). Since the value of this portion of the study depended on whether the students responded to the opportunity statements presented in the open-ended tests with elaborate and coherent arguments, I determined that this data be discarded since it added nothing to the qualitative analysis process.

Finally, during the field research portion of the study, one novice practitioner was scheduled to take a maternity leave. For that reason, only one problem-solving session was scheduled with this participant. For the other two novice practitioners, the study proceeded as described earlier.

[12] These three participants were not native English speakers. All independently expressed to me concerns about the tests requiring a lot of reading and especially *writing* admitting that they felt at a disadvantage.

Multiple-Choice Tests

See figure 3.5 for an example of a multiple-choice item as used in the post test. It is important to note that the questions as articulated in the multiple-choice tests (with the exception of item 1) were not intended to elicit declarative knowledge or simply recalling of a story. After the problem situation was presented in the root of the multiple-choice test, the questions asked in the post test, and the corresponding outcomes, were as follows (the questions asked in the pretest were virtually identical):

Item 1: This situation is an example of the following:
Outcome: Reminding (identify example/outcome)

Item 2: Why do you think this company has failed to make this product a success?
Outcome: Identify/explain failure

Item 3: Select the most appropriate solution to the problem.
Outcome: Identify/recognize problem

Item 4: Why do you think the company ended up with this problem?
Outcome: Select/recognize solution, adaptation (Kolodner, 1992)

Item 5 and 6: What do you think is the problem the owners are facing?
Outcome: Identify/recognize problem
Identify/explain failure

Item 7: What do you think <u>will most likely</u> happen next and why?
Outcome: Identify/predict outcome

Item 8: Why do you think *Seven Seas*' actions led to the success of the product?
Outcome: Identify/explain success

Item 9: Instead of this promotion campaign, what other approach you think should have been pursued?
Outcome: Identify/judge alternate strategies/actions

Item 10: Why do you think the company is not able to sell this product?
Outcome: Identify/recognize problem

Item 11: What piece of information would you like to have most?
Outcome: Identify information needed (on obstacle)

Figure 3.5

Multiple-Choice Test Item as Used in Post Test

5.[*]
A major U.S. food company that markets a successful line of salty snack products created a series of snack products to tap the aging baby-boomer population who are starting to experience higher cholesterol levels. Medical research demonstrates clearly that higher levels of cholesterol can contribute to an individual's incidence of heart disease and stroke. As everyone else, this company regards this population segment as the best hope to fuel growth for the next decade. The products are one of a kind using a new cholesterol-lowering ingredient, Cholestra, produced by a major pharmaceutical firm. The decision was made to sell the new snack as a line extension of one of its traditional and highly successful products. Against all expectations, the product is not selling. The company is not able to figure out the problem. After spending millions of dollars in R&D, the company watches in horror as its products are being returned even before the shelf life cycle ends.

What do you think is the problem the company is facing?

a. They do not possess the know-how to market this unique snack product to baby-boomers.
b. There is probably no market for a snack health product in the U.S. or anywhere else.
c. They are not marketing the product to retailers appropriately.
d. They perceive its market strictly in terms of snack food consumption.
e. They are operating in a market that is over saturated with snack products.

* The "preferred" answer is "d."

The results from the multiple-choice tests were organized as follows. The multiple-choice tests (items 1-11) had been designed with five possible choices laid out in the following manner: one choice, the "distractor" (Nitko, 1996, p. 138), which was unrelated to the issues being discussed; three choices that were entirely plausible; and only one choice that alluded to the lesson to be learned from a story. The preferred choice was randomly associated with a letter from A to E throughout the 11 test items. A score of 1 (one) was given for choosing the preferred answer and 0 (zero) for any other choice. The 44 student scores corresponding to the multiple-choice pretest and post tests were tabulated, identified with each student's unique access code, classified by group (control, comparable or experimental) and entered into a 44 x 24 MS-Excel worksheet. The worksheet was then imported into the statistical software package SPSS. The tests were automatically scored by SPSS after I provided a column with the "key," the preferred answers.

All statistical computations were double-checked by a Penn State Ph.D. instructional design candidate. A number of statistical tests were run on the exam scores and are presented in the next chapter.

Short-Answer Tests

See figure 3.6 for an example of a short-answer item as used in the pretest. As with the multiple-choice test items, the questions used to prompt student reasoning (with the exception of item 18) were not intended to elicit declarative knowledge or recalling of stories. The pretest was intended to establish a baseline while the post test was intended to determine cognitive gain. Some sample questions are shown below:

- What is your opinion regarding the way *Pets 'n Things* handled this product? Elaborate. How could you have done it differently? Explain.
- What do you think the food company will do with this information? Why? Elaborate.
- Do you think this product will now be successful? Explain.
- What strategy do you propose for marketing this product? Make sure you explain why you think your strategy is better than the two other strategies that have been implemented so far.
- Why do you think this company is unable to sell its products?
  What research would you recommend *El Greco* management conduct? How do you recommend they go about acquiring this information?
- As a partner in this marketing firm, you have been selected to lead this launching effort. This is the biggest opportunity of your career so far. What do you foresee will be your most outstanding problems? Explain. Propose solutions to address each of these problems.

The relationship between short-answer items and outcomes follows:

Item 12: Strategize (describe, state, judge)
Item 13: Evaluate the quality of the solution(s)
Items13, 16, 17: Recognize problem(s)
Item 14: Predict outcome (through analogy)
Item 15: Evaluate (criticize) the quality of the solution(s)
Item 16: State/explain obstacle(s)
Item 17: State/justify solution(s), adapt (Kolodner, 1992)
Item 18: Reminding (produce example)

Figure 3.6

Short-Answer Test Item as Used in Pretest

12.
Dr. Molten, a VP of marketing in a small food product company, has a unique strategy for determining market potential and size, and percentage of sales. This strategy comes in handy for this small company since it does not have many resources for elaborate market research methods. Every time the company needs data for forecasting purposes for a product (sales, volume, etc.), he sends out to randomly selected supermarkets in the city of Atlanta for junior marketing personnel to measure the area ("footprint") dedicated to similar or related products. With this information Dr. Molten predicts future performance of products existing only on the drawing board. Many products whose performance was predicted with the "footprint" method have become actual successes after launch.

a. Explain why this "footprint" strategy seems to work.
b. Do you think this is a good approach for conducting market research? Why or why not?
c. Instead of the "footprint" strategy, suggest at least one other alternative and explain why it should work for this company.

The student responses to the short-answer tests (items 12-18) and necessary scoring team were organized as follows. I transcribed verbatim the results of the 44 short-answer pretest and post tests using the word-processing program MS-Word. No attempt was made to correct misspellings or modify punctuation, style, organization, etc. I selected three judges to design a rubric and score the students' responses after consulting with an instructional design senior faculty member from another university who personally knew the judges' professional qualifications. Considering that food product developers frequently have to work within cross-functional teams and deal with numerous perspectives coming from multiple talents such as technicians, ingredient specialists, brand and finance managers, salespeople, engineers, scientists, senior management, consultants, suppliers, etc. (Fuller, 1994; Smith & Finley, 2000), the major areas of science, business and industry into the scoring process were incorporated. The judges were chosen for their extensive food systems academic and industry expertise, for having experience in teaching a food product development course similar to the one that was the object of this study, for their unique perspectives, and for their commitment to this task. One judge is a faculty member at Penn State with 25+ years food science academic and industry

experience. He was expected to provide a food science perspective. Another judge is also a faculty member at Penn State with 15+ years of academic experience in agricultural economics and business. He was expected to provide the economics, business and qualitative perspective. The last judge currently holds a Chair in Penn State's agricultural business department. He has 28+ years industry experience in developing or overseeing the development of numerous food products. He was expected to provide the industry perspective.

The rubric was developed as follows. In a meeting with the three judges present, I explained what was expected of them, the procedure we were to follow for designing a rubric for scoring each test item, and the scoring process. After that, I met with each judge individually to design the rubric by going over the 7 pretest and the 7 post test items. As a result of the ensuing exchange, I developed the criteria they all felt had to be addressed by each test item. From that effort, the first rubric draft incorporating their unique perspectives was completed. I randomly selected a set of responses from one student from the pretest and post test, attached each rubric item to the corresponding test item and distributed that to the judges (14 items to score). This individual training session was for "exercising" the judges, assessing the rubric's workability, and gathering additional feedback. This rubric was also reviewed by the instructional design senior faculty member to judge the quality of the rubric as a scoring instrument. In addition, a Penn State instructional design Ph.D. student was also asked to review the rubric for the same purpose. From these efforts, minor modifications to the rubric were incorporated into the final version.

The scoring and tabulation of results proceeded as follows. Three binders with the tests items were prepared. The binders were divided into 14 sections (7 pretest and 7 post test items). Each section started with the test item question followed by each student response always at the

top of the page, and that was immediately followed by the corresponding item rubric (see figure 3.7). The student responses were placed inside the binder at random. In addition, no student-identifying information was provided, to keep the judges' review double-blind. That is, the judges had no way of knowing which item was the pretest or post test or to which treatment group the student response belonged. The scoring criteria were always defined with four letters as follows: "a" for the highest score (3 points), "b" for the next to highest score (2 points), "c" for the next to lowest score (1 point), and "d" for the lowest score (0 points). The results of all the scores for each rubric pertaining to each test item for each judge for pretest and post test for all students classified by group (control, comparable or experimental) were tabulated and inputted into a 44 x 114 MS-Excel worksheet. The worksheet was then imported into the statistical software package SPSS. For each student, the results from a rubric pertaining to the same test item were averaged giving a number from 0 to 3. Each score generated like this by the three judges was totaled, thus producing one overall pretest score and one overall post test score for each student. The judges' scores were totaled since one criterion used in the judges' selection was each one's unique perspective. Rather than inter-judge reliability, the goal was a holistic score incorporating the major food product development areas of science, economics and business, and industry experience. All statistical computations were double-checked by a Penn State Ph.D. instructional design candidate.

Figure 3.7

Sample Short-Answer Response and Corresponding Item Rubric

a. He bases sales etc. on that of similar products. If there is no need for them, he goes back to the drawing board.

b. Yes. But it is not the ONLY method to take into account. By finding success & failure in the industry, he can look for error/improvements.

c. Look at the product lifestyle: was it a fad? Is it dying? Has it had a regrowth? Also, competition is important.

a. Linkage between retailers and final consumer

1. Recognizes the food company's need to take into consideration retailer's and consumer's actual demand

a.	b.	c.	d.
Fully recognizes relationship	Partially recognizes relationship	Hardly recognizes relationship	Does not recognize the relationship at all

2. Recognizes the difference between actual versus stated demand

a.	b.	c.	d.
Fully recognizes the difference	Partially recognizes the difference	Hardly recognizes the difference	Does not recognize the difference at all

b. Adequacy of the "footprint" strategy

3. Recognizes strengths and weaknesses of the data collected at retailer's site

a.	b.	c.	d.
Fully recognizes strengths and weaknesses	Partially recognizes strengths and weaknesses	Hardly recognizes strengths and weaknesses	Does not recognize strengths and weaknesses at all

c. Evaluation of respondent's proposed strategy

4. Does the proposed strategy complement the "footprint" strategy (adds more information) or substitute it (verify)?

a.	b.	c.	d.
Fully complements or substitutes it	Partially complements or substitutes it	Hardly complements or substitutes it	Does not complement or substitute it or does not propose a strategy

Open-Ended Tests

See figure 3.8 for an example of an open-ended test as used in the pretest. The purpose of the pretest was to obtain pre-intervention material for qualitative analysis. The purpose of the post test was to obtain post-intervention material for qualitative analysis. It was hoped that learners' arguments would reflect the lessons contained in the specific treatment material to which they were exposed to; that is, stories, fact sheets or even random text. The data from the open-ended tests had to be discarded. Students were not able write the lengthy arguments that were needed for this part of the qualitative analysis.

Figure 3.8

Open-Ended Item As Used in Pretest

19.
The purpose of this exercise is to measure your understanding of the food product development process, particularly as it pertains to assessing market potential. Consider the following case:

Baked Alaska

Baked alaska is served as a gourmet dessert in a fine restaurant in a small rural community. People come from miles away to eat at the restaurant ostensibly because of their baked alaska.

The restaurant provides the recipe gratis to their customers. However, customers report that they are unable to duplicate the restaurant product when they make it at home. Furthermore, they complain that it is time consuming and difficult to make. Some have said that while they would like to learn how to make the product, they feel it is hardly worth the bother.

The restaurant operators sense a marketing opportunity for their baked alaska in supermarkets. The nature of the product requires that it be frozen.

Instructions
Describe how you recommend this firm introduce this product to the public. Make sure that in your discussion you place special emphasis on how you will assess the market potential for this product. While some general notions and characteristics of the food product development process are welcomed, be sure to discuss the process in the context of this case; in other words, remember that this is about a Baked Alaska! Make sure to identify the important activities and the facts and information you need to acquire before making recommendations.

To summarize, the pretest and post test were composed of three parts: 1) eleven multiple-choice items (items 1 through 11), 2) seven short-answer items (items 12 through 18), and 3) one

open-ended test (item 19). Novice learners were given exactly 62 minutes to complete these tests.

Questionnaire

See Appendix H for a description of the questionnaire administered in the study. The questionnaire data set was organized as follows. The results of the 44 questionnaire responses were tabulated and input into an MS-Excel worksheet. Each selection made for each question was counted as an instance. All instances for each question were totaled for each group (control, comparable, and experimental). In the case when the response was stated numerically ("How much time did you spend reading the material?"), the result for that group was represented as an average.

Novice learners and novice practitioners in-depth interviews

See Appendix I for a description of the exploration strategy followed during all interviews. The in-depth interviews and related documents were organized as follows. Each interview was initially transcribed into an MS-Word file from audiotape with support from a third party. Each transcript attempts to represent the conversation as closely as possible to the actual recording, not omitting the ubiquitous *uhum*, *but*, *you know*, etc., and fully representing the pauses and other communication subtleties (laughs, chuckles, etc.). The interviews resulted in 6 novice practitioner files for the field experience, and 6 novice learner files as a result of the study (see Appendix L for all source data description). Attached to those transcripts were field notes [i.e., "detailed, nonjudgmental, concrete descriptions of what has been observed" (Marshall & Rossman, 1999, p. 107)] and memos, which were links of "records of research event (field notes, transcripts or interviews, etc.) with each other and with records of subsequent interpretation and discovery (memos, diaries, research notes, etc.)" (Richards, 1999, p. 29).

The in-depth interviews were then coded following a Grounded Theory tradition (Strauss & Corbin, 1998). After having thoroughly reviewed the transcripts with the audiotapes, the files were imported into the qualitative analysis software program NVivo (Richards, 1999). For a period of about seven months, I subjected these transcripts to close examination in support of the coding effort as prescribed by Grounded Theory tradition using NVivo. Using open coding to reflect "The analytic process through which concepts are identified and their properties and dimensions are discovered in data" (Strauss & Corbin, 1998, p. 101).

For instance, in the case of the 3 novice practitioners, this process permitted the systematic identification and segmentation of conversation segments related to job context, past formal education, company culture, aspects of the problem-solving phenomena (behaviors, obstacles, attitudes, etc.), the novices' perspective on stories and storytelling within their work setting, issues related to expertise (acquiring, using, becoming an expert, etc.) and other issues (see Appendix I for a description of the data collection strategy employed). Each segment was initially represented in NVivo as a "free node" (Richards, 1999, p. 58). This open coding process was geared towards organizing the numerous concepts emerging from the conversations. Then the resulting segments are organized as "tree nodes" in NVivo (Richards, 1999, p. 58). For example, NVivo allows all discussions that throw light on one participant's job context to be segmented and managed as if it were a single document regardless of its position within the transcript.

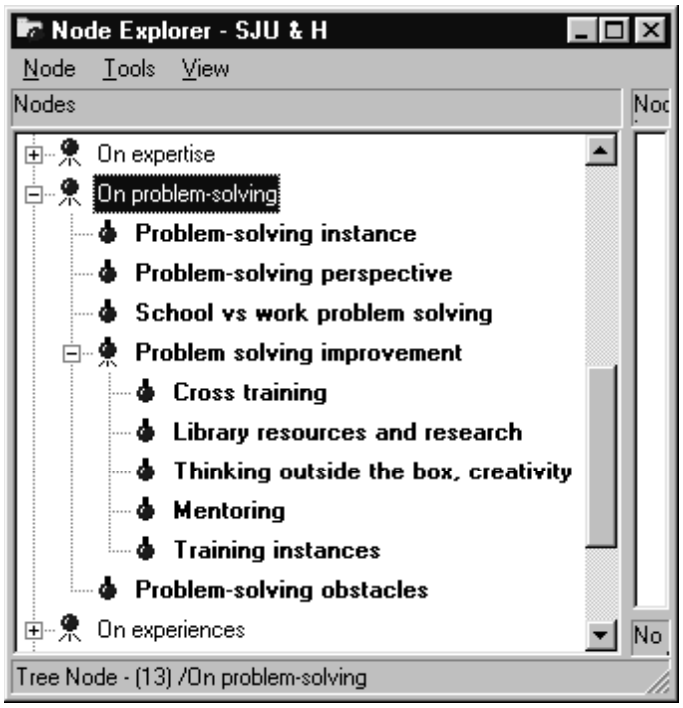
As the coding progresses, it is expected that the categories to which these conversational segments belong will emerge. According to Strauss and Corbin (1998), a category is a concept that stands for a phenomena (p. 101). These categories in turn will belong to broader categories (more central problem-solving phenomena) or will have subcategories belonging to them

(storytelling phenomenon). For example, the *job-context* free node was placed under the broader structure *Organizational-matters*, which also includes *initial-experiences-when-joining-the-company*, *company-culture-values-and-policies*, and *existing-problems-in-the-organization*.

As the organization around categories started to emerge as explained earlier, I engaged in axial coding, "the process of relating categories to their subcategories" (Strauss & Corbin, 1998, p. 123), that is, further structuring the categories under broader categories or over narrower subcategories. For example, many conversational segments were coded as *problem-solving-improvement* (actions the company or participants take to improve problem solving). Later on emergent concepts forced this free node to be placed under a broader category called *On-problem-solving*, which already contained under it the subcategories *problem-solving-instances*, *problem-solving-perspective*, *school-problem-solving-versus-work-problem-solving*, and others. A tree node structure in NVivo very much resembles a computer file system (see figure 3.9). For example, as concepts associated with *mentoring*, *cross-training*, *library-resources-and-research*, etc., emerged, they were judged to be subcategories of *problem-solving-improvement*, requiring that they all be placed as branches (or subcategories) under this tree. When I had made repeated passes through the data without producing any new categories the data were judged to have reached theoretical saturation; that is, "when no new properties, dimensions, conditions, actions/interactions, or consequences are seen in the data" (Strauss & Corbin, 1998, p. 136). Then a final effort was made to selectively find quotes and overarching themes within and around these category systems, effectively engaging in selective coding; that is, "The process of integrating and refining the theory" (p. 143). This coding and recoding process went on for about seven months as new transcripts and related material became available.

Figure 3.9

Example of a Tree Node in NVivo



The main categories, the roots of every tree, were used as the basis for building a model explaining the central phenomenon of problem solving with stories. Support was continuously drawn from the six novice practitioners' transcripts in the form of quotes to explicate how all roots of the tree (the major categories) interacted (Creswell, 1998, p. 57; Strauss & Corbin, 1998, p. 128). As stated by Strauss and Corbin (1998), at this stage of the analysis special attention was paid to the following:

1) causal conditions: sets of event or happenings influencing phenomena;

2) action/interactional strategies: conditions mitigating or otherwise altering the impact of causal conditions on phenomena;

3) context and intervening conditions: patterns of conditions creating circumstances or problems to which persons respond through actions and interactions; and

4) consequences of the strategies: outcomes of actions/interactions.

This same coding and organizational approach was applied to the six novice learners' in-depth interviews. I walked each of them through one multiple-choice and one short-answer item for both the pretest and the post test. In addition, I showed and asked them to contrast fact sheets and stories applicable to the test items they were reviewing. This was the qualitative data used to determine their ability to think in terms of stories.

Problem-Solving Sessions

See Appendix I for a description of the exploration strategy followed during all problem-solving sessions. The problem-solving sessions and related documents were organized as follows. As mentioned earlier, I reviewed each video carefully numerous times for the purpose of producing a log identifying all meaningful events as they occurred in the sessions (see Appendix M for a log of the most relevant problem-solving episodes). The episodes were coded according to the concepts already identified in the in-depth interviews. The exact times (locations) in the tape where the episodes took place were noted. This log was then used to explore further the concepts and categories that had already emerged in prior analyses of the data. Specific questions were constructed according to the log to stimulate a reaction from the novice practitioners to provide additional insights, clarifications, etc. The results of their reactions comprised the bulk of the 2nd in-depth interviews, which were processed and analyzed as explained earlier.

Validity and Trustworthiness

To ensure the validity of the qualitative part of the study, particularly since I am using a Grounded Theory tradition, I had to check constantly for "contamination" (Dey, 1999) from preconceived ideas on how novices acquire problem-solving skills from experts' stories stemming from my exposure to the existing literature. I had to be mindful of my personal biases in favor or against the research hypothesis or existing theoretical frameworks.

At this point, then, it is only appropriate that I state the most important biases I have had to deal with during the course of this study. It is my belief that stories, particularly those that frequently are referred to as "horror stories" or "war stories," usually have lasting impressions on people. Not only do we enjoy telling and retelling them but also enjoy listening to others' as well. Having worked in various companies during the past 15 years as a computer programmer, systems analyst, and database developer and manager, I have had direct experience with experts and the knowledge to be acquired by listening to them. I have listened to my fair share of stories that have proven to be beneficial in performing many problem-solving tasks. In addition, as stated earlier, I have worked for the past 3 years as an instructional designer almost exclusively dedicated to building task environments around real-life food product development cases as a member of a team composed of faculty, other instructional designers, and food product development industry experts. It has always been the team's shared belief that cases and storytelling are an important element in learning, which is partly the reason for my interest in conducting this study. I believe this study has created expectations in the team that the results will support our beliefs. Therefore, given my experience and beliefs about storytelling and problem solving, it made it imperative to keep this in mind when performing analysis on the

qualitative data, eliciting unbiased opinions from knowledgeable individuals outside this team when in doubt.

It is difficult to summarize in a few lines all the effort that this mixed-model design study required without giving the impression that conducting the study was all too easy. Appendix L provides a quick overview for the qualitative part of the study by presenting a list of documents and their sizes, and the number of direct contact hours with participants. To summarize, this study required about 27 hours of in-depth interviews and about 6½ hours of videotaping. This generated over 450 pages distributed in 95 documents of various lengths, plus 51 memos and related field notes ranging in lengths from a few lines to over 5 pages long; a total of 146 documents. All these documents were organized and coded by employing 352 codes, 25 documents sets, 11 node sets, 14 node and document attributes, and 16 intermediate models.[13] In addition, the quantitative part of the study required engaging students in either training, participating in the study, or the in-depth interviews at various times during a two-month period. The learning environment required about 10 hours of direct contact with experts for eliciting stories and numerous hours for coding the instructional material in HTML. The experimental study generated 88 multiple-choice and 88 short-answer test responses. The short-answer test responses (short essays) and rubrics were put into three 763-page binders (one for each judge). The judges had to score a total of 616 test items (44 students x 7 pretest items, plus 44 students x 7 post test items). Each test item required specific rubric elements (ranging from as little as two rubric elements to as many as 6 rubric elements. In reality, the judges had to select a score on 4,048 rubric elements, a truly monumental effort. Seven professors from four major universities in the northeast U.S. supervised all study efforts regarding food systems content, instructional

[13] For specific information on the qualitative terminology employed in NVivo, please refer to Richards (1999).

design methods and techniques, and research methods employed. This study was my fulltime occupation from May 2000 until February 2001.

Finally, thirty-one versions of the qualitative data have been kept in NVivo files throughout the past seven months. These files are a living record of the evolution of the research and analysis of this study.

CHAPTER 4

RESULTS

This chapter restates the study's questions and hypothesis. This is immediately followed by the research findings, which are presented in terms of what each question set out to answer.

Research Results Regarding the Effect of Stories

This study set out to address the following question and related hypothesis:

1. Would a Case Library have any effect on the problem-solving skills of undergraduates (junior/seniors) specializing in some aspect of the food product development process when working on ill-structured food product development problems? This aspect of the study was geared toward testing the following hypothesis:

A group of junior/senior food product marketing/retail students (novice learners), who had access to a number of stories contained in a Case Library, will

- obtain higher scores on a multiple-choice test that assesses high-order cognitive skills than comparable and control groups which will not have access to the Case Library;
- obtain higher scores on a short-answer test that assesses various problem-solving skill components as they provide arguments, in response to the issues and problems faced in given situations, that are more reasonable, persuasive, realistic and feasible than comparable and control groups, which will not have access to the Case Library.

For the multiple-choice and short-answer tests, the independent variable is the presence of a Case Library in the task environment. The dependent variable is represented by the problem-solving skill gained as reflected in the pretest and post test scores for both types of tests. The research findings—results of the multiple-choice and short-answer tests—pertaining to the research questions and hypothesis are presented next.

Multiple-Choice Tests Results

Forty-four multiple-choice and short-answer exam scores were tabulated and processed as explained in the previous section (see figure 3.5 for a sample test item). The sample had a gender ratio of 22/20 male/female, all but 7 between the ages of 21-23 years old, all senior food marketing or retail majors, forty-three Caucasians and one Asian, with GPAs (self-reported) as shown in Table 4.1 (some did not report).

Table 4.1
Student GPA Ranges

GPA	Number of Students
3.49-3.00	5
2.99-2.50	24
2.49-2.00	6
less than 2.00	2

Most students reported that the primary reason they were taking the course was because it was a graduation requirement. The self-reported work experience as part-time, full time, assistantships, etc., is show in Table 4.2 (some did not report).

Table 4.2
Student Work Experience

	Food Systems Work Experience	Unrelated Work Experience
0	7	0
1-3 months	5	5
4-6 months	3	4
7-9 months	5	0
10-12 months	5	2
13-15 months	2	2
16-18 months	2	1
19-21 months	0	4
22-24 months	2	2
2 years or more	9	12

Tables 4.3 through 4.5 below address the part of the question pertaining to the multiple-choice test.

TABLE 4.3

Multiple-Choice Tests Descriptive Results
Items 1 thru 11

		N	Mean	Std. Dev.	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Min.	Max.	CV (as %)	% Δ CV (as %)
	1: Random text	14	.0000	1.3587	.3631	-.7845	.7845	-3.00	3.00		
GAIN	2: Fact sheets	16	.1250	1.2042	.3010	-.5167	.7667	-3.00	3.00		
SCORE	**3: Stories**	**14**	**2.0714**	**1.8590**	**.4969**	**.9980**	**3.1448**	**-2.00**	**4.00**		
	Total	44	.7045	1.7331	.2613	.1776	1.2315	-3.00	4.00		
	1: Random text	14	3.6429	1.4469	.3867	2.8075	4.4782	1.00	6.00	39.7	8.2
POST	2: Fact sheets	16	3.2500	1.3416	.3354	2.5351	3.9649	1.00	6.00	41.3	18.7
TEST	**3: Stories**	**14**	**5.4286**	**1.6968**	**.4535**	**4.4489**	**6.4083**	**2.00**	**7.00**	**31.3**	**-39.5**
	Total	44	4.0682	1.7441	.2629	3.5379	4.5984	1.00	7.00	42.9	4.4
	1: Random text	14	3.6429	1.3363	.3571	2.8713	4.4144	1.00	6.00	36.7	
PRE	2: Fact sheets	16	3.1250	1.0878	.2720	2.5453	3.7047	1.00	5.00	34.8	
TEST	**3: Stories**	**14**	**3.3571**	**1.7368**	**.4642**	**2.3543**	**4.3599**	**.00**	**6.00**	**51.7**	
	Total	44	3.3636	1.3825	.2084	2.9433	3.7839	.00	6.00	41.1	

TABLE 4.4

Multiple-Choice Tests ANOVA Results
Items 1 thru 11

		Sum of Squares	df	Mean Square	F	*p*
	Between Groups	**38.481**	**2**	**19.240**	**8.699**	**.001**
GAIN	Within Groups	90.679	41	2.212		
SCORE	Total	129.159	43			
	Between Groups	**39.153**	**2**	**19.576**	**8.758**	**.001**
POST TEST	Within Groups	91.643	41	2.235		
	Total	130.795	43			
	Between Groups	2.003	2	1.002	.512	.603
PRETEST	Within Groups	80.179	41	1.956		
	Total	82.182	43			

In Table 4.4 we can see that the ANOVA results for the pretest show that there were no significant differences between the groups ($p = 0.603$, $\alpha = .05$), lending support to the fact that, as expected, all groups possessed about the same ill-structured problem-solving skill level at the outset. However, in the post test we then see that there is a significant difference between the

groups ($p = 0.001$, $\alpha = .05$). Inspecting the impact on score gain for all three groups reveals that the Case Library group is the cause of the significant difference in gain when compared to the other groups ($p = 0.001$, $\alpha = .05$). In addition, when we calculate the coefficients of variation—the standard deviation over the mean—of student scores and represent them as percentages of change from pretests to post tests (last two columns in Table 4.3), we find that only the Case Library group experiences a sharp drop in variation (-39.5%) from pretest to post test.

Tukey follow-up tests explore these differences as shown in Table 4.5. As shown, the results of the multiple-choice tests offer support to the hypothesis that students who are exposed to a Case Library will obtain higher scores compared to a group exposed to comparable fact sheets ($p = 0.001$, $\alpha = .05$) and compared to a group that received random text ($p = 0.008$, $\alpha = .05$). This table also shows that within the context of this study, it did not make a difference whether students were exposed to fact sheets or simply random text ($p = 0.754$, $\alpha = .05$). These results offer the strongest evidence yet that a Case Library did influence students' decisions given that the choices they had before them in the multiple-choice tests were ill structured. The process the students followed while making those decisions remains to be explored.

TABLE 4.5

Multiple-Choice Tests Tukey Follow-up Results

Items 1 thru 11

Dependent Variable	(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	*p*	95% Confidence Interval	
						Lower Bound	Upper Bound
GAIN SCORE	Random text	Fact sheets	-.1250	.5442	.971	-1.4484	1.1984
		Stories	-2.0714	.5621	**.002**	-3.4383	-.7046
	Fact sheets	Random text	.1250	.5442	.971	-1.1984	1.4484
		Stories	-1.9464	.5442	**.003**	-3.2699	-.6230
	Stories	**Random text**	2.0714	.5621	**.002**	.7046	3.4383
		Fact sheets	1.9464	.5442	**.003**	.6230	3.2699
POST TEST	Random text	Fact sheets	.3929	.5471	.754	-.9376	1.7233
		Stories	-1.7857	.5651	**.008**	-3.1598	-.4116
	Fact sheets	Random text	-.3929	.5471	.754	-1.7233	.9376
		Stories	-2.1786	.5471	**.001**	-3.5090	-.8481
	Stories	**Random text**	1.7857	.5651	**.008**	.4116	3.1598
		Fact sheets	2.1786	.5471	**.001**	.8481	3.5090
PRETEST	Random text	Fact sheets	.5179	.5118	.574	-.7266	1.7623
		Stories	.2857	.5286	.852	-.9995	1.5710
	Fact sheets	Random text	-.5179	.5118	.574	-1.7623	.7266
		Stories	-.2321	.5118	.893	-1.4766	1.0123
	Stories	Random text	-.2857	.5286	.852	-1.5710	.9995
		Fact sheets	.2321	.5118	.893	-1.0123	1.4766

Short-Answer Tests Results

Tables 4.6 and 4.7 below address the part of the question pertaining to the short-answer test.

TABLE 4.6

Short-Answer Tests Descriptive Results
Items 12 thru 18

		N	Mean	Std. Dev.	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Min.	Max.	CV (as %)	% Δ CV (as %)
GAIN SCORE	1: Random text	14	**-4.1667**	4.0224	1.0750	-6.4891	-1.8442	-10.75	2.83		
	2: Fact sheets	16	**-4.5938**	4.8008	1.2002	-7.1519	-2.0356	-16.50	.83		
	3: Stories	14	**-3.0952**	7.0873	1.8942	-7.1873	.9968	-13.33	15.50		
	Total	44	**-3.9811**	5.3407	.8051	-5.6048	-2.3573	-16.50	15.50		
POST TEST	1: Random text	14	27.5000	6.3442	1.6956	23.8370	31.1630	18.92	39.17	23.1	37.5
	2: Fact sheets	16	28.6667	6.3287	1.5822	25.2943	32.0390	14.75	39.25	22.1	22.1
	3: Stories	14	27.7976	4.5240	1.2091	25.1855	30.4097	18.17	33.25	16.3	-23.8
	Total	44	28.0189	5.7085	.8606	26.2834	29.7545	14.75	39.25	20.4	10.9
PRE TEST	1: Random text	14	31.6667	5.3289	1.4242	28.5898	34.7435	22.50	42.25	16.8	
	2: Fact sheets	16	33.2604	6.0047	1.5012	30.0607	36.4601	17.58	43.75	18.1	
	3: Stories	14	30.8929	6.6058	1.7655	27.0788	34.7070	16.75	43.50	21.4	
	Total	44	32.0000	5.9483	.8967	30.1916	33.8084	16.75	43.75	18.4	

TABLE 4.7

Short-Answer Tests ANOVA Results
Items 12 thru 18

			Sum of Squares	df	Mean Square	F	*p*
GAIN SCORE	Between Groups		17.474	2	8.737	.296	.745
	Within Groups		1209.038	41	29.489		
		Total	1226.512	43			
POST TEST	Between Groups		11.169	2	5.584	.165	.849
	Within Groups		1390.093	41	33.905		
		Total	1401.262	43			
PRETEST	Between Groups		44.135	2	22.067	.612	.547
	Within Groups		1477.296	41	36.032		
		Total	1521.431	43			

In Table 4.7 we can see that the ANOVA results for the pretest show that there were no significant differences between the groups ($p = 0.547$, $\alpha = .05$). This is consistent with the multiple-choice results, again showing that all groups possessed about the same ill-structured problem-solving skill level at the outset. However, here we also find that for the post test there is no significant difference between the groups ($p = 0.849$, $\alpha = .05$). In addition, we also see that no groups showed any significant difference in gain ($p = 0.745$, $\alpha = .05$). It is interesting to note that, as with the multiple-choice test results, the coefficient of variation pertaining to the Case Library group is the only one that drops sharply from pretest to post test (-23.8%). Also in Table 4.6 we see that the gain scores on *all* participants are negative; that is, they experienced a drop in scores from pretest to post test. Despite these results, these statistics fail to support the notion that the Case Library had an effect in the arguments the students constructed in response to the short-answer test items. This contradicts the multiple-choice test results and may be pointing to errors due to student fatigue, the test itself, the rubric, or a combination of the above.

Research Findings Regarding Meaning-Making Experience and Process

In addition to research question 1 as presented above, this study also set out to address the following research questions:

2. How do novice learners and novice practitioners make meaning of experts' stories when problem solving? How is the pedagogical value of these stories developed by the novices? What is the role of context in school or the workplace in this meaning-making process?
3. What is the process at work when novice learners and novice practitioners listen to, read, recall, or use experts' stories while problem solving? Specifically,
    - What is the novice's thinking and meaning-making process as she progresses through the following sequence of events:
        - The moment a novice learner comes in contact with a problem situation in school or a novice practitioner wrestles with an ongoing problem at work?
        - When a novice learner reads a story from a Case Library or a novice practitioner listens to a story that contributes to an ongoing problem-solving situation?
        - Right after they have experienced the stories?
        - Right after they attempt to make decisions regarding a related problem situation?
        - Sometime later (say weeks, months, years), when they are confronted with a new problem situation and are required to work on a new set of problems?
        - Right after they provide decisions regarding these new set of problems?
    - How do novices incorporate the lessons to be learned from the stories into a new problem situation?
    - What are the overarching themes emerging from the novice's introspection regarding the impact the stories have had on her learning and meaning-making processes?

As apparent from these research questions, the issue of story meaning-making experience and process has to be addressed by referring to the qualitative data collected in the field and the data collected in the school after the post tests. Since the ultimate purpose of the qualitative portion of this study is to develop a model identifying the role of storytelling, the presentation of the findings will proceed as follows. The model will be presented and described in general, followed by a more detailed explanation and application of the model within the context of the data collected from novice practitioners (work setting) and novice learners (school setting).

Then, the research questions will be addressed. In the next chapter, portions of the data from both types of novices will be contrasted within the context of the model while some implications will be discussed.

Theoretical Model on Experiencing Meaning Through Stories During Problem Solving

Figure 4.1 shows a Grounded Theory model for experiencing meaning through stories during problem solving. This model was developed employing Strauss and Corbin's (1998) Grounded Theory framework and using the qualitative data collected from novice practitioners (work setting) and novice learners (school setting).

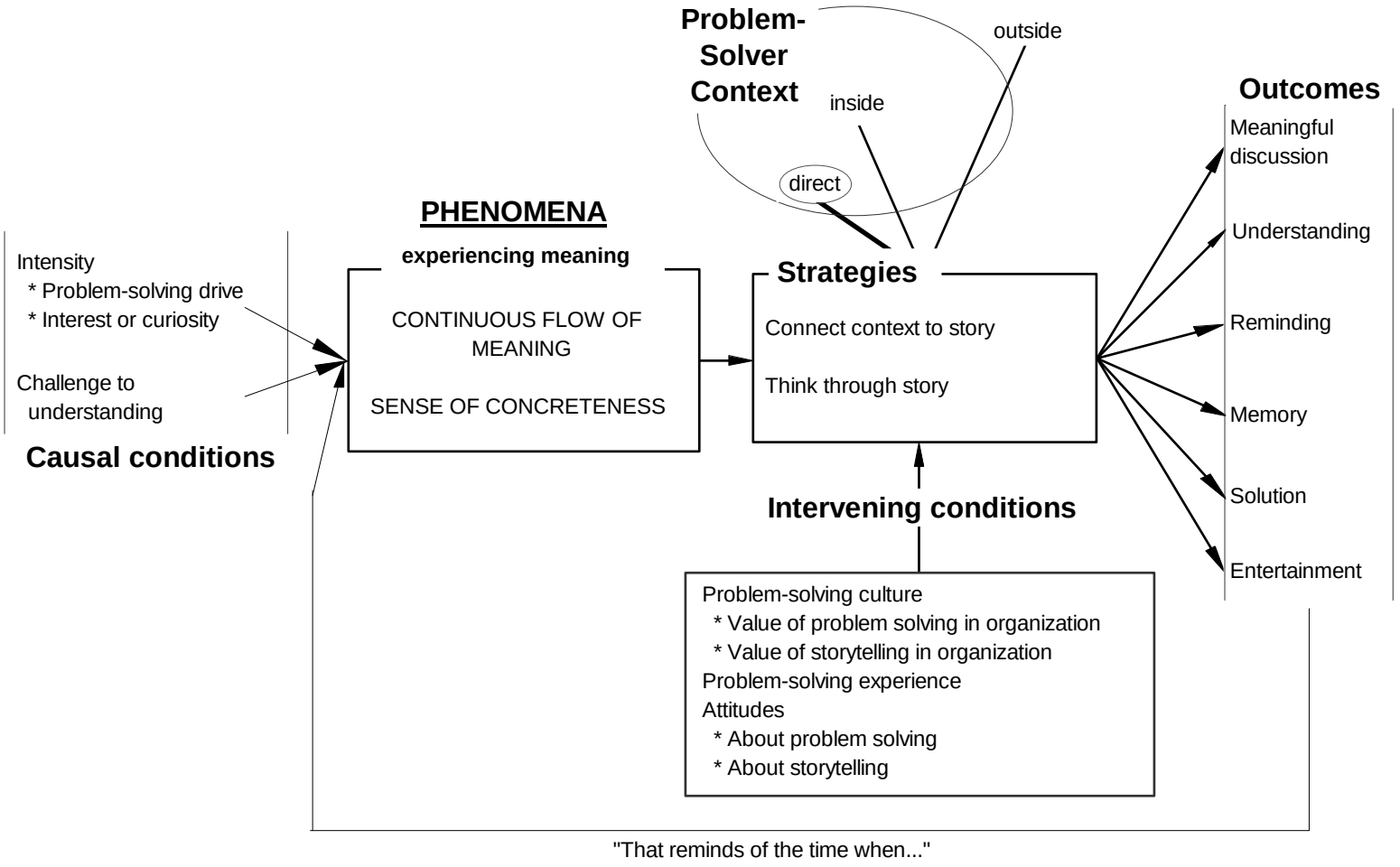
In general, this model is an attempt to represent the phenomenon of experiencing meaning when problem solving through stories. Following the general guidelines laid out by Strauss and Corbin (1998), this model identifies *causal conditions* emerging from the qualitative data (intensity of problem solving, interest or curiosity, and challenge to understanding), which ultimately led the participants to experience meaning through stories. It presents the *phenomena*; that is, the most prominent experiences of meaning as articulated by the novices (continuous flow of meaning and sense of concreteness). It also presents the *strategies* developed by the participants for experiencing the phenomenon of meaning through stories by connecting to and thinking through the story. Then it presents the influence that *context* exerts on these strategies: a) direct context, meaning the immediate problem the novice is wrestling with and most likely what originated the causal condition; b) inside context, meaning the organizational factors encompassing the direct context, such as the company culture the novice practitioner has to operate in or the undergraduate course the novice learner has to deal with; and c) outside context, meaning anything outside the organization the novice operates in, which is beyond his reach such as what happens in other companies, other courses, universities or the world at large. In addition it presents the *intervening conditions* that also may affect the strategies (individual/organizational value, attitudes and experience with regards to problem solving and storytelling). Finally, it presents the *outcomes* ensuing from these strategies (also referred to as

consequences). Each element in the model will be explained in more detail while always attempting to ground the explanations on all the qualitative data from which they emerged.

At this point, it is important to heed a warning that Strauss and Corbin (1998) make regarding the use of a Grounded Theory tradition in the explanation of phenomena. The objective of this model is to serve as a basis for discussion regarding the complex path of relationships that were observed during this research. This model is not to be taken as a basis for deriving simplistic "if . . . then . . . else" rules. It is not intended either as a definitive objective representation of the phenomenon of problem solving through stories. It is presented here as an anchor for grounding the discussion for the rest of this thesis. With that caveat in mind, now we turn to the explanation of each of the elements in the model.

Figure 4.1

Theoretical Model for Experiencing Meaning Through Stories During Problem Solving



Novice Practitioners Meaning-Making Experience and Process

Causal Conditions

Everything starts with a cause. For Thomas (see figure 4.2), the cause is always a problem he is wrestling with in one of his projects. Despite being an Associate Scientist, he is still considered a novice. He states, "I still feel novice, as a scientist who has to organize and lead a project team. And I still rely on the technical expertise of one of my Associate Scientists" (Thomas I, ¶ 348). Project *McKinley* is very much on Thomas' mind lately, and for that reason he suggested I use it for the context of the present study. Project *McKinley* is about delivering

Figure 4.2

Thomas Gere

Thomas Gere is a graduate in biochemistry from a large private university in the eastern U.S., class of 1996. Thomas' only work experience is with the company Y&Z Candies, where he has worked for the past four years. He started as a temporary technician through a Temp Agency. After six months he was hired to a permanent position as technician, and later promoted to senior technician. A year ago he was promoted to Associate Research Scientist, his current job title, under the Research & Development (R&D) division. His duties are complex, more often than not wrestling with problems that are highly ill structured and requiring him to constantly interface with scientists, technicians, marketing personnel, division directors, and food product developers.

In brief, Thomas' job is to turn product concepts that presently exist only on paper into a reality within a given timeframe following a familiar product development sequence. That is, after product marketing isolates a product concept through research (say, a new candy with cinnamon flavor) and if the concept is promising, they come to him with a detailed concept report. He is charged with creating a product that matches the concept. In his own words, "I do the formulation myself. I do the batching myself; I do the weighing and the *cooking* and making the prototype myself" (Thomas I, ¶ 17). The concept is articulated with marketing reports often including drawings and specifying what the product should look, taste and behave like (hard, soft, brittle, sticky, etc.). Basically, he provides the necessary leadership to make a product from this concept report. This includes, but is not limited to, finding the appropriate ingredients, developing a procedure for mixing the ingredients, and making a prototype for evaluation. If the resulting prototype (the evolving product) matches the concept, he continues to support marketing as they take the product to consumer tests, and later on, if successful, to scale up (a procedure to mass-produce the prototype). After scale-up, he hands over all responsibility to the company's production department and his relationship with the product ends.

Thomas' tasks embody the combination of science (particularly biochemistry) and management (people, time, equipment, etc.) as it is applied to the food product development process. In contrast to Nancy and Amy, the two other practitioners, who perform at a very specific level within the food product development process (lab testing), Thomas is the prototypical food product developer. He is sitting "in the front row" and despite his very short career with the company, he has already seen a good number of products rise and fall. Thomas did not have any problem in identifying ill-structured problems for my inquiry since working on complex problems is his game.

sweetness, creaminess and coolness to hard/chewy candy. This is an ambitious project that, if successful, will bring about the creation of at least a dozen new products, which have the potential to earn the company, Y&Z Candies (see figure 4.5), hundreds of millions of dollars. For the last two months he has been working very hard on a problem. Delivering sweetness and creaminess is easy (done), but not easy delivering the coolness in a hard candy that marketing demands (not done).

The cause for Nancy (see figure 4.3), a lab technician, is that "our suppliers don't all give us the same thing . . . for ingredients" (Nancy I, ¶ 385). As a lab technician, she was engaged in a

Figure 4.3

Nancy Murphy

Nancy Murphy is a Biology and English graduate (double major) from a private university in the eastern U.S. She joined the company shortly after graduating in 1997. Nancy's full time work experience has only occurred in Y&Z Candies where she has acquired three years of experience. Like many typical college students, she came into contact with the company as an intern for one summer. After graduation, she formally joined the company when a job opened in the Microbiology area (also referred to as Micro) at the technician level under the Research & Development department (R&D). Her job title is Senior Technician in Micro.

In general, her duties require her to spend most of the time in a lab where she rotates jobs with six other technicians every one or two months performing a whole range of intricate technical analyses. Each rotation requires different skills; however, tasks within Micro are relatively unchanged through the whole rotation cycle. Her most important responsibilities include ingredient sampling—making sure the materials used for manufacturing the candy products are free of contamination (pesticides, bacteria, etc.)—environmental sampling at the plant—inspecting equipment to see if they are a source of contamination—and making sure a finished product was manufactured according to specifications. Because of the nature of her duties, she is considered a service person. She evaluates numerous samples that come to her lab from a number of company researchers who work on specific projects. Most often she works as the Micro assistant to a number of these researchers.

Even though Nancy was hired because she possessed the appropriate scientific and technical background to work in a laboratory, problem solving in her area does not necessarily proceed according to the scientific method. When I asked her to describe for me the kind of "typical" problem she faces in her area, this is how she responded:

"You go on the [production] line and see where the problem might be. And I guess you are looking for problem spots, spots that could be causing the problem . . . you take the environmental swab, or you could take samples from different parts of the line I guess before it reaches this point and see if it's clean. If you find something contaminated you know that it's somewhere, then you have to narrow it down since it [the production area] is such a huge place and it can be anywhere and micros [microbes] aren't big and they can be hiding [laughs] anywhere. That's why I use the analogy of finding a needle in a haystack. That's what my job is about, just trying to narrow it and narrow it" (Nancy I, ¶ 485).

project that originally was just trying to change how technicians in the lab do their sampling for regular testing. Now it has turned into a full-fledged project, involving a half dozen technicians and a half dozen researchers. She works closely with more senior technicians on finding solutions to the numerous problems that have arisen since, as she blatantly states, there are "a lot of different opinions on what the problem actually is" (Nancy I, ¶ 385). They hope that by early in 2001 a standard procedure for dealing with suppliers and ingredients will be implemented on a pilot basis. They hope that by the summer of 2001 all suppliers will implement their new and elaborate sampling program. This new sampling program will ensure standard procedures for handling and testing ingredients with which the company makes its candy products, the products that ultimately will be ingested by people. Nancy well realizes the importance of her problem-solving ability: "anything that comes out of here [Micro lab] for problem solving you want to make sure that it is the best that you can make it" (Nancy I, ¶ 1001).

For Amy (see figure 4.4), another lab technician, the problem is that things are out of specification. A particular sample analysis is showing that the pesticide level is not within the

Figure 4.4

Amy Thomson

Amy is a former food science major from a large public university in eastern U.S., class of 1998. She is a Senior Technician in the Microbiology lab area. Amy has only worked for Y&Z Candies, where she has acquired one and a half years of experience. She started as an intern for two summers prior to her date of hire. After graduating, she decided to work as a nanny in addition to taking a part-time position in the company ("menial work") waiting for a position to open in the company ("I basically didn't want to work anywhere else but here"). At that time, there was a hiring freeze except for hires from within the company. Since she was considered to be an "insider," when a position opened up in the Micro lab area she was hired as a regular technician.

She works in a 4-person self-directed work team; that is, "Any problems . . . we are supposed to work out on our own as much as possible. And only come to [suppressed: the team supervisor] as a last resort" (Amy, ¶ 352). As part of that arrangement, all four team members are required to work together a lot, and arrive at decisions together with little or no intervention from senior management. Her specific duties include working with highly specialized equipment for finding and removing pesticides from lab samples, and testing ingredients and finished products for other contaminants. "It is very chemical" (Amy I, ¶ 11).

acceptable range. This could have serious implications, possibly indicating to a high level of pesticide in the candy product tested. "It was happening pretty consistently here for a while [showing me the tables and graphs with unusual spikes], which is why we [she and her team members] decided we needed to do something about it" (Amy video log, ¶ 16).

In summary, for Thomas, Nancy and Amy, the three novice practitioners in my study, the importance of finding solutions to their problems is clear, whether it is making money for the company (see figure 4.5), getting the best-quality ingredients from suppliers, or ensuring that

Figure 4.5

Y&Z Candies

The company that eagerly opened its door to my research, Y&Z Candies, has been around for a long time. In fact, its founder, Mr. Stanley, was a true pioneer who built the company from scratch into one of the first truly national candy companies in the U.S. in the early 20th century. While achieving his dream, he also instilled a strong sense of perfection, pride, social responsibility and human values into the company. In Y&Z, he is a true legend and great stories abound: "You always hear about all the generous things he did" (Amy I, ¶ 330).

Y&Z is a company that fosters close relationships between its employees. "As far as individually and interaction with the other co-workers, it's very family oriented. Everybody is conventional and also caring towards others. Always somebody who is ahead of you always trying to become a mentor and trying to take you not only at work as an understudy but also outside of work, you know churches, sports, things like that" (Thomas I, ¶ 371).

Employees are made aware of the importance of their work very early in their careers as Nancy expressed with these words: "The Y&Z name holds such trust, for people . . . trust the name . . . and people like the thought, I mean it's such a good thing that anything that comes out of here [Micro] for problem solving you want to make sure that it is the best that you can make it. You have the best type of product, or the safest product, or the best packaged, or whatever your department is. You are proud to put the Y&Z name on it and that is part of the problem solving. You need to make it the best that you can make it in the cost that you have to make it in and in the time that you have to make it in" (Nancy I, ¶ 1001).

This is Y&Z Candies, the company Nancy, Amy and Thomas work for, a company founded by a legendary character over 100 years ago with a longstanding record of success and a company, which has gained immense respect from its employees and the surrounding community.

products are free from pesticides. They know that the company expects them to work on these problems with intensity. The intensity is such that oftentimes problem solving even extends beyond the lab. Amy's intensity is a case in point. In addition to her duties, Amy is the ordering person in her area. Not long ago when she was about to go on vacation, a solvent used in the lab

had not arrived. She worried, "I am not going to go on my vacation if this solvent doesn't come in before I leave" (Amy I, ¶ 675). When I asked her why was that so important, she replied that without this solvent "we can't test any of our cocoa butter or cocoa beans and that means the plants can't make chocolate because they don't have any cocoa butter and that is a really big problem. So, lots of money lost" (Amy I ¶ 683). It is employees like Amy, who approach all problems with such intensity, who have made Y&Z Candies a very successful problem-solving company.

Phenomena

The causal condition, such as Thomas and his "coolness" problem, varying in level of intensity, interest or curiosity, propelled these novices into a path of experience and understanding. Their problems led them to unique paths in search of a solution. Some chose paths that led them to experience stories. For this study, descriptions of their respective experiences are the basis for explaining the phenomenon of meaning making through stories.

For these novices, stories are a means of maintaining a continuous flow of meaning. Thomas' "coolness" problem is a case in point. While working on the *McKinley* project, Thomas prepared about a dozen prototypes with variations of "coolness" that he felt would be acceptable to Lana, the marketing person who wanted the cooling effect. Doug, product development director, Audrey, a product developer who worked with Thomas on other projects, and David, a market researcher were also present at this meeting. These meetings are intense explorations of product concepts. It is a true food product development drama in which consumer marketing data, what science can make possible, and intuition determine the fate of would-be products. A VP in marketing some two-and-a-half years ago shared with me that products follow the 1000-100-10 rule at Y&Z; that is, of 1000 product ideas dreamed up by

marketing, only 100 are turned into concepts, and of those, only 10 get produced and test marketed. Of those, only 2 or 3 actually make it to the stores! Thomas was now working with a product that already made it to the top 10. At this stage of the game too much money had already been invested, so there was a lot of pressure on the whole group to do things right. During the meeting, over a dozen products were tested (and literally *tasted*) while intense discussion ensued on the prototype's characteristics such as taste, shape, size, texture, color, appeal, etc. But the most significant part of this meeting (close to two hours) was the number of prior cases that were brought into the discussion (see Appendix M, Thomas' 2nd session, 3). When I showed one segment of the tape to Thomas during our 2nd interview and then listed the number of prior cases that were brought up, I inquired,

> JULIAN: What's the value of bringing in a prior product like *TasteBud* into this discussion?
> THOMAS: The value is since we are talking about concepts and prototypes that are yet to be developed and finished, having a product that was already made would give you a basis. *You are at least on the same page.* (Thomas II, ¶¶ 264-5)

By continuously referring to product after product during this two-hour meeting when wrestling with complex conceptual problems, they were able to maintain a continuous flow of meaning that helped keep their problem-solving discussion going.

> JULIAN: How are they so important? You guys are very intent when talking about this.
> THOMAS: They are very important to us because we don't want to duplicate works before. So we learn from successes or failure of the prior tests . . . what had happened. For example, when I talked about the cookies and cream having not delivered the flavor and also having bad texture, what I draw into her [Lana] is she wants to do a cookies and cream the same way that we did it before. So it immediately clicks and [I] said, "We did that. We sent it to focus groups and it was butchered!" It was absolutely not liked. So what I am giving her [is] a flag "This route is not a good way to go because it has already been done and tested" (Thomas II, ¶¶ 288-9)

Lana, Audrey, Thomas and Doug also turned to prior cases for making a point like the example above. It seems like a discussion that rests on past stories of products that bring about dramas of success or failure afford a sense of concreteness difficult to attain by simply talking in the

abstract of concepts of taste, shape, size, texture, color and appeal regarding products that are not yet completely designed.

In a similar form, I found how Nancy and a teammate, by bringing a prior case, were able to keep the rest of the team focused on the sampling problem by making the discussion more concrete. In this case, Nancy, the most novice member of the team, brings up the case first. At this point in the meeting, which by this time had been going on for over an hour and seemed to be getting out of focus, everyone was struggling with the notion of the size of a sampling lot. Several suppliers' names were brought up and experiences were shared on how some team members had interpreted the size of a lot in the past. During the 2nd interview, it is at this point during this intense debate that I show Nancy a fragment of the video on this discussion and asked her to reflect on what was going through her mind at that time:

> JULIAN: Janice [one senior researcher in the team] is going to bring something up. [I show that segment of the video] You bring up briefly the case of [suppressed, a supplier's name]. Janice takes it from there and elaborates a little bit more and focuses the conversation on the [suppressed, a supplier's name] case. What was exactly she elaborating on?
>
> NANCY: We had sent out a form to all the suppliers asking specific questions about their sampling, how they sampled for us, how they defined their lot, how much they are sending to us as a sample, things like that. Janice had the [suppressed, a supplier's name] paper in front of her. We were discussing "Well what kind of samples are we getting from here?"
>
> JULIAN: Prior to the meeting?
>
> NANCY: Just like in general there. I said "[suppressed, a supplier's name] will send us this, this and this" and Jan said "Well that's not defined here!" That is what she said. "That is not defined here!" She was actually referring to the paper that was in front of her from [suppressed, a supplier's name] and saying that what we have actually think we are probably getting from [suppressed, a supplier's name], may not be what we are actually getting from them based on their information, which is something that we didn't know before. (Nancy II, ¶¶ 264-7)

When I asked her if that was a good way of keeping a problem-solving discussion focused, she responded:

> Yes. And that was Janice's point in bringing that up . . . [it] was "We really need to sit down and talk, not just on paper because sometimes it is very difficult to deduct things from paper. We

> need to sit down and talk to the people from [suppressed, a supplier's name]. Bring them here or let's go there." And actually that happened last week. (Nancy II, ¶ 275)

By Nancy and Janice bringing up the case of the discrepancy between what a lot is regarding this particular supplier, the discussion quickly gained focus (established a continuous flow of meaning) and this opened an opportunity for Janice to focus on the dilemma (lack of information) and a possible solution (talk to each supplier in question).

Context

The strategies employed for experiencing meaning through stories will be influenced by the proximity of the story to the novice practitioner's context. If the story deals with issues directly applicable to the problem the novice is wrestling with at the moment (a failed product similar to the prototype), connection to the story is direct and immediate making it almost unnecessary to explicate the story *or even to recount it fully*. If the story is removed from the novice's immediate context in such way that it is only somewhat related to her context, the novice's strategies for connecting will not be as effective. And if the story deals with events impossible for the novice to experience or control, then the story's capacity to connect with the novice is hampered even further. It seems like experiencing meaning is possible in any context, but the intensity of the meaning-making experience will depend on the ease with which the problem solver is able to make a connection between the story context and the context in which the causal condition occurred.

For a novice practitioner like Thomas, when Lana, the marketing person in the *McKinley* project, brought up the case of the successful company product called *TasteBud* she did it with the understanding that Thomas knew exactly what she was talking about. While referring to the complexity of applying multiple flavors to a hard candy (à la *TasteBud*), all she had to do was remind Thomas that he had worked on that product, and the problem-solving discussion

seamlessly turned to why the prototype was or was not facing problems similar to what *TasteBud* did when it was being developed. When questioned about this incident, Thomas had this to say:

> For the hard candy part, it is relevant because we were trying to make *TasteBud*-type candy that has more than one flavor in it, like a chocolate crème center with a mint hard shell for example . . . I think that was an excellent example because they are so close. (Thomas II, ¶¶ 255-9)

The number of *TasteBud* stories (successes and failures) shared between Thomas and Lana made possible an intensive examination of possible solution paths for dealing with flavoring issues for the upcoming *McKinley* products. *TasteBud* stories were directly applicable to the problems at hand thus making the experience of the storytelling phenomena immediate and effective.

In Nancy's case, a story, though far removed from her immediate problems at the lab, becomes relevant if it deals with issues that bring meaning to her life. She has enormous interest in health policy issues. For that reason stories about food poisoning (outbreaks) do not go unnoticed. She shared a story with me about an outbreak in Japan that resulted in 12,000 people getting sick. Some of the older victims died. She laments, "I think things like that really prey on somebody who is in my position to think about that kind of stuff. It could have been prevented" (Nancy I, ¶ 645). She quickly adds in an emotional tone,

> It affects people. It is not just the fact that a person got sick, a human . . . got sick. *It kind of makes it a personal issue*. I don't want my mom to get sick off of something that she ate that I didn't check. (Nancy I, ¶ 651)

That story is bound to stay with Nancy for a long time despite it not providing a lesson directly applicable to her daily activities in the lab or not being relevant to the sampling project's problems she has been working on.

When I asked Amy about the value of stories, she immediately declared that stories are valuable. However, when asked why, she quickly seems to connect the value of stories with the problems that are immediate to her, that is, chemical analysis. In fact, she expressed that beyond

obtaining the experience herself, she thinks that learning about someone else's experience through a story is almost as good as *or even more* than going through the experience herself:

> If it is a story that sticks with you, then it really stands out in your mind, then I would say it has as much if not more [value than one's own experience]. Any time it is your own experience, it is somewhat guaranteed to stick with you I think. When I was learning GPC [a sophisticated procedure for doing chemical analysis] . . . I made a lot of mistakes but I never made the same mistake twice because I was learning from my mistakes. If anyone gave me a very specific example of when they made a mistake—I don't think they did—it probably would have helped me. [laughs] If they had given me like stories, like if they would have said "Well one time I did this and this happened" then I think I might have learned from their mistakes better. (Amy I, ¶ 101)

To Amy, the value of learning through stories will depend on how well stories will "stick with her," and that itself will depend on how well the stories impact her work; in other words, how well the stories support her problem-solving tasks *right at her lab*.

Intervening Conditions

When these novices practitioners choose to experience the meaning conveyed by a story, they seem to do so based on conditions related to the value attributed to storytelling as it is applied to problem solving. Likewise, attitudes about problem solving (just wanting to be a better problem solver) will eventually lead these novices to turn to a good story in support of meaning. Finally, only those who have experience in problem solving will have a plentiful stock of meaningful stories to tell—and only if they see value in sharing them.

In the *TasteBud* example alluded to earlier, Thomas finds significance and meaning, but this only happened because he was willing to *think in the terms required by a story*. This belief in the value of storytelling opens a space to those who want to share a story that can help with a problem. When Doug, the food product development director in Thomas' team, shared a story for about one and a half minutes ("But when we did the focus groups for KarMichael . . ."), time during which no one interrupted, the intense attention to what he had to say demonstrated that

value. All eyes seemed riveted on Doug as he forewarned against market testing the hard candy prototype with a bland-looking color.

I asked Nancy to reflect on her past academic experience. Storytelling emerged early in this discussion.[14] For her, the value of learning through stories is taken for granted:

> NANCY: *I think I learn better with stories*. I had an old chem teacher who had worked in the field in pharmaceuticals and I think he was a whole lot better at teaching Og chem than some of the others that I had had like other chemistry teachers because they could tell you why it was important to learn what you were learning and give practical "This is what you do in such and such a field with this information." He would make up stories about bromide ions . . . I am more of a visual need . . . to hear that kind of stuff and see... and he would make up little stories about them and I would remember that better than just by looking at a compound and saying "That is what that is . . ." and "This is what it does . . ." straightforward kind of. *I need more of a little story* about.
> JULIAN: So it was more like literature?
> NANCY: Yeah.
> JULIAN: Do you think that the other students saw it that way or they thought it probably was silly?
> NANCY: I don't know. Maybe a little bit of both. I guess in the Liberal Arts College there were a lot of people with double majors that were odd: chemistry, art.
> JULIAN: So maybe they could make sense of that combination?
> NANCY: Yeah.
> JULIAN: So that was a good teacher, that particular one because of that?
> NANCY: Yeah. (Nancy I, ¶¶ 36-44)

Amy, barely two years on the job, recognizes that such a thing as problem-solving "history" exists in Y&Z Candies. She has learned to pay serious attention to these stories because of the value it is attributed to them in the organization. At one point in the problem-solving meeting, the discussion turned to a past incident long before Amy's time, the possibility that a detergent was the cause of the unusual peaks. This piece of past "history" is shared during this intense problem-solving meeting, which is a way for Amy, the newest in the team, to come in contact with that history, problem solve with it, and, most importantly, learn. I asked her to explain to

[14] I had not informed novice practitioners about the specific nature of my research at this stage. All they knew was that it dealt with problem solving. I informed them at the end of the 2nd interview that it was about experts' stories.

me the process and this is how she responded:

> AMY: I think there may have been, see a lot of it . . . *there is history*. They [the two senior members of the team] have been working on problems like this since before I have been here and some of these things may have been things that they tried before and they have worked for a time. I think for example using the type of detergent that they [the workers who wash the lab instruments] used to wash our dishes. I think before, they were using a kind that they weren't supposed to be using. We found that out and asked them to switch it and things got better. So it was our kind of like "Well did they switch back and not tell us...?" or you know, "...switch to a new kind?" So that, maybe, that would be a contamination problem.
> JULIAN: Have you seen that actually happening?
> AMY: Seen what actually happening?
> JULIAN: That problem of the detergent . . . ?
> AMY: *Not since I have been here*. It hasn't actually been the cause of something here.
> JULIAN: How do you know? You just explained that to me very concretely. How did you know that that as a fact happened in the past?
> AMY: Because *they*[her older teammates] *told me* [laughs] that they had this problem before. (Amy II, ¶ 26-32)

However, learning through someone else's experiences through stories has not always been like that for Amy. She also shared with me her disappointment regarding the time when she joined the company and was asked to perform and learn but with little explanation. When Amy came to work in the lab, she wished she was given more elaborate examples, but the person in charge of her lab area did not seem to think much of lengthy explanations ("Oh you do it this way"). During that critical early period, Amy was never told any good stories.

Strategies

Learning through stories, understanding a story, telling a story or even attempting to remember a story requires a conscious effort to think in narrative form. Likewise, problem solving through stories about past product failures or successes requires the novice practitioner to think through a story and connect that story to the problem at hand.

For Thomas, when he consults with the experts in the product development division regarding a problem he is facing, he prefers to receive explanations in terms of older products in which the expert has worked on. Although he sees value in any form of explanation (facts,

stories, graphs, etc.), it is less difficult for him to understand the explanations when the problem is put in the context of a product he can "think through." He described for me an instance in which he went to see an expert who actually keeps a library of past products and associated problems:

> THOMAS: He [the expert] has a library of products in his office actually. Sometimes I know there were 2 times where the problem I was going into he had faced before. He overcame them by a certain process and he gave me an example of the product.
> JULIAN: If he didn't give you those examples, do you think that he would be less effective as far as explaining to you?
> THOMAS: No. It would add more . . . I can still understand . . . it would make it more . . . difficult. It would make it then that you have to either find such products yourself, or try to make it in the lab and see if it worked . . . I prefer him *showing me the product and making it* [getting the explanation] in that context. (Thomas I, ¶¶ 329-39)

For Thomas, this library of products and related problems as articulated by the expert is a way for him to think through the problems that he is about to face with his new products.

For Nancy, the connection to the story is made by picturing the character in the story, that is the teammate telling the story, going through the experience:

> I think that [the story] is what you remember the most. Like when you think back in situations, you remember the stories because those are the personal aspects of it. You say "Oh yeah Lauren [a teammate] experienced that" and so you remember that versus if it was just a bunch of facts that Lauren spouted off. I think you remember that a lot more saying "Oh yeah..." because you can *picture going through that experience* and hear her tell about that personal experience, personal meaning in a professional setting as well, more than if she would just say "I learned this, this and this..." without telling the story around it. I think you don't remember that as well. (Nancy II, ¶ 385)

Amy explained to me that when her teammates where helping her in identifying the cause for the unusual peaks on the graph, in her mind she was constantly going over the cases they were sharing with her. When someone suggested that the peaks might be due to flavor or dyes and not pesticides, she quickly connected that suggestion to a conversation long ago about a similar situation: "This happened before where we had a new peak and it turned out to be a flavor" (Amy II, ¶ 46). Similarly, when someone raised the possibility of the peaks being similar to

those found on a cinnamon-flavor candy the team had worked on, she again quickly connected to that incident 6 months earlier. For this product, it was found that the peak was due to a pesticide only after a more comprehensive test was run ("gas chromatography"). As a consequence, she reasoned that this was a promising solution path to explore.

Outcomes

Pursuing a strategy of thinking through a story will lead to an outcome. The number of outcomes associated with storytelling are varied as it is apparent from these novice practitioners. In the case of Thomas, the desired outcome of thinking through a story was a "narrowing it down" to a possible solution. When a prior project was brought up by a team member that could possibly help Thomas with the elusive "cooling" effect he had been wrestling with, he explained, "So him interjecting and saying 'project KarMichael' *it opened up a window for me to go and look at project* KarMichael" (Thomas II, ¶ 83). As it turned out, it was a not a good lead after all. Or was it?

> THOMAS: By bringing that up it was relevant but later I found out it was a diversion from my side.
> JULIAN: Was it worthwhile pursuing?
> THOMAS: Yes. That eliminated one of the issues.
> JULIAN: So you learned?
> THOMAS: Yeah . . . I find it useful because it eliminates one of the possibilities most of the time. Once in a while you get lucky and find some answers to your questions. But *its use is mostly in eliminating possibilities*, that you don't have to do an experiment to rule that out. It has been already done. (Thomas II, ¶¶ 83-93)

For Nancy, the outcome may be about sustaining meaningful conversations on problems:

> I think it is probably *one of the most effective ways to get a point across*. Everybody has experiences with different things and when you come to approach a problem and you say "No don't do that" they don't say anything why. But if you say "Oh let me tell you about this time when I tried to do that and this is what happened . . ." then it is much more of an explanation than just "I wouldn't do that if I were you!" or something like that. (Nancy II, ¶ 387)

But, as it was the case with Thomas, sometimes it may be about ruling out possibilities based on prior experiences, as in the following in which she explains to me how she researches and learns to use others' experiences when working on problems in her area:

> JULIAN: How does she [the most senior member in her team] relate experiences to you?
> NANCY: She probably will tell me about another prior case . . . "Two years ago we had this problem, we had this problem before . . ."
> JULIAN: Does that happen very often you think? Is it kind of repetitive . . . you can always relate that kind of experience?
> NANCY: Especially in something like we are working on in Y&Z Candies. There are only so many types of microbes that grow in [suppressed, an ingredient]. I am not concerned about a lot different things. So in that case, *experiences can repeat itself.* "We found this because of this." (Nancy II, ¶ 504-7)

Likewise for Amy, who when thinking in terms of a teammate's past experience in which the calibration of the equipment corrected unusual peaks similar to the one she was wrestling with, it led her to think in terms of a possible solution, that maybe all she needed to do was re-calibrate. After further inquiry, they all learned that someone had already done the re-calibration and the possible solution immediately vanished. But Amy still felt the impact of the experience: "In that case it was kind of like using an older experience to rule out one possibility" (Amy II, ¶ 66).

In summary, we see how these novice practitioners are able to experience the phenomenon of meaning through stories. It all starts with a cause, which can be the desire to arrive at a "cooling" effect on a hard candy, or grounding a discussion about ingredient sampling problems on specific prior experiences with current companies, or simply trying to explain the presence of pesticides in a finished product. These causes propel the novice practitioners into a number of problem-solving activities some of which will bring them in contact with stories. Listening to, relating, or problem solving through stories offers them the experience of meaning and concrete understanding. They can picture themselves in the stories or they can "see" possible solutions being "attempted" in existing products. However, for the novice practitioners to experience this meaning, they have to make a conscious effort to think through the story and the events, the

characters and the lessons contained in the story. They need to connect the story to the context of the problem they are wrestling with, which is what originated the quest for a solution. In addition, they need to see the value of stories and storytelling as legitimate forms of problem solving. Finally, the experience of meaning making through stories affords them continuous meaningful discussions, understanding, and possible solutions.

Let's now explore how the novice learners experience stories in the school setting.

Novice learners meaning-making experience and process

To explore the process of using stories in a school setting, I asked the two novice learner who were assigned to the Case Library group to walk me through the process of using stories as it was experienced by them while studying the material and working on the post test. For the other four novice learners who were not asked to go over stories during the course of the study (control and comparable groups), I showed them stories during the in-depth interviews, gave them time to study them carefully, asked them to connect the stories to the issues being raised in the Contadina case while I asked probing questions and stimulated discussion and gathered their impressions. I also showed all six novice learners fact sheets, asked them to contrast those with the corresponding stories, asked them to apply both fact sheets and stories to specific pretest and post test items while also gathering their impressions. The results of these intense conversations are the basis of this section.

Causal Conditions

As mentioned earlier, for the phenomenon of experiencing meaning through stories to occur there has to be a cause. For Cynthia (refer to Table 4.8 for the name of a novice learner and the group she belongs to), one of the novice learners randomly assigned to the comparable group

Table 4.8

Novice Learners

Group	Name	Description
Experimental	Joan Bob	Assigned to the case library with stories; that is, 24 stories with elaboration of issues as raised in the Contadina in the form of short stories (Edelson, 1993).
Comparable	Samuel Cynthia	Assigned to the fact sheets; that is, presentation of the same issues in the stories but without characters, timeline, drama or resolution.
Control	Bernard Laurie	Assigned to the random text; that is, text randomly selected from a food product development textbook unrelated to the issues covered by the facts sheets or stories.

(fact sheet), the problem was preparing for class. She always makes a conscious decision about how thoroughly she goes over any material assigned for study: “If I am going to discuss

something, if I am reading this [referring to the fact sheets] and I know that the next day in class we are going to discuss it, I know that I have to read this carefully and I can't just skim over it" (Cynthia, ¶ 328). When I asked, she admitted to having "skimmed" over the material for the course of my study. For Bernard, who was randomly assigned to the control group (random text), the problem is preparing for a test: "[If] this is going to be on the test, this is going to be on the exam, you have to, you have to take it. You can't just look at it and breeze through it" (Bernard, ¶ 135). For Samuel, also assigned to the fact sheet group, the problem seemed to be time: "I am so busy. I was trying to read it [fact sheets] so I could get it done quick enough so that I would have time for other things" (Samuel, ¶ 18). For Joan, assigned to the experimental group (stories), the problem was understanding the stories and how she could best prepare for the post test: "I had a problem with finding like a real narrow . . . what it was talking about. I would just put the main . . . what I thought the main gist was, what the most important part of the article [story] was underneath the company name so I could remember it for when I went to go take the test" (Joan, ¶ 52).

So, for Cynthia, Bernard, Samuel and Joan, their participation in my study created a series of problems, ranging from how in-depth to go over material, worries about the test, not enough time, and even about not understanding the material well enough. I suspect that these problems were also shared by their classmates.

Phenomena

My study created the basic need that would lead some of the novice learners to avail themselves of the stories in the Case Library. Further exploiting this need, I showed them stories during the interviews and gathered their impressions on the experience of meaning through stories. Their experience of the phenomenon is what is described next using the study as a basis.

For some of these novice learners, stories offer meaning by providing grounding and concreteness. I showed Samuel (fact sheet group) stories that were the counterparts to the fact sheets that he reviewed for the study. I asked him to contrast them for me. Regarding the narrative style he said: "It gives you *grounds* to understand on . . . it gives you *something tangible* to look at and to actually work with rather than just a jumble of words" (Samuel, ¶¶ 160, 248). For Bob (stories group), placing information in context gives it meaning: "it would be easier to digest and understand better information when you are given a direct context *to put it in.* When it's explained in something that already happened and just tell that story I think it makes it easier" (Bob, ¶ 120). For Cynthia (fact sheet group), stories are a means to relate a problem situation to concrete solutions as experienced by others: "they [the students] can get a lot of those kind of cases [stories] because *it is actually something you can relate to* and I think something like this probably would help with that case [the Contadina case used in the task environment] (Cynthia, ¶ 333). She elaborates:

> If I had a problem and I could type in key words of whatever [about what] my problem is and stories come back with how . . . similar stories . . . [I could] *read them and relate them to my problem* and see how the other problems [found in the task environment]. . . to see how everything worked out there. If the product failed or if the company is losing money, [I would] realize "Ok if we continue to do this, we need to switch gears and we need to try something else." (Cynthia, ¶¶ 347-9)

For Joan (stories group), the stories provide concrete descriptions on how real-life companies do things: "I thought the articles [stories] were definitely interesting and really *described the whole process* that the company had to go through to implement or do whatever they were trying to do (Joan, ¶ 42).

Context

As mentioned earlier, if the story deals with issues directly applicable to the problem the novice learner is wrestling with at the moment (a project for a class), connection to the story is

expected to be direct and immediate reducing the amount of effort necessary to understand and apply the story to the problem.

For the novice learners, the difference between experiencing the meaning inherent in the stories will depend on whether they can easily recognize familiar contextual elements, and whether the stories deal with issues that are relevant to their immediate problems. For Joan (stories group), the closer the story's context is to her context, the better the chances of understanding *and remembering*. She was able to remember the Hershey stories contained in the case library but she attributes it to the fact that Hershey is an easily recognizable company whose products she frequently consumes: "That probably does have something to do with it because I have seen those products" (Joan, ¶ 108). Laurie (random text) spoke similarly about some stories I showed her:

> If I were told the story in class and then I actually went to the store and I was like 'Oh look, Boston Market does have frozen . . .' it would kind of *hit home more*. I think I would absorb it a lot more. (Laurie, ¶ 303)

As Joan (story group) was quick to point out when referring to the relevance of stories used in the study, "It is not something that I draw on in any of my classes" (Joan, ¶ 98).

Despite the stories not being applicable to an immediate problem, for Bob (stories group) just placing information in space and time makes it easier to experience understanding when compared to plain facts:

> The same information is provided in both [fact sheet and story], but it would be easier to digest and understand better information when you are given a *direct context* to put it in. When it's explained in something that already happened and just tell that story I think it makes it easier. (Bob, ¶ 120)

Intervening Conditions

As mentioned before, the value placed on stories and storytelling by these novice learners will greatly influence their capacity to think through a story as they problem solve and the intensity of the experience of the meaning-making phenomenon.

For Cynthia (fact sheet), when asked about preference between stories and fact sheets, she sees value in a story *but not for her*: "I would rather read the one from the textbook [fact sheet] because it gets directly to the point. But I don't know if I would remember it as well" (Cynthia, ¶ 320). Stories were an inefficient way for her to get "the point." On the other hand, for Bob (story group), this apparent inefficiency is a small price to pay given the rewards of good understanding: "Even though it [the story] might take longer to read, I think for myself at least I have an easier time getting something . . . that is written as a story as opposed to something that is written like a textbook [fact sheet]" (Bob, ¶ 118).

For Laurie, stories are valuable but not when used on their own, but when they are used as a basis for class discussion:

> Being able to *use a real life experiences and examples to help you* [as they are presented in the stories] . . . if I am going to use like for example this thing [a story], for me someone telling me and re-learning it in class would be more valuable than me reading it. I would comprehend it more if someone were to explain it. (Laurie, ¶ 301)

She added that she foresaw even more value if she later on experienced the products or came in contact with the companies featured in the stories.

For Samuel, thinking through stories is a valuable and powerful way of thinking compatible with his explaining strategies:

> I tend to use examples a lot more than just explanations. That is just the way I am personally. I use a lot of metaphors and examples or experiences that I have had in trying to relate them to what I am teaching a person or what I am trying to explain to a person that happened. That is just the way I am. *It works better for me*. (Samuel, ¶ 162)

Strategies

However, to experience the meaning contained in a story requires conscious effort. For Samuel (fact sheet), experiencing meaning through a story requires a different form of thinking and a search for connections:

> It gives you . . . *rather than thinking about it in the sense of yourself or what your own experiences are,* you are looking at other people with another company's experience and what they have done. I think it really helps make a solid connection between the material you are learning and its real world aspects and implications. (Samuel, ¶ 224)

For Bob (stories group), making the connection to the context of the problem (the Contadina case) was a deliberate effort: "I found it kind of easy to make the connections. I understood how each one, there was a Coca-Cola one and Pokémon I believe, I understood how they related to the text [Contadina case]" (Bob, ¶ 25). While Bob and I reviewed the post test, he explained to me how he tried to answer some of the questions: "When I was taking the test, it took me a few minutes to think of a proper example to draw from and try to make correlations between what happened there and what could plausibly happen given this situation" (Bob, ¶ 249). For him, it was a different way of thinking: "In an academic setting maybe I think through telling. . . through giving a story and giving these facts . . . actual reference points, makes it easier to understand initially" (Bob, ¶ 128). On the other hand, the experience of meaning through a story may never be achieved despite all efforts due to an inadequate connection strategy and contextual distance. This was the case with Joan (story group) with one of the stories in which she gave up after being unable to see how the story connected to the Contadina case: "I don't think I really picked up on that" (Joan, ¶ 76).

Outcomes

For the novice learners in my study, the outcomes realized from the meaning-making experience of problem solving through stories are varied. For Bob, it is about reminding, committing to memory and adapting (Schank, 1999): "when something is talked about in a context and actually how it was done it is easier to remember and recall and answer" (Bob, ¶ 77). Further on he added that it helps him in the acquisition of "experience":

> BOB: I think it almost gives you experiences that you never really experienced but now you have seen a certain set of problems and you know exactly how it was solved. It is kind of like *gaining experience* without really . . . um . . .
> JULIAN: Being there?
> BOB: *Being in the industry*. (Bob, ¶¶ 261-3)

For Cynthia, the outcome is about committing to memory because it is unique, maybe entertaining or bizarre:

> CYNTHIA: This one [story] I could read and remember it. The other one [fact sheet] I will read and remember and forget it. [laughs]
> JULIAN: You will forget it quicker?
> CYNTHIA: Yes
> JULIAN: You think so?
> CYNTHIA: Because this one I have like . . . story of the stupid manager who didn't look at his research and who was trying to compete with competition, the competition was coming out. Didn't do research. *I will remember* that one rather than the other ones. (Cynthia, ¶¶ 303-7)

For Samuel, the outcome resulting from thinking through a story is about understanding within the context of "the real world":

> It gives you a real something tangible to hold on to rather than just a definition or an explanation of what market potential is because you could talk about market potential until you are blue in the face but if somebody can't see how that *relates to what is happening in the real world*, when they get out there they are just going to be clueless. (Samuel, ¶ 154)

In summary, novice learners are propelled into the phenomenon of experiencing meaning through stories via a cause. Within the context of this study, the cause became understanding the treatment material, connecting the issues to the stories, etc. It seems like all novice learners' most important experience was the sense of concreteness that the stories offered. For some, the

context of the stories was easier to relate to if they knew the companies or if they experienced their products. However, connecting to the stories, while for some it was natural and easy, for others it created some difficulties. While some novice learners looked for connections, others looked for correlations, but all saw great value in the stories. For five novice learners, the value of stories and storytelling is taken for granted, while for one novice learner fact sheets are preferred because they are more efficient. Finally, many outcomes were realized by going through stories such as the capacity to obtain a lesson and remembering it in the future, understanding the issues in a situation, applying the lessons learned in a story to a future problem, etc.

After having explained the model and its elements (causal conditions, phenomena, context, intervening conditions, strategies, and outcomes) from the perspective of the novice practitioners and novice learners, we proceed to address the remaining study questions.

Meaning-Making Experience and Process (research questions # 2 & 3)

Meaning Making During Problem Solving

The meaning-making experience and process all novices undergo as they learn with stories will be explained according to the model shown in figure 4.1. The following description proceeds linearly, but the interrelationship of the elements in the model interact in very complex ways. A causal condition sets in motion a series of events that initiates the problem solver into the meaning-making phenomenon. The cause is a problem for which there is a certain level of intensity. The cause can be a challenge to the problem solver's understanding, something in which he holds an interest. This situation prods the problem solver into searching for a continuous flow of meaning and concreteness that can be provided by a story. The flow can only be sustained if the problem solver deliberately chooses to connect the story to his problem-solving context and *think in terms of that story*. The experiencing of meaning that ensues leads to outcomes that completely, partially or continuously, satisfy the original cause (the problem) to a certain degree. The outcome can be understanding or addressing the challenge to understand. Another outcome can be sustaining a flow of meaning during a problem-solving discussion between the problem solver and the people he problem-solves with. Another outcome can be the reminding of relevant stories ("This reminds me of the time when . . ."). Another outcome can be the storing in memory of the story (partially or fully). Still another outcome can be the reaching of a solution (or eliminating dead ends). Finally, an outcome can simply be maintaining a state of entertainment (e.g., awaiting the punch line on a "war story"). One problem can trigger numerous opportunities for experiencing meaning as is the case during very complex problem-solving situations.

This continuous flow of meaning experienced by the problem solver is dependent on intervening factors such as his attitudes towards storytelling as applied to problem solving, level of problem-solving relevance attributed to stories within his context, or his stock of stories, to name just a few. The intensity of the meaning-making experience will be dependent on the proximity of the story's context to the problem solver's context. This level of intensity as well as the intervening factors will affect the outcome resulting from the meaning-making experience.

Development of Pedagogical Value of Stories and the Role of Context

First of all, we may expect that not all stories are brought up during problem solving strictly for their pedagogical value. For example, a problem solver may bring up stories just for maintaining a flow of meaningful discussion. On the other hand, the problem solver may choose to be brought into a meaningful discussion by connecting to a story.

For the problem solver, the learning value of stories is realized depending on the level at which the story impacts his problem-solving context. This impact will depend on the proximity of the story's context to the problem that triggered the meaning-making phenomenon. In addition, the intervening conditions must support the learning process. Some of these conditions will depend on the problem solver (his attitudes about problem solving through storytelling). Other conditions will depend on the setting he operates in (corporation, university, etc.) and the support he receives in this setting. For practitioners, learning through stories happens through the causal conditions that naturally arise in any setting where humans socialize. In other words, where there is problem solving, there needs to be communication, and most likely storytelling forms part of that communication.

The story's context and the problem solver's context support (or obstruct) problem solver efforts to connect to the story. Connecting is making both contexts meet as much as possible.

Again, she must be thinking in narrative form for the story to have any effect, that is, for the connecting effort to succeed. This effort to connect is what sustains the phenomenon of meaning-making experience that will lead the problem solver to realizing an outcome of learning value, such as committing to memory a story that impacts her problem-solving context (a solution to a nagging problem). The closer the story's relevance is to the problem solver's context, the stronger the intensity of the meaning-making experience felt by the problem solver, and the more meaningful and lasting the memory obtained from the lesson embodied in the story.

The *KarMichael* Incident

Let me present to you an incident that portrays the meaning-making phenomenon of problem solving through stories to conclude this chapter with a concrete form. Of course, for this portrayal to be a meaningful experience for you, I must first appeal to you to think through this story.

For over an hour, the second problem-solving session with Thomas in Y&Z had been proceeding in a lively fashion. I was happy to see that many instances pointing to problem solving through stories had occurred. Thomas, one of my participants, and Lana, the person in charge of marketing the future *McKinley* hard candy products, were "driving" the discussion in a way that seemed to me like a rather intensive cross-examination session albeit in a very friendly tone. `[problem-solver context: direct]`[15] Lana wanted to know specific information from Thomas about the hows and whys of the sweetness, creaminess and cooling of the hard candy. Thomas wanted to have more specific information from Lana on the desired characteristics of the *McKinley* products (shape, color, texture, etc.). Sitting at Lana's side was David, market researcher, while Audrey, Thomas' teammate, was sitting next to him. Doug, the director of food product development in Thomas' team, was the senior person in the meeting. He was sitting at the head of the table but had been rather quiet during most of the session. He was participating in the tasting of the product and once in a while he had interjected quick comments or gentle approval gestures ("Hum, very good!").

About one hour and fifteen minutes later, during which many important decisions had been made, the discussion turned to market testing. `[causal condition: intense problem-solving drive]` Lana had decided to set specific dates for conducting a series of consumer tests with

[15] Please refer to figure 4.1 to get an idea about where to place the specific component of the model referred to here; that is, causal condition, phenomena, strategies, intervening conditions, context or outcomes.

some candy prototypes to obtain first-hand comments from consumers on a range of product characteristics. One of the products targeted for the test was an oval-shaped hard candy the size of a hazelnut. It was entirely white, but it was to have a chocolate flavor. While Lana and Thomas were busy talking back and forth and agreeing about how they would prepare the samples, Doug gently attempted to enter into the lively discussion [causal condition: intense problem-solving drive | strategy: resort to narrative, connect to a prior case | intervening condition: problem-solving experience | outcome: reminding]. On a second attempt [intervening condition: very high value of a story for this situation], about 5 seconds later, Doug leaned forward, decidedly pointing to the bowl with the hard candy samples and he "burst onto the scene" emphatically changing the tone and strength of his voice. He started relating a story. "But when we did the focus groups for *KarMichael* . . ." At this point Lana and Thomas stopped talking [strategy: narrative intelligence, connect context to story | phenomena: continuous flow of meaning, sense of concreteness | outcome: meaningful discussion], instead decidedly turning their chairs toward Doug while riveting their eyes on him. He now had the floor to himself. I could feel the intensity with which Lana and Thomas were looking at Doug while he proceeded ". . . [story suppressed] . . . So, I'd just say to be aware of that. They had a hard time connecting with that color and that chew . . . They'd like more color material . . . We could test it in this format though but it would be interesting to see what comes out of that. [outcome: possible solution] And that was in three or four groups, it wasn't just like in one group when they said that." About 4 seconds of absolute silence followed—a long time for this lively group. Doug concluded with a tone of voice that clearly pointed to a warning while nodding several times. After the "long" pause, Lana, her eyes still looking intensely at Doug, also started nodding. I could almost feel how she was taking the time to let this one "sink in." With a gentle voice she said "Hum [pause] interesting!" [outcome:

commit story to memory] Then Lana and Thomas turned their attention to the papers they had strewn on the table and resumed their lively discussion. (Thomas T-Tape II, 0:14:35 – 0:15:55)

Two months later, I asked Thomas to recount for me what he could remember by only showing him a *3-second video segment* of that incident right when Doug starts to talk. This is how he responded:

> [outcome: reminding] And the point was that when you make a prototype and show it to consumers, if you add color to indicate a flavor type, then people are actually . . . the respondents are more receptive to the idea. And he said, for example, if he said strawberry and then color it with pink, they would perceive it as strawberry . . . (Thomas II, ¶ 418)

Thomas had in fact turned Doug's story into a case in his personal Case Library.

CHAPTER 5

DISCUSSION

Preparing novice learners with the necessary ill-structured problem-solving skills ought to be one of the most important goals of education. As stated by Gagné, "the central point of education is to teach people to think, to use their rational powers, *to become better problem solvers*" (1980, p. 85, emphasis added). This becomes even more critical when we look into professional practice, which is inherently filled with problems and uncertainty (Schön, 1993). Some argue that all problems found in life and work are ill structured (Lave, 1988). Promoting expert-like reasoning in novices to prepare them to make the transition from novice learners to novice practitioners is a way to deal with this situation. Many propose that cases systematically collected and input into a Case Library can alleviate this problem by bringing novices into contact with the experiences of expert problem solvers and thereby stimulating expert-like reasoning (Collins, 1991; Ferguson et al., 1991; Jonassen, 1997; Kass et al., 1993/1994; Kolodner, 1993; Kolodner et al., 1996; Schank, 1990; Schank et al.,1993; Schank, 1999). Thinking in terms of the experiences of others is an innate human ability most likely based on the existence of a narrative intelligence (Bruner, 1990; Polkinghorne, 1988; Randall, 1999). For this reason, Case Libraries have been regarded by a number of scholars as a useful systematic approach to transferring expertise to novices.

Given such a monumental challenge, this study has set out to explain how novice learners and practitioners alike learn from stories while problem solving. It also tried to demonstrate how a learning environment that incorporated 24 stories from experts could promote ill-structured problem-solving skills on these novice learners based on an outcomes-based approach to learning (Schank, 1999). To that end, a mixed-model research design (Tashakkori & Teddlie, 1998) was

employed in the study to explore storytelling while problem solving in a work setting as well as in an university. Discussion of the findings obtained from this study is the objective of this chapter.

Discussion of Research Results Regarding the Effect of Stories

The purpose of this part of the study was to determine if a Case Library of experts' stories would support ill-structured problem-solving skills in novices. Participants randomly assigned to one of three groups experienced different treatments for a period of three weeks. A pretest was given to establish a baseline and the post test for determining cognitive gain. These tests were composed of items presented in the form of one-paragraph stories (situations) that required students to choose from a number of given options (multiple-choice) or articulate their own decisions (short-answer) to explain failure, recognize problems, and demonstrate other high-order cognitive skills. What follows is a discussion of the results presented in the previous chapter regarding these tests.

Discussion of Multiple-Choice Tests Results

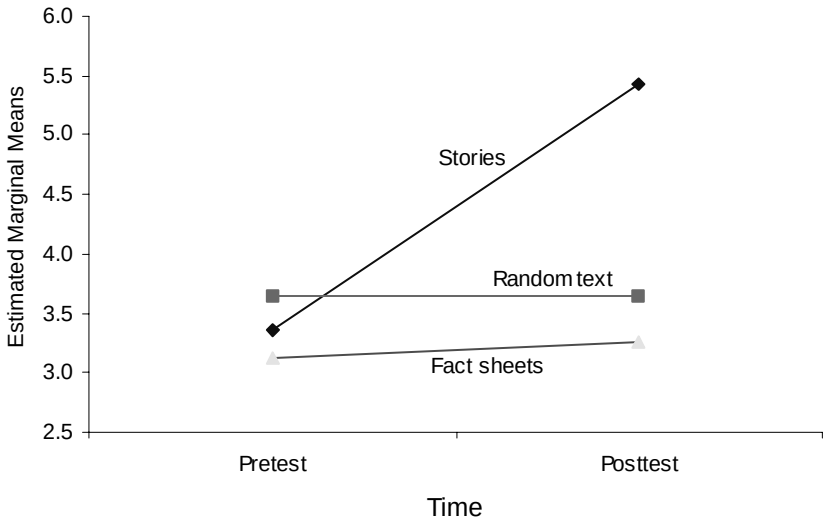
In the previous chapter, the ANOVA results (Table 4.4) regarding the pretest scores for control (random text), comparable (fact sheets) and experimental (Case Library) groups shows that there were no significant differences between the groups ($p = 0.603$, $\alpha = .05$), lending support to the idea that, as expected, all groups possessed about the same ill-structured problem-solving skill level at the outset as defined in this study. However, in the post test we then see that there is a significant difference between the groups ($p = 0.001$, $\alpha = .05$). When this fact is combined with what is shown in Table 4.3, it indicates that the Case Library group seems to be the cause for that difference with its mean score gain of 2.0714. Furthermore, when we inspect the impact on score gain for all three groups, we again see that the Case Library group is the cause of the significant difference in gain when compared to the other groups ($p = 0.001$, $\alpha = .05$). In addition, the coefficients of variation shown in Table 4.3 also demonstrate that the Case Library group is the only one that experiences a sharp drop in variation (-39.5%) from pretest to

post test. A drop in variation indicates better convergence of treatment scores, which can only be attributed to the effect the Case Library had on the students in the experimental group.

In summary, as shown in figure 5.1, analysis of the multiple-choice tests strongly suggests that the stories in the Case Library did seem to have an effect on the choices the students made

Figure 5.1

Gain Score



within this group. That is, given the test design whereby there was not one "correct" answer but rather a preferred answer (i.e., the choice that alluded to one or more lessons contained in the stories in the Case Library), the students who read the stories generally seem to have been persuaded to decide in accordance with a story's lesson. Considering that there was only one recall item in the test and 10 items eliciting a number of high-order skills (see Chapter 4), such as explaining, predicting and judging, this result lends support to the hypothesis that a Case Library will help students obtain higher scores in a multiple-choice test that assesses higher-order cognitive skills.

Despite this finding, significant in and of itself, during the in-depth interviews I was not able to uncover the process that made this result possible. As part of the interview protocol, I asked two novice learners to walk me through the thinking process that led them to make a particular choice. What I found is that many factors can influence a student's decision under these circumstances. For example, Joan was more inclined to use her personal experience in making a choice even though two weeks after studying the material she could remember some of the stories: "I think it does have a lot to do with just *my experience or what I know of the product* or products better like that product" (Joan, ¶ 173). For Bob the determining factor for his choice in one post test item was something he learned in school before participating in this study: "Because I saw that they had done BASES research and *we were taught when we first learned about this* that you should always" (Bob, ¶ 67). A CBR proponent would be tempted to argue that, in general, students in the Case Library group were reminded of a Case Library story after reading a post test item and that this in turn prompted them to make a choice consistent with the story lesson (Kolodner et al., 1996; Schank, 1999). Although this explanation is tidy and reasonable, it is not one that I am ready to support based on the qualitative data collected in this study. On the other hand, these results break new ground by employing an outcomes-based learning (Schank, 1999) approach for building the task environment and providing access to the Case Library. Now that this study was able to support the idea that effect is possible despite the given limitations of this study's design, a baseline has been established. It remains now to find a way to explain the actual process followed by the students while taking these multiple-choice tests or other legitimate forms of assessment of ill-structured problem-solving skill gain.

One last note regarding the choice of scores. Gain score determines if there are significant differences between the three groups (control, comparable and experimental) based on the

differences obtained from pretest to post test scores. This score was chosen in this study to determine difference for the following reason. Random selection ensures a homogeneous sample. Theoretically, all pretest scores should be equal. However, minor differences are the norm. For this study, the control group's average score happened to be the highest score albeit with a statistically insignificant difference when compared to comparable and experimental groups (0.5179 and 0.2857 respectively, Table 4.5). As shown in Figure 5.1, the random text group did not gain in score from pretest to post test. Knowing this and since difference in effect for studies such as the present study will be determined by very small differences, selecting difference in gain was deemed to be the most appropriate choice.

Discussion of Short-Answer Tests Results

As presented in Chapter 4, we can see that the ANOVA results (Table 4.7) showed that there were no differences on the post test scores between the random text, fact sheets and Case Library groups ($p = 0.849$, $\alpha = .05$). On the same table we also see that no groups showed any significant difference in gain ($p = 0.745$, $\alpha = .05$). These last two results do not support the hypothesis that a Case Library will help students obtain higher scores in a short-answer test that assesses higher-order problem-solving skills based on students' arguments in response to a number of selected issues than students who do not have access to the Case Library. In addition, these results contradict the multiple-choice results discussed earlier.

A possible explanation for the discrepancy between multiple-choice and short-answer scores may be found among the reasons presented below:

1. The student factor: Some students mentioned that the test style was fatiguing, with too much reading and writing. Since the multiple-choice exam came first, students were more rested and most likely had a better attitude during that portion of the tests. Many

students expressed irritation in the questionnaire about the difficulty of the tests. This situation might have worsened as the 62 minutes allotted for the test went by. When effect is being measured with differences of 2 or 3 points, withholding of effort will make it even more difficult to discriminate between good and not-so-good arguments. In support of that argument, it is worthwhile noticing that in Table 4.6 *all* mean scores dropped from pretest to post test by 3.9811.

2. The test factor: There is always a question whether the short-answer pretests and post tests could elicit student performance in a way that would facilitate the emergence of differences between good and bad student thinking. Despite the fact that no significant differences were found between and within groups for both pretests and post tests, it is interesting to note that all gain scores were negative; that is, all student scores went down from pretest to post test. Although these differences were not statistically significant, still a close look at the short-answer instrument is necessary to ensure that the post test was not more difficult than the pretest. On the other hand, the short-answer tests might have measured something different than what the multiple-choice tests measured. Either way only a more consistent short-answer instrument could elucidate this matter.
3. The rubric factor: It is possible that the rubric did not appropriately support the three judges in discriminating between good and bad student arguments. The judges were closely involved with the development of the content of the study, designing the rubric and finally testing it. Despite being kept double-blind, their judging capacity may have been compromised. Three other judges who do nothing but *judge* may have been able to better maintain an "uncorrupted" perspective throughout the tedious, repetitive and arduous task of judging.

Despite the fact that the judges were chosen for their unique perspectives, it would be expected that still there would be reasonable inter-rater reliability. Unfortunately, the inter-rater reliability statistics were too low to perform a judgment on this matter.[16] Most likely the reason for the apparent inconsistency between multiple-choice and short-answer tests is a combination of the reasons given above. However, as mentioned in the previous chapter, it is interesting to note that as shown on Table 4.6 the coefficient of variation pertaining to the Case Library group dropped sharply from 21.4% to 16.3 % (a 23.8 % drop), while the coefficients for the other groups went up. The consistent behavior of the coefficients of variation in the multiple-choice and short-answer tests lends support to the idea that despite any confounds the Case Library does seem to have the effect of a "tightening up" of scores around the mean, which can only be explained by the effect that the Case Library had on student reasoning. In a future study, all of these issues should be addressed.

Summary of Discussion of Research Results Regarding the Effect of Stories

The quantitative portion of the present study revealed through the multiple-choice assessment that a Case Library seems to have an effect on the choice students are willing to make when given a number of equally reasonable choices. This is a significant outcome in itself considering that the situations featured in the test items were highly ill structured; however, the process by which students arrive at a definitive choice and how that may support arguments for explaining effect remains to be revealed. On the other hand, the short-answer assessment provided inconclusive results. This may be due to a number of factors such as an unreliable test design, student fatigue, an unreliable rubric, or inconsistency in the scoring. However, the coefficients of variation between pretests and post tests scores on the multiple-choice and short-

[16] However, this may be expected since they bring unique perspectives to the scoring process (science, economics and business, and industry perspectives).

answer tests pertaining to the Case Library group consistently show a sharp drop lending support to the idea that this was caused by the effect of the stories in student reasoning.

Discussion of qualitative research results

The purpose of this part of the study was to find explanations regarding the meaning that novice practitioners and novice learners make of experts' stories when problem solving. It also set out to try to explain this meaning-making process. To that end, three novice practitioners participated in two in-depth interviews as well as allowing themselves to be observed while engaged in problem solving. In general, this study, similar to Orr (1996), Schön (1993), Lave & Wegner (1991), Lancaster & Kolodner (1988), Kopeikina et al. (1988), Klein & Calderwood (1988), among others, found that the use of stories or prior cases when problem solving is a common phenomena found in the workplace. For example, this study captured numerous moments when stories were used for sharing problem-solving experiences (Orr, 1996), for speculating about new situations (Polkinghorne, 1988) and for providing solutions or discarding dead ends (Orr, 1996). For Thomas, Nancy and Amy, the three novice practitioners, stories provided a way to diagnose problems (Orr, 1996), helped them explicate conflicts (Brunner, 1996), and contributed in maintaining focused the problem-solving process. Novice practitioners never questioned the value of the stories they heard during the problem-solving sessions, which attests to the value of credibility of stories in the workplace (Orr, 1996). Thomas saw through stories ways to avoid pitfalls and false starts (see warning in *KarMichael* incident in Chapter 4) by problem solving through the experience of others (Polkinghorne, 1988). When I asked Amy about how was Y&Z Candies as a place to work, she told me a story about the time when its founder, Mr. Stanley, during the Great Depression, preferred to keep the plant operating despite sustaining heavy losses so as not to lay off employees during this difficult period. Stories about trust and care abound in this company. Through the sharing of these stories, Y&Z employees build a sense of corporate community and identity (Henning, 1996; Polkinghorne, 1988). In

summary, the present research reveals that solving problems through stories is a common occurrence in a work setting (Schön, 1993).

In addition, six novice learners' experiences on using stories during problem solving were also gathered through in-depth interviews after the post test. It was found that the novice learners placed great value in understanding a story, applying it to the immediate problem-solving context (the Contadina case), and storing it in memory for future application to new problems (Kolodner, 1997; Schank, 1999). Novice learners were also able to picture the characters going through the problem-solving experience in the stories and identify with their actions (Brunner, 1990; Coles, 1989; Sutton-Smith, 1995). All novice learners felt that stories are more memorable than plain facts, particularly if the problem-solving situation depicted in a story is unusual (Brunner, 1990; Schank, 1999). Finally, all novice learners thought that the most important value of a story is that it does not look like "a textbook" since the story embodies a context they can relate to, which is regarded by many as possibly the most important advantage that stories have over just plain facts (Paley, 1995).

However, as shown in the selective quotes presented in the previous chapter, in many ways novice practitioners and novice learners used stories differently. The most important differences are explored next.

The Implicit Use of Stories

Novice learners seem to have difficulties in problem solving through stories. Although the experimental study only lasted three weeks, I was still expecting that novice learners could related the stories to the issues being raised in the Contadina case and apply those stories to the test items seamlessly. My expectations were raised primarily after the training session in which novice learners did not raise any significant issues on using the stories (or the fact sheets).

However, as I asked them to walk me through the process of applying a story to a particular problem raised on a test item, the process was marked my much hesitation, re-reading of the story and test items, mumbling, thinking aloud, etc. In this example, Laurie (random text) was struggling to see how she could apply a story dealing with the positioning of a dog food product to a test item dealing with what she called "real food": "I wouldn't think with dog food . . . I wouldn't have associated that with real food. Like I don't think I would have *made that logical link*. I wouldn't have been able to use that example" (Laurie, ¶ 121). On the other hand, for novice practitioners the "logical link" between the stories they are exposed to and the problems they are facing on a day-to-day basis is implicit in the environment they problem solve in. Amy referred to her older teammates' prior experiences as "history" (Amy, ¶ 26), a form of problem-solving communal memory (Orr, 1996). She saw problem-solving meetings as opportunities to learn from that "history," become a better problem solver and share her own "history" as well, which is what Orr (1996) also found in his research. This sharing process happens naturally. Thomas expressed to me that bringing up prior cases (and stories) is a common occurrence during his meetings. Thomas, Amy and Nancy will not question this way of problem solving. Given the disparity regarding the implicitness with which stories are used in the workplace, it remains to be seen whether that same implicitness can be paralleled in a school setting by simply making available to novice learners a case library with 200-250 stories. More work needs to be done in this area.

Well-Structured or Ill-Structured Problem Solving with Stories

The novice learners in my study seem to be well attuned to well-structured forms of problem solving. They always seem to be expecting "a point" from a story or a convergent answer or an immediate clarification of the issue raised in the task environment (e.g., the Contadina case). For

example, Joan (story group) struggled with some stories because she was looking for "*a real narrow* . . . what is was talking about" (Joan, ¶ 52). In the case of Cynthia, she seemed to think of a Case Library as a stock of problems and their solutions:

> If I was in that situation [a market potential problem] I would have to go through and read all this [a number of stories dealing with market potential issues] and say "Ok *that is the problem* and *this is what is wrong* and *this is how we fix it*." (Cynthia, ¶ 333)

However, the novice practitioners did not seem to expect that convergence from a story. Nancy, after three years of experience in Y&Z Candies, recognized that working on problems was like "finding a needle in a haystack" and "narrowing it and narrowing it" (Nancy I, ¶ 485), what Lave (1988) refers to as "gap-closing, sense making processes" (p. 176). For all three novice practitioners, problem solving through stories sometimes helped them in eliminating possibilities or avoiding dead ends. Stories were not expected to provide quick and dirty answers, unless you ran lucky: "Once in a while you get lucky and *find some answers* to your questions" (Thomas II, ¶ 93). The implementation of a Case Library in a school setting has to consider that novice learners may tend to use the stories as a way to find definitive answers to their problems.

The Desired Outcome of Thinking Through a Story

For the novice practitioners, problem solving through stories served primarily the purpose of maintaining a meaningful discussion. For Thomas, it was a way on concentrating on what worked in the past and avoiding what did not. For Nancy, this helped her and her teammates keep focused on the issues. For Amy, it was a meaningful way to bring her older teammates experience to bear on problems. Novice learners were only exposed to stories for a three week period. During that period, they were asked to work and study the material individually. Further studies need to be conducted in which the sharing of stories is openly encouraged (or required)

by having students work and study in groups for longer than a mere three weeks. When questioned about this particular, novice learners foresaw great potential:

> BOB: Like if you went on the Internet and logged onto the web site and the assignment was to read about market potential but as you are reading about market potential you had these things [stories] to draw correlations to, I think it would *produce more interesting class discussions* each time. You would have 3 or 4 mini cases of experiences to discuss during class.
> JULIAN: So class discussion. You would... obviously some times we did it [during my study] sort of as a side activity, so you would have discussions in class?
> BOB: Yeah, I think those stories would be very helpful in at least *starting a class discussion*. It is hard to have a class discussion of a textbook [fact sheets]. It is just facts, you can't really argue it, or I mean even give your opinion about it. But when you do get a story that actually happened and these problems were actual and this is actually how they solved it, it makes it seem a little bit more human. I could foresee *a lot of very interesting class discussions* happening because they get these little 2 or 3 paragraph stories to go along with the 1 or 2 paragraphs of just information [referring to the way the treatment materials were implemented in the study within the Contadina case]. (Bob, ¶¶ 265-7)

The Passion Engendered by Stories

The stories associated to a prior case tend to promote passionate problem-solving discussions. Thomas explained to me that after having worked in the *TasteBud* product, he learned important lessons. When Lana, the marketing person in the *McKinley* project, expressed her preference for a *TasteBud*-like product, Thomas was inundated with many recollections (stories) on how difficult it was to scale up the process in a full-scale production situation. Thinking in terms of these recollections (stories) may promote passionate problem solving. Thomas explained:

> THOMAS: But *when you bring those examples, it is typical that you have intense discussions* because everybody's memory is not the same and they remember one aspect or the other.
> JULIAN: Why? One aspect or the other?
> THOMAS: It depends on how their feeling was towards the product. It depends on how much work they put in it. It depends on what the conclusion was. Depending on those factors, some are passionately for that product to go further and some are not.
> JULIAN: Let's say that Lana would be passionately for a product. This *TasteBud* idea, she is passionately for it. How can you see yourself not being passionate for it?
> THOMAS: In terms of process.
> JULIAN: May be a great marketing idea but for you?

THOMAS: Yes, for me it would be a big headache. I can make it in the lab but it cannot be done in the plant situation. (Thomas II, ¶¶ 297-303)

The novice practitioners I interviewed were passionate about their problems. Thinking in terms of theirs or others' experiences through stories heightened that level of passion. This promotes intense problem-solving processes. This passion seems to be inherent in everything that they do. It remains to be seen if this intense problem-solving passion can be paralleled with novice learners in a school setting. We need to learn and find ways to stimulate and generate passion for problem solving so that stories feed and stimulate further discussions.

The Culture Surrounding Stories

Finally, stories at work tend to be primarily driven by a social or joint activity that creates culture, as Polkinghorne clearly states (1988). This culture provides the basis for continued problem solving through storytelling. In the case of Thomas, when Lana brings up the prior case of *TasteBud* when the team is wrestling with understanding the complexity of the flavor in the prototype, she is not simply trying to get Thomas to think about *one* story but about *one set* of stories shared between them; in fact, possibly shared by most people working within the product development division at Y&Z Candies. When I questioned Thomas about how *she knew* about the specific work that he had done with the *TasteBud* product, even *he* was surprised:

JULIAN: Was it a good example to be brought up to focus the conversation on?
THOMAS: Yeah. I think that was an excellent example because they are so close.
JULIAN: How did Lisa know that?
THOMAS: I don't know! I was surprised.
JULIAN: She knows you were working on it, and she knows about *TasteBud* also.
THOMAS: She should know about *TasteBud*. That she knows I worked on it, I don't know. She did her research I guess [laughs]. I don't recall . . . she was not the marketing person for that project . . . the first time I saw her and knew about her was sometime in 2000. The *TasteBud* project we were doing was in '98, '99, something like that. (Thomas II, ¶¶ 258-63)

The culture shared between Lana and Thomas is what makes stories about *TasteBud* meaningful. The important issue in a school setting is, how do you "create" such a cohesive problem-solving culture that would make the switching from stories and problem solving a seamless process?

Therefore, it is to be expected that novice learners will use stories differently when compared to novice practitioners. Given the intervening social influence encompassing storytelling, an important problem to be addressed in a school setting is the need to drive problem solving so that stories become an important *and implicit* problem-solving component. Given the implicitness of storytelling in a work setting, it is to be expected that the experienced phenomenon in a school setting will be different. The fundamental question then is: Is it possible to design learning environments paralleling the kinds of activities that take place in a work setting so that they would stimulate and promote in learners the experience of the phenomenon when recreated in a school setting? These differences will most likely create difficulties for the novice learners as they attempt to think through and connect a story's context to the context of the problems they are facing. This in turn will reduce the value of a Case Library in a school setting. These are all issues that need to be addressed in future studies.

The Proposed Model

In Chapter 4, I proposed a model for problem solving through stories as an attempt to explain the phenomenon of meaning-making attained by these problem solvers. However, an important question to ask is, why create a model for explaining the phenomenon of experiencing meaning through stories? It could be argued that the CBR literature already provides sufficient explanation. For example, the model in figure 4.1 identifies as a causal condition a challenge to our understanding. This, in fact, is equivalent to an expectation failure (Edelson, 1993; Read & Cesa, 1990; Schank, 1999). Similarly, a challenge to understanding is equivalent to an outcomes-based learning approach in that it exploits humans' natural curiosity to find out "the rest of the story" (Schank, 1999). The model identifies context as a factor that can affect the ability of the problem solver to fully understand (connect with) a story and its lesson. This is similar to CBR thinking in which it is required that the person who wants to apply the solution from one case to a new problem adapt the solution from the case to his unique problem, in effect engaging in a conscious strategy of connecting the context to the story. There are many other parallels as well.

On the other hand, the storytelling literature, though not directly applied to problem solving, is also filled with similar explanations covered in the proposed model. For example, the strategy of "thinking through story" as it was mentioned by one of the novice learners in the model is also referred to by others as "narrative intelligence" (Polkinghorne, 1988, p. 51; Randall, 1999, p. 13). The idea about "continuous flow of meaning" is the same as Bruner's ideas on "meaning making" (Bruner, 1990; see also Polkinghorne, 1988).

However, the present model attempts to establish an understanding of the phenomenon of problem solving through stories by attempting to bring together the broad areas of CBR and

storytelling literature. CBR has concentrated substantial efforts in design and implementation with special focus on memory processes, thus limiting the power of its explanations, at times appearing rigid and reductionist. On the other hand, current literature on the use of stories is too general, still dealing with issues such as whether storytelling is a legitimate form of learning in the classroom (McEwan & Egan, 1995). The proposed model is an attempt to incorporate both approaches of explaining the phenomenon in ways that would facilitate discussion of the design and development of instruction.

With that in mind, let me raise a number of important issues within the context of the proposed model:

Problem-Solving Drive

Prior research on the use of stories, prior cases, and related issues (Kolodner, 1993; Lave & Wenger, 1991; Orr, 1996, Schön, 1993) has been done primarily at practitioners' sites where there is no question about the intensity of problem solving since that is what the practitioners are paid to do and where their interests lie. In school, the nature of this drive has to be taken into consideration when trying to understand and support learning within the novice practitioner and particularly the novice learner population. Questions of value and context become critical.

Context

Context will have an powerful impact on how intensely the problem solver experiences the meaning-making phenomenon (for example, Nancy and her interest in outbreaks). The level of proximity of a story's context to the problem solver's context will determine the level at which the lesson will be understood, committed to memory and employed in the future. As in the case of Joan (story group), by not finding a clear application of the stories in her other classes, two weeks after the post test she could not explain to me why she made the choices in the multiple-

choice and short-answer tests. And yet she and the majority of the novice learners in the Case Library group were able to score 18% higher than the other two groups in the post test. A library of cases will make a difference as shown in the multiple-choice test results, but this difference will be extremely fleeting unless we deal with the proximity of context in the long term.

The Role and Importance of the Intervening Conditions

Experiencing meaning is a totally subjective process. From an instructional designer's perspective, there is one aspect of the phenomenon on which influence can be exerted: the intervening conditions. For example, instructional designers must strive to design and develop learning interventions in which student activities will lead students to the stories, thus raising the value of employing stories within their own problem solving. During the course of the present study, the two faculty members required student projects on existing companies (Campbell's Soup, Giant Supermarkets, etc.). In the words of a professor, students were required "to assume the personality of a company." A Case Library with, say, 100 stories of successes and failures from that company alone will not only drive students to the stories (it will be directly relevant), but the stories and lessons will also stay with them for "longer than a few hours" (Coles, 1989, p. 189). A more generic case library will still have an impact (as per the multiple-choice results) but it will require more effort on the part of faculty to stimulate discussion or the effect will be fleeting.

In addition to the intervening conditions, the learning environment in which the story will be embedded needs to provide a scaffolding mechanism (Jonassen, 1999) to help learners make the connection between the story and the learning issues that the teacher wishes them to work with. As mentioned earlier, it would be like putting the story-*teller* in contact with the story-*listener*. The students I interviewed provided many suggestions. For example, make clear and highlight

the connection between the task environment and the learning issue, which is a point also raised by Schank (1999). One could also provide a note pad on which the student could write down some of her reflections as she attempts to make the connection, a small private area in the environment to which she can turn later. A most basic suggestion was to discuss the stories in class; this could be the most natural follow-up study to the present study. Realizing that the intervening conditions and context factors (though partly) are the *only* elements of the experience over which the instructional designer has any control, valuable resources and effort should be spent on those and not on building ever more efficient and smarter indexing mechanisms (Kolodner, 1993) or extraordinarily attractive (and expensive) interfaces à la Goal-Based Scenarios (Schank et al, 1993).

Implications

Organizing and Indexing Stories

CBR researchers have probably been the most important contributors to what we know about Case Libraries. As mentioned earlier, it is my impression that CBR thinking has traditionally been concerned with explaining and exploring elements of the storytelling phenomenon over which instructional designers have little control, such as reminding (building indexes and accessing stories from memory), adapting a case to a new situation, re-indexing, storing into memory an adapted case with new index, etc. (Kolodner, 1992). CBR is the brainchild of information processing theory scholars (Schank, 1999), a theory that concerns itself with an individual's internal mental processes. Although the issues raised by CBR make for interesting discussion, which in itself is important from a theoretical perspective, from an instructional designer's perspective it can become an unnecessary diversion. The quest for building ever-more sophisticated indexes for accessing the stories is a case in point.

While collecting the stories for this study, I came to realize that even indexing is a subjective phenomenon. That is, it was not unusual to have one expert refer to a learning issue not only using a different vocabulary but even seeing totally different learning issues as well. And yet all stories for that learning issue seemed alike on the surface. Likewise, when performing the in-depth interviews with the novice learners, the same phenomenon was often repeated but in reverse. A learning environment incorporating stories ought to provide ways for keeping generic indexes (say, with the expert's vocabulary) that would link stories to particular learning issues as needed and desired by faculty members. But the learning environment also ought to provide a way for allowing the novices to generate *their* own indexes as they review the stories connected to these links. Of course, this approach needs to address the issue of training students to index

stories as part of the process of learning to use them. That is, reviewing a story connected to a particular learning issue and upon determining the relevance of the story to her particular problem-solving activity, she will initially most likely need support to articulate an index to the story as it applies to her particular problem from her perspective in a way that it would allow her go back to it, reflect on it, or even make annotations that she can go back to. Such an approach for using a Case Library should be explored.

The Act of Telling Stories

While eliciting stories from experts for this study closely following the procedure laid out in Chapter 3, using the skills analysis as the basis for starting a storytelling session (the causal condition), I was able to collect stories almost effortlessly. However, the stories had to be edited so that they would comply with Edelson's (1993) criteria defining a story. Therefore, the "but," "you know what I mean," hesitations, hyperbole and many other everyday conversational elements were left out in the process, condensing each storytelling effort into three paragraphs and one picture (see figure 3.2). However, when storytelling occurred in the problem-solving sessions, the transition from causal condition to the establishment of a continuous flow of meaning was transparent, almost unidentifiable. Though it was established that stories in this study did exert an influence on a person's cognitive processes (within the context of a multiple-choice test), more powerful approaches need to be explored that would allow a seamless connection between the story-*teller* and the story-*listener* paralleling natural conversational dynamics.

How to Use a Case Library

Case Libraries have been regarded as particularly useful for supporting problem-solving processes in settings where there are no clear-cut answers (Kolodner, 1997); that is, in settings

where problems are ill structured. Case Libraries have been proposed for learning environments that exploit expectation failures (Edelson, 1993), as case-based aids (Kolodner & Guzdial, 2000) and for many other uses (Schank, 1990). However, as important as these prior efforts have been, I believe that they are not enough to empower instructional designers to design entire courses with Case Libraries in mind.

Toward the end of the in-depth interviews with the novice learners, I asked them to reflect on how a Case Library could best be incorporated into three forms of teaching and learning; namely, a lecture-based course, a problem-based course, and a case-based course. Bob thought that that a Case Library is most useful in case-based and problem-based formats:

> I think it [the case library] would fit most appropriately with the case studies., because you are giving . . . these are actual cases too. I think case studies are a good mode to really get a class discussion going about things that are happening in industry or what actually occurred and why it occurred. I think case studies help give an historical perspective that this is helpful with. I could also honestly foresee this [the case library] being really useful in as far as group projects are concerned . . . because when you are doing your project, especially at the college level and most business classes nowadays involve a group project . . . there is a lot of guess work involved, because this is the first time you are really doing it. You are not really positive about how things get done. I could see these little anecdotes about segments of industry as being helpful guidelines to follow . . . [it] would allow your project to discuss more issues. (Bob, ¶¶ 272-284)

Laurie foresaw more value in a problem-based learning approach:

> I guess you could talk about even just in the question, just like meeting in small groups you could say "Here is a given situation, how do you think Hershey should position itself?" [referring to a story used in the study] Just like having us think about kind of how those questions were as a group sort of do it and then we would talk about what that . . . what we all thought should happen and what actually did happen. I think that would make it stick more. (Laurie, ¶ 359)

Finally, Joan foresees value in a case-based approach but more value in a problem-based approach. She also forewarns that there may be limits to how many stories you can process:

> Probably if working in a group sort of aspect, like all semester would really . . . I would learn a lot about it and go through a lot of background research on it and so that would definitely make it stick with me because I worked so much on it. I also think that the case format like that [as implemented in the study] would be good too. I think if you kept... if you just went from one case to another, like one right after another . . . there might be too many things to draw from. It might get confusing with so many different problems and different products . . . I think if in our group project or whatever, we came across like something, like I said, and that it would apply to what

> we were trying to do, it would probably stick out, be relevant and I might remember it more or whatever. (Joan, ¶ 243-247)

Without exception, all novice learners foresaw that the most important impact that a Case Library can have in a school setting is as a mechanism for stimulating class or group discussion. More studies need to be conducted incorporating these recommendations and expanding the discussion on designing instruction with the support of Case Libraries.

I also asked all three-novice practitioners how a Case Library could be designed so that it would be useful with their problem-solving activities. Amy foresaw value but was not able to talk specifics: "I think it is a good idea although I think it depends on the situation. It depends on how well it is explained or how well the story will stick with you" (Amy II, ¶ 99). When I asked about her opinion on how to make a Case Library that it would be useful for her case (so that the stories would "stick"), she responded:

> I don't really know how . . . I can't think of a good way to make a story stick. But like you were saying, if you can make it stick, then I think it is a very good way to learn. Other than your own experience which I think they are probably both equal but you need so much more time to build up all your own experiences where if you can just learn from what everyone else, you learn a lot more quickly. (Amy II, ¶ 120)

Nancy reacted similarly. However, Thomas was much more specific, actually informing me that in his area there is something similar to a Case Library, which is the first resource he consults whenever he works on prototypes:

> THOMAS: Actually on that regard we have data at the information [suppressed, actual location]. If one likes when I got my project, that is what I did. I went back and looked. It is in a microfiche on what people made since 1967 . . . As part of a researcher you have to go [to consult this file] . . . when you first get it, you have to go back and say: "Have we done something like this?"
> JULIAN That is part of your research?
> THOMAS: Yeah. *Actually that would be the first thing I would do. Have we done it before?*
> JULIAN: You go and check that?
> THOMAS: I go and check that. If we did . . . it is hard because most of the notes are not decipherable because they were photocopied and entered into a microfiche. It's hard . . .
> JULIAN: Is it notes like the little notes that people were taking on the product or typed documents or. . . ?

THOMAS: The nicest ones are the products prototype made, went through some sort of consumer test and there is usually a summary of that typed and like tape it to the notebook page.

In addition, the concept of a food product development Case Library and the sharing of experiences reminded Thomas of regular product exchange meetings product developers in his area conduct once a month:

THOMAS: In the interview that you taped especially with the marketing people [the 2nd problem-solving session] you said there were about 10 or more than . . . 10 products or issues that we remembered just like that. When somebody talks about some project, we seem to know what happened there even though we only work for a certain amount of projects a year.
JULIAN: We are talking about the prior cases that were brought up in conversation?
THOMAS: Yes. So I remembered it at the time but I didn't say it in tape so you might want to have this one. There is a program like set in the [suppressed, actual location] actually in product development that is called Product Exchange. Once a month we have a gathering for 2 hours. Everybody or selected people bring their products, their prototypes for a project and explain the formulation ingredients process and the expectation.
JULIAN: It is like a person give a quick presentation?
THOMAS: Quick presentation.
JULIAN: Does it get recorded like a video?
THOMAS: No.
JULIAN: It just happens?
THOMAS: It just happens, yes. If you go, you go. I mean, we make ourselves . . . You are not required to go but . . . so that I would know what is going on in the product development . . . what new developments, what new technologies are coming in. It is very important for me. I always go and ask questions and stuff. And that also helps in . . .
JULIAN: You recall some of those prototypes?
THOMAS: Yes, yes! and some of the processes.

More research needs to be conducted within companies such as Y&Z Candies to determine the best methods for making available to novice practitioners like Nancy, Amy and Thomas the vast amounts of knowledge contained in corporate records, within experts' past problem-solving experiences and novice practitioners own experiences as they work on projects. Case Libraries should be built, tested within these environments and refined. This research needs to be accompanied with ways of exploring the problem-solving processes these novice practitioners

engage in as they use a Case Library thus built. This should shed light into the design of Case Libraries in a school setting as well.

Assessing the Value of Case Libraries

Despite the value attributed to Case Libraries by the novice learners and novice practitioners engaged in this study, more systematic methods of research are needed for determining the value that a Case Library may have in school and work settings. Specifically, further experimental (quantitative) and non-experimental (qualitative) studies should be conducted in a school setting incorporating some of the recommendations presented earlier. Better assessment instruments should be designed for determining ill-structured problem-solving gain. It is important that qualitative methods be employed for exploring the various problem-solving processes stimulated by a Case Library to better define the phenomenon of experiencing meaning while problem solving through stories.

On the other hand, the use of Case Libraries in a work setting should be researched through qualitative means. Research techniques should be employed that demonstrate the value that a Case Library adds to, for example, an area such as the product development division where a novice practitioner like Thomas works. Such a study should address issues such as scale (how many stories can you input into the Case Library before reaching a point of diminishing returns), creation and management costs, etc. Findings from such a research can shed more light into the process of building Case Libraries for school settings as well.

Generic Versus Specialized Case Libraries

The present study was partly conducted in a school setting completely focusing on one course and one specific set of students (senior marketing/retail students). However, it did not

take long for students like Bob to realize that the stories he studied applied to other courses as well:

> I could see these little anecdotes about segments of industry as being helpful guidelines to follow. I think they can be put together essentially for any class. Examples could be found for it . . . doesn't matter if it is a marketing class or a finance class. I think this actual format could be used. (Bob, ¶ 274)

Considering that creating a Case Library is a difficult proposition that requires engaging numerous experts, technical talents (instructional designers, media specialists, programmers, etc.), and time, possibilities of collaboration among faculty from many disciplines should be considered. The present study is a case in point. It involved the talents of faculty from food science, agricultural economics, food marketing and retail, instructional systems, and numerous experts from industry. It seems like efforts such as this one will make the creation of effective Case Libraries possible, which may have the potential for being used in a wide variety of disciplines. Future research needs to explore the practicality of such an approach.

Closing Comments

Storytelling and the application of stories to problem solving is a bona fide human activity. Despite its ancient history, narrative's potential for education, specifically for promoting high-order cognitive skills, has yet to be realized. Not until more research is done will we uncover the benefits. Many studies such as the one presented here should be conducted to learn more about humans' ability to problem solve through stories.

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APPENDIX A

Key Terms and Definitions

For this study, a **story** is defined according to Edelson's criteria (1993): 1) it must have characters, real or fictitious; 2) it must have an identifiable incident; 3) it must deal in specifics (it should not be structured as an abstraction); 4) it must have a point (it must provide a lesson to the listener or reader); and 5) it must be told or observed but not directly experienced. In addition, a story should be concise. For this study, the stories elicited from experts will be edited for style, length and structure so that they will look like the one presented in figure 3.2. In essence, stories such as the ones that will be used in this study are the interpreted representations of real experiences from the perspective of the actual storytellers (experts).

An **experience** is a person's direct or indirect contact with a problem-solving situation. We recount our experiences, or listen to other people's experiences, in the form of stories. An experience is indirect if the person learned about it through a story; it becomes a vicarious experience.

A **case** is the actual encoding in memory of an experience or story. When we tell a story, we essentially go through a decoding process (Edelson, 1993).

A **Case Library** is a systematic collection and organization of a number of experts' experiences. These experiences, encoded as cases, are presented in the form of stories to a learner while interacting with a task environment (Edelson, 1993).

A **task environment** is the main element driving the pedagogy (Edelson, 1993). It can be based on a case, a simulation, a problem, a dilemma, etc. Task environments are usually computer-based (see Appendix C).

A **personal Case Library** is the set of cases that a particular human being is able to remember.

An **expert** is a person who falls into at least one of the following three categories: 1) who has 25+ years of experience in the food industry working in a number positions reflecting increasing levels of responsibility (ideally starting in a staff-level position, to managing important food product development projects, to having obtained a position with executive-level decision-making power such as vice president, CEO, etc.); 2) who has 15+ years of experience specifically working in some specialized aspect of the food product development process (specialists in packaging, flavor, formulation, regulatory issues, etc.); or 3) who has 15+ years in a faculty position of a major university developing and teaching food systems courses, conducting research and offering consulting services for the food industry, and in general being active in the academic development of the field.

A **novice learner** is an undergraduate student in some food systems field (food science, food marketing or retail, agricultural economics, etc.) who has less than two years fulltime work experience; this experience is primarily acquired through short-term internships or through summer or part-time work within a food product development concern (large corporation, ice cream parlor, food retailer, restaurant, etc.).

A **novice practitioner** is a person who has graduated from a university between two to no more than four years prior to this study and who has been working between at least one but no more than three years full time in the development of food products or some major associated aspect (laboratory analysis, packaging, ingredients, etc.). Although this person may be experienced in some jobs or tasks previously performed, he would be considered a novice in the position he currently holds.

APPENDIX B

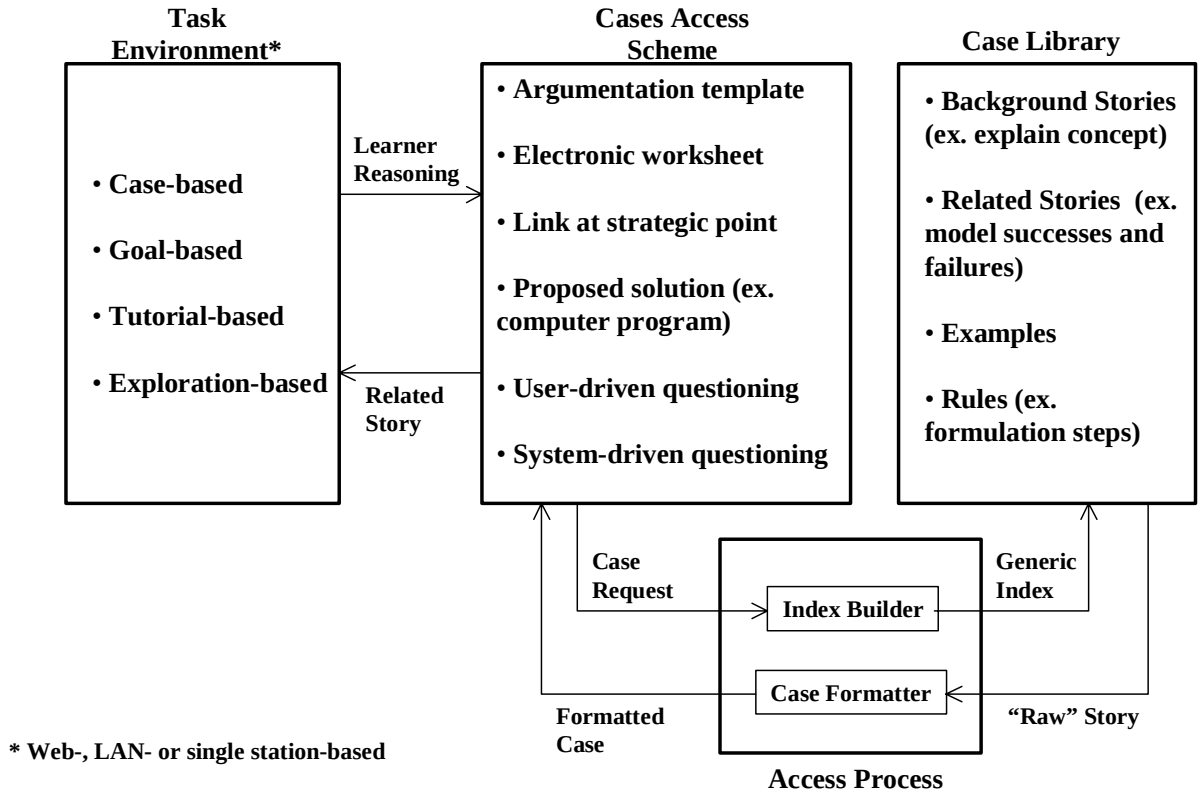
Some Case-Based Reasoners Already Developed

System	Purpose	Reference
ARCHIE	Architectural design plans	Pearce et. al. (1992)
BROADCAST NEWS	Teaching social studies topics	Schank (1995)
CASCADE	Suggesting solutions on computer crashes	Simoudis (1992)
CASEY	Case-based diagnostician	Kolodner (1993)
CELIA	Diagnosing automobile problems	Kolodner (1993)
CHEF	Recipe creation	Kolodner (1993)
CLAVIER	Designing manufacturing layouts	Hennessy et. al. (1992)
CREANIMATE	Teaching biology topics	Edelson (1993)
CYCLOPS	Landscape design	Kolodner (1993)
DUSTIN	Language training system	Schank (1990)
GuSS	Social skills development	Kass et al. (1993/1994)
HYPO	Creating legal arguments	Kolodner (1993)
JULIA	Meal planning	Kolodner (1993)
KRITIK	Design mechanical assemblies	Kolodner (1993)
MEDIATOR	Settling disputes	Kolodner (1993)
PERSUADER	Solving labor management disputes	Kolodner (1993)
PROTOS	Case-based classification	Kolodner (1993)
Sickle Cell Counselors	Teaching genetics	Bell et. al. (1993/1994)
TAXOPS	Tax opportunity advisor	Schank (1990)
VICTOR	Voice and image tutor	Schank (1990)
YELLO	Teaching novice advertising professionals	Kass et. al. (1993/1994)

For a more comprehensive list, see Kolodner (1993, pp. 581-628), Khan & Yip (1995).

APPENDIX C

Case Library Concept



APPENDIX D

Story Type and Related Cognitive Outcomes

	Story Type[17]	Desired Ill-Structured Problem-Solving Outcome in Novices[18]
1	Suggest sample solutions to problems (as raised by particular tasks)	• Planning activities to avoid problems • Repairing problems • Providing solutions with a high chance for success • Justifying solutions • Predicting successful results (based on solution)
2	Suggest warnings against certain solutions (sample failures)	• Anticipating problems before they happen • Identifying unacceptable solutions • Predicting unsuccessful results (based on warning)
3	Suggest methods for achieving specific tasks	• Planning activities to avoid problems • Justifying solutions
4	Reveal obstacles to be encountered in the tasks	• Anticipating problems before they happen • Identifying what's important in problem situation
5	Illustrate the relative merit of different approaches (methods) or solutions or perspectives	• Recognizing what good and bad solutions look like • Evaluating multiple solutions • Evaluating multiple perspectives

[17] (Kolodner, 1993)
[18] (Jonassen, 1997)

APPENDIX E

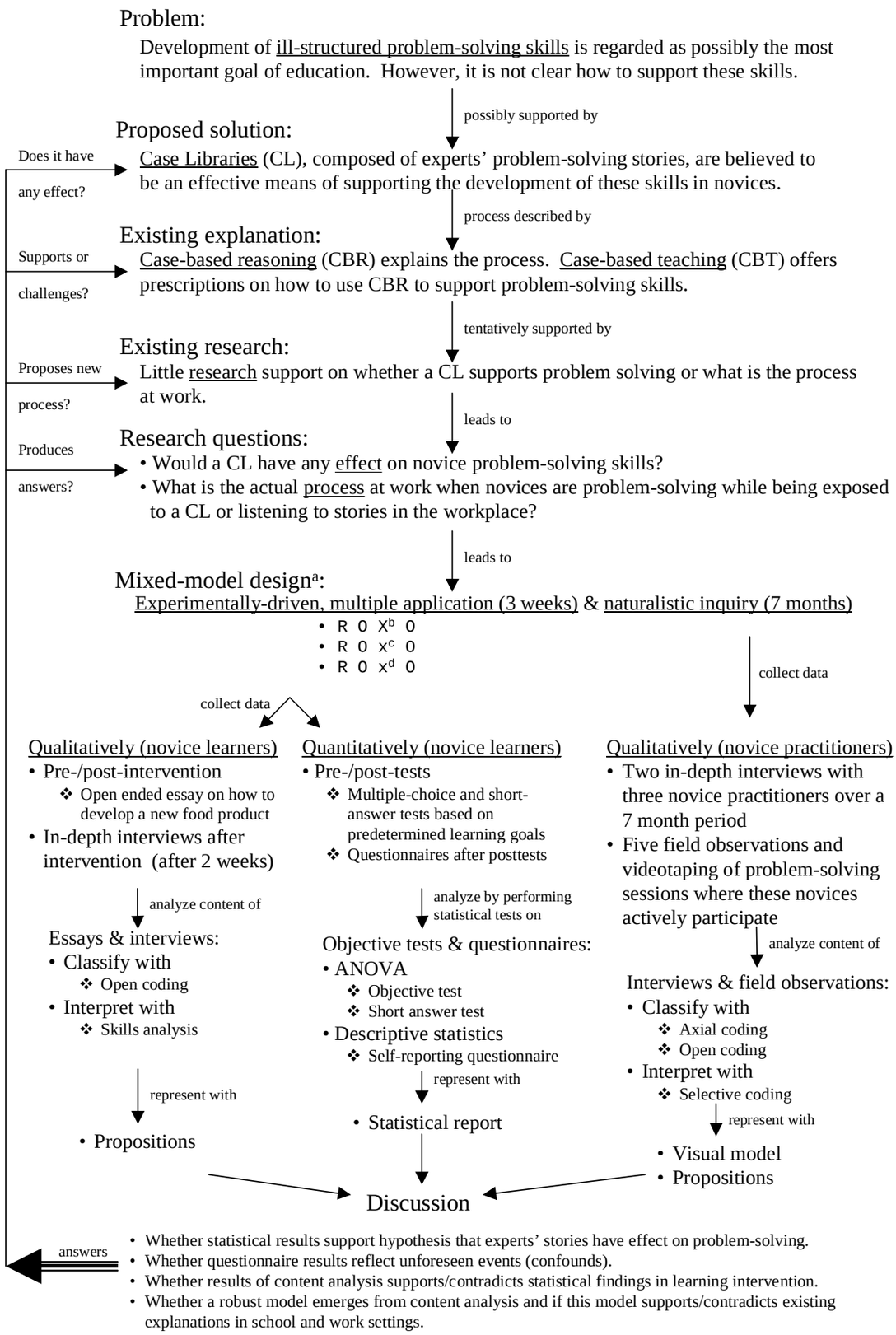
Mixed-Model Design

Stage	Quantitative paradigm	Qualitative paradigm
Design	Experimental	"Opportunistic"[19] and Naturalistic
Data Collection	▪ Multiple-choice pre- & post-test ▪ Short-answer pre- & post-test ▪ Self-reporting questionnaire after post test	▪ Open essay pre- & post-test ▪ Semi-structured interview after post test ▪ Field observation & in-depth interviews
Analysis	Statistical analysis as follows: ▪ ANOVA on all pretests (for homogeneity) ▪ ANOVA on all post tests (for effect) ▪ Item reliability test ▪ Correlation tests between multiple-choice and short-answer tests ▪ Descriptive statistics with questionnaires	Analysis of essays, in-depth interviews, and field observations as follows (Creswell, 1998; Dey, 1999; Strauss & Corbin, 1990, 1998): ▪ Classifying: ▪ Axial coding (causal condition, context, intervening conditions, strategies, consequences) ▪ Engage in open coding (categories, properties, dimensionalize properties) ▪ Interpreting: ▪ Engage in selective coding, identifying supporting quotes
Representing, Visualizing	The results will be presented closely following the format used in a statistics software package.	▪ Presentation of a visual model ▪ Presentation of propositions
Discussion	▪ Whether the statistic analyses support the hypothesis (stories have an effect on problem solving) ▪ Whether the questionnaires reflect unforeseen events that would create validity problems or reflect the influence of major confounding factors	▪ Whether the analysis partially or wholly supports or contradicts the results of the quantitative analysis and/or the existing theoretical basis ▪ Whether the analysis makes possible the emergence of a new theoretical model

[19] The study is opportunistic to the extent that within the experimental design it also "seizes" the opportunity of expanding on data collection and analysis with the potential of influencing the results. It is naturalistic to the extent that qualitative data will be collected in the field.

APPENDIX F

Conceptual View of the Study



[a] Inquiry, data collection/operations, and analysis/inferences contain important elements from quantitative and qualitative designs.
[b] Treatment group will be exposed to the stories in the CL.
[c] Comparable group will be exposed to fact sheets composed of a summary of the lessons learned from the corresponding story.
[d] Control group will be exposed to text randomly selected from a food product development textbook dealing with unrelated issues.

APPENDIX G

Study Timeline

	Activity	From	To
1	Contacted *novice practitioners*' sites, negotiated entry, negotiated terms and conditions.	May 2000	June 2000
2	Contacted *novice learners* site, agreed about specifics of content domain with faculty regarding learning intervention, negotiated study protocol.		
3	Completed instruments (objective & short-answer tests, opportunity statements, questionnaires), completed rubric for short-answer tests.	June	Sept.
4	Piloted and revised in-depth *novice practitioner* interview protocol	1st week July	2nd week July
5	Designed and developed task environment for learning intervention	June	Sept.
6	Identified, collected and prepared stories for case library to be used during learning intervention	June	Sept.
7	Conducted 1st in-depth *novice practitioners* interviews, problem-solving sessions, 2nd in-depth interviews	3rd week July 2000	Jan. 2001
8	Piloted and revised learning intervention materials, instruments, and in-depth interview	Sept.	same
9	Recruited *novice learners* during class	1st week Sept.	same
10	Trained *novice learners* on the use of the learning intervention materials	2nd week Sept.	4th week Sept.
11	Pretests (objective, short-answer, open-ended essay)	4th week Sept .	1st week Oct.
12	Commenced learning intervention for *novice learners*	1st week Oct.	3rd week Oct.
13	Post tests (objective, short-answer, open-ended essay), questionnaire about learning intervention experience (affective domain, unforeseen problems, general opinion, etc.)	3rd week Oct.	same
14	Conducted in-depth *novice learners* interviews and data analysis	1st week Nov	same
15	Grading of objective tests (by me)	Nov.	same
16	Finalized short-answer rubric development	Nov.	same
17	Grading of short-answer tests by judges	Dec.	Jan. 2001
18	Completed statistical tests on quantitative results	Jan. 2001	Feb.
19	Completed qualitative data analysis	July 2000	Jan. 2001
20	Presented problem-solving model to *novice practitioners*	Jan. 2001	same
21	Compiled results	Feb. 2001	same

APPENDIX H

Novice learners questionnaire
(administered right after the post test)

Purpose

To uncover any unforeseen events that might have gone unnoticed during the study.
To collect data regarding gender, age, race, GPA, semester standing, reason for taking the course, and work experience related and unrelated to any aspect of the food industry.

Sample questions (with a *brief* description of the scale employed from highest to lowest measure):

- How much time did you spend reading the assigned material?
  a lot ➔ none

- Circle the approximate number of hours you spent reading the material:
  10 ➔ 0 hours

- What do you think about the time spent reading the assigned material?
  worthwhile ➔ not worthwhile

- Do you think that this material is credible?
  highly credible ➔ not credible

- Were you able to recall this material as you worked on the tests?
  remembered all ➔ remembered none

- To what extent was this material helpful as you worked on the tests?
  extremely helpful ➔ not helpful

- How much of the material assigned to you did you show to some other classmate?
  all ➔ none

- How much of the material NOT assigned to you was shown to you by some other classmate?
  all ➔ none

- If you were asked to voluntarily go over material presented this way for another course, what do you think you would do? I would…
  definitely go over it ➔ not go over it at all

- Suggestions for improving the study.

APPENDIX I

Exploration Strategies During Interviews and Problem-Solving Sessions

Novice Learners In-Depth Interviews

Individual in-depth interviews were conducted with two students from each group on the university premises (for a total of 6 interviews lasting 2 hours each). The main objective was to uncover the problem-solving process followed by these six students to determine if this process reflected the incorporation in any form of the treatment material. This was done by reviewing specific answers from multiple choice and short-answer tests as well as open-essay examination. In addition, there was a follow up on the results of the questionnaire. The following questions were used as cues for the inquiry:

- Why did you choose that particular answer?
- Was there anything that you studied that made you feel that was a good answer?
- When you first read the question or situation, what was the first thought that came to mind?
- Why did you take this position?
- What did this situation remind you of?
- Was there anything in the material you studied that helped you propose this kind of approach/argument/solution(s)?

General inquires were made regarding problem solving in school and work, their perspective regarding problem solving and stories, etc. Finally, I asked for recommendations for carrying out the study in the future and ideas for educators regarding the support for problem-solving skills and the incorporation of stories in school.

Novice Practitioners First In-Depth Interview

The objective of the individual in-depth interviews was to provide me with information about contextual factors surrounding the three practitioners' day-to-day activities so that I could see

their perspective on problem solving. The interviewers lasted from 2½-3 hours each. The following points served as cues during the inquiry:

- Their perspective on the company's culture as it pertains to novices, experts, good/bad problem-solvers, etc.
- Their perceived value of problem-solving sessions and activities within the company
- Problem-solving techniques used in the company
- Their perspective on what are the main components of their problem-solving activities (including stories and others)
- Their perspective on ways in which novices learn from more experienced practitioners (experts in the company, inside/outside consulting, etc.)
- Their perspective on:
    - Status in the company
    - Characterization of problem solving: what's good problem-solving behavior, what's not, what's good to know, what's useless to know, what's good to acquire, etc.
    - Characterization of a person who is a good problem-solver and sample behaviors
    - Characterization of a person who is a bad problem-solver and sample behaviors
    - Feelings about his job in general, about adequacy during problem solving in particular, about "school knowledge" and the role it has played and still plays in her job
    - Transition from novice learner to novice practitioner to expert as problem solver

Novice Practitioners Second In-Depth Interview

After having video recorded and analyzed two problem-solving sessions, I interviewed the participants to find confirmation of the data obtained in the first in-depth interviews and to observe them engaging in natural problem-solving behavior. The following points served as cues during the interviews as the participants and I together reviewed selected segments of the videotape (see Appendix M for a brief description of these segments):

- Explore the process of employing expertise
- Explore the process of problem solving when immediate expertise is not available
- Explore the process when a peer suggests a particular solution path based on prior experiences
- Explore the process of problem-solving knowledge acquisition when factual information in the form of advice is the only argument given

APPENDIX I (continued)

Exploration Strategies During Interviews and Problem-Solving Sessions

- Inquire about memorizing and reasoning with plain facts or non-story forms of explanation, presentation or exposition such as graphs, equations, etc.
- Inquire about the value of personal experience
- Explore the process of explanation, particularly the sources of knowledge that are brought to bear, when asked to support a particular solution path
- Inquire about the nature of an expert's timely intervention and the learning value of these interventions
- Inquire about what seems like an instance of spontaneous situated teaching and learning
- Inquire about the possibility of "situated" formal training
- Inquire about learning processes during equipment demonstration
- Explore the problem-solving process when the discussion is grounded on a prior case
- Prompting participant to relate a story with all the elements (character, timelines, etc.)
- Inquire about the process of learning by simply being there or learning incidentally from an "outside" conversation
- Explore the learning process within a quick exchange of ideas in the session ("learning and problem solving as you go")
- Determine to what extent participant is able to remember a story and its elements and lesson
- Inquire about the phenomenon of "stories untold"

Finally, toward the end of the interview, I inquired about issues still unclear from the first interview, requested clarifications on their background, clarifications on the project that was the object of the problem-solving sessions, and raised validity issues ("Do you think that all members acted naturally through out this process? If I hadn't been there, would the session have evolved differently? If that's the case, in what way?").

At the end, I requested feedback (confirmation) regarding the themes/categories/properties/relationships that I extracted from the data analysis thus far as well as my preliminary recommendations. Then I presented and requested their perspectives on the preliminary problem-solving model I completed based on data collected thus far from the three interviews and problem-solving sessions, as well as the specific storytelling component within the model. Finally, I asked for recommendations for novice learners, novice practitioners and

Exploration Strategies During Interviews and Problem-Solving Sessions

educators regarding problem-solving skill development in the area of food product development and the design of instructional tools for the incorporation of stories into their jobs.

APPENDIX J

Brief Description of the Skills Analysis

"Develop a Product Development Plan"

Objective: To support ongoing instructional design work for a food product development course offered every fall at Penn State (AG EC 440 / FD SC 497A – Food Product Innovation Management)

Timeline: Completed after 5 months (January - June 2000, approximately 84 man-hours)

Who participated:

Main contributors: Penn State food science professor with 25+ years of academic and industry experience, Penn State agricultural economics professor with 15+ years of academic experience, and myself who guided the two faculty members through the process

Reviewers: The two faculty members who provided their classes for the study (both food marketing/retail professors, one with 25+ years of academic experience and the other one with 28+ years of food retail experience); also reviewed by a retired former senior vice president of a major U.S. food corporation with 28+ years in food product development experience

The final goal of the skills analysis and four sub-goals specifically targeted by the stories in the Case Library are as follows (sub-goals 4 through 7 were not covered in the study):

0. Goal: Develop a Product Development Plan

    1. Evaluate market opportunity

    2. Generate product idea/concept

    3. Evaluate preliminary plans for the purpose of deciding to develop the product

    8. Plan Launch

APPENDIX K

Learning Issues, Related Skills and Stories Contained in the Case Library

Twelve learning issues where identified within the "Market Potential" section of the Contadina case. They are listed below followed by the specific hierarchy within the skills analysis that supports each, followed by the titles of the stories targeting the skill(s). In addition, stories are classified by outcome (success, failure, method application, obstacle, or merit decision).

I. For the learning issue Evaluate (scan) data on existing retail products, the associated skills are:

1. Evaluate market opportunity
1.1. Evaluate market opportunity with expertise and knowledge
1.1.2. Articulate firm's competencies
1.1.2.2 / 1.1.2.2.1. Evaluate access to and knowledge of the new market system
1.1.2.2.1.1. Analyze market trends within current market system
1.1.2.2.1.1.1. Evaluate demand within current market system
1.1.2.2.1.1.1.2. Evaluate actual demand (scan data, Nielsen, etc.)

Story title:
Early IRI (failure)

II. For the learning issue Determine potential market size for a product, the associated skills are:

1. Evaluate market opportunity
1.1. Evaluate market opportunity with expertise and knowledge
1.1.2. Articulate firm's competencies
1.1.2.2 / 1.1.2.2.2. Evaluate access to and knowledge of the new market system
1.1.2.2.2.1. Analyze market trends within new market system
1.1.2.2.2.1.1. Evaluate demand within new market system
1.1.2.2.2.1.1.1. Evaluate demand on related products

Story titles:
Retailer's unique way to determine market size for a product (success, merit)
The Dog Litter Product (success, methods, merit)
Coca-Cola's share of the stomach (success, merit)

APPENDIX K (continued)

Learning Issues, Related Skills and Stories Contained in the Case Library

III. For the learning issue Select and use forecasting methods, the associated skills are:

1. Evaluate market opportunity
1.1. Evaluate market opportunity with expertise and knowledge
1.1.2. Articulate firm's competencies
1.1.2.2 / 1.1.2.2.2. Evaluate access to and knowledge of the new market system
1.1.2.2.2.1. Analyze market trends within new market system
1.1.2.2.2.1.1. Evaluate demand within new market system
1.1.2.2.2.1.1.2. Perform simulation of consumer purchasing habits

Story titles:
The dry dog food profit generator (failure, method)
Reese's Sticks (failure)
Hershey's Sweet Escapes (success, method)

IV. For the learning issues Determine consumer characteristics and Collect and analyze demographic data, the associated skills are:

1. Evaluate market opportunity
1.1. Evaluate market opportunity with expertise and knowledge
1.1.2. Articulate firm's competencies
1.1.2.2 / 1.1.2.2.2. Evaluate access to and knowledge of the new market system
1.1.2.2.2.1. Analyze market trends within new market system
1.1.2.2.2.1.1. Evaluate demand within new market system
1.1.2.2.2.1.1.3. Evaluate consumer profile within new market

Story titles:
The perfect store location (success, method)
Friendly's Ice Cream in Hershey (success, merit)

V. For the learning issues Elicit consumer attitudinal data and Assess consumer perception on various product positionings, the associated skills are:

2. Generate product idea/concept
2.1. Generate product idea/concept for retail
2.1.2. Generate and evaluate retail product concepts
2.1.2.1. Gather *qualitative* data on retail product concept(s) through the use of:
2.1.2.1.1. Story boards
2.1.2.1.2. Brainstorming sessions
2.1.2.1.3. Focus groups
2.1.2.1.4. Mock ups

APPENDIX K (continued)

Learning Issues, Related Skills and Stories Contained in the Case Library

Story titles:

Snacks For Pets: The "Successful" Product That Was Never Stocked (failure)
Nabisco's Chips Ahoy! (success, method)
The One-Hundredth Birthday (Disastrous) Celebration: The New Coke (failure)
Meal solutions (failure, obstacles)
Tidy Cats (success)

VI. For the learning issues Determine first year trial volume and Determine first year repeat purchase volume, the associated skills are:

3. Evaluate preliminary plans for the purpose of deciding to develop the product
3.2. Design preliminary marketing plan
3.2.1. Specify target market

Story titles:

How General Mills Targets Its Markets (success, merit)
Anheuser Bush's Tequila-Flavored Beer (obstacle)
Beyond the first trial (success, method, merit)
Treating retailers as individuals (success, method)

VII. For the learning issues Make/justify product launch recommendations and Make/justify product positioning recommendations, the associated skills are:

3. Evaluate preliminary plans for the purpose of deciding to develop the product
3.2. Design preliminary marketing plan
3.2.2. Specify product positioning

Story titles:

Hershey's Tastetations (success, method)
Super premium dog food (success)
The Golden Almond Bar (failure)
Hershey's Nuggets (success)

VIII. For the learning issue Plan market activities, the associated skills are:

8. Plan Launch
8.4. Design advertising and promotional events to coincide with market introduction
8.4.3. Select media
8.4.4. Identify promotion

Story titles:

The Pokémon Mania (success, method)
Performing the Symphony (success, method)

APPENDIX L[20]

Qualitative Source Data Description

Document	Media	When / Where	Size
Nancy's 1st in-depth interview	A	Jul 20, 2000 at 1:00 PM Company's site	3½ hours, 67 pages
Amy's 1st in-depth interview	A	Sep 1, 2000 at 1:00 PM Company's site	3 hours, 53 pages
Open-ended pretests	41 Ds	4th week Sep 2000 university premises	≈ ½ page
Thomas' 1st in-depth interview	A	Sep 29, 2000 at 1:00 PM Company's site	3½ hours, 43 pages
Nancy's 1st problem-solving session	V	Oct 2, 2000 at 12:10 PM Company's site	36 minutes
Open-ended post tests	42 Ds	3rd week Oct 2000 university premises	≈ ½ page
Bernard's in-depth interview	A	Nov 1, 2000 at 9:00 AM University premises	2 hours, 27 pages
Laurie's in-depth interview	A	Nov 1, 2000 at 4:15 PM University premises	2 hours, 26 pages
Joan's in-depth interview	A	Nov 2, 2000 at 10:30 AM University premises	1¾ hours, 25 pages
Bob's in-depth interview	A	Nov 2, 2000 at 12:15 PM University premises	1¾ hours, 39 pages
Cynthia's in-depth interview	A	Nov 2, 2000 at 2:30 PM University premises	1¾ hours, 27 pages
Samuel's in-depth interview	A	Nov 2, 2000 at 4:15 PM University premises	1¾ hours, 25 pages
Amy's problem-solving session	V	Dec 12, 2000 at 12:45 PM Company's site	36 minutes
Amy's 2nd in-depth interview	A	Dec 12, 2000 at 1:40 PM Company's site	40 minutes, 13 pages
Nancy's 2nd problem-solving session	V	Nov 22, 2000 at 12:45 PM Company's site	1 hour 56 minutes
Thomas' 1st problem-solving session	V	Nov 29, 2000 at 10:40 AM Company's site	48 minutes
Thomas' 2nd problem-solving session	V	Dec 5, 2000 at Company's site	1 hour 55 minutes
Nancy's 2nd in-depth interview	A	Jan 23, 2001 at 1:15 PM Company's site	2½ hours, 29 pages
Thomas' 2nd in-depth interview	A	Jan 23, 2001 at 9:30 AM Company's site	2½ hours, 29 pages
Memos and field notes	51 Ns	Jun 2000 through Feb 2001	Various lengths

[20] A = audiotape transcription, V = video, N = NVivo docs, D = MS-Word docs. Size in pages according to MS-Word 2000 format with 1½-spacing. All electronic documents were (re-)coded from July 2000 until January 2001 starting immediately after creation.

APPENDIX M[21]

Problem-Solving Video Data Log

Nancy's 1st Session

Log (segment start)		Segment Description	Objective of my Inquiry
1	N-Tape I 0:02:30	Discussion about consultation with statistical software package expert regarding lab data setup and analysis.	To explore the process of employing expertise. To explore process of problem-solving knowledge acquisition when just factual information in the form of advice is the only argument given.
2	0:11:45	Conclusions about the number of vendors that currently meet material specifications.	To inquire about memorizing and reasoning on plain facts or non-story forms of explanation, presentation or exposition such as graphs, equations, etc.
3	0:18:00	The senior (most expert) member in the meeting explains her rationale for interpreting the data ("It's okay!") as she walks through the spreadsheet and graphs seeming at all times to teach Nancy, who quickly follows this learning request.	To inquire about what seems like an instance of spontaneous situated teaching and learning.
4	0:31:05	The senior member laments that Nancy will have the learn Excel "the hard way."	To inquire about the possibility of "situated formal training."

[21] Only showing the most meaningful problem-solving episodes.

APPENDIX M (continued)

Problem-Solving Video Data Log

Nancy's 2nd Session

	Log (segment start)	**Segment Description**	**Objective of my Inquiry**
1	N-Tape I 1:05:20	The most expert team member inquires about e-coli protocol looked at three years ago.	To explore problem solving process when grounding discussion on a prior case.
2	1:22:35	Prototype machine is shown to automatically mix different types of powder material used in the manufacture of products.	To inquire about learning processes during demonstration.
3	N-Tape II 0:10:55	Very elaborate discussion led by the session's expert on the issue of amount of sampling sent by suppliers and what the company should do to maintain standards.	To explore thinking process when an expert justifies decisions based on an elaborate factual exposition.
4	0:24:45	Session's expert confidently expresses what should be the next step for initiating suppliers into the sampling program ("We have done that before...initiate them in the program and have them pick it up from there.").	To inquire about prior experience within company ("collective experiences") and to determine the value of this experience for learning.

APPENDIX M (continued)

Problem-Solving Video Data Log

Amy' Session

Log (segment start)		Segment Description	Objective of my Inquiry
1	A-Tape I many short segments	The senior member of the team (but not the expert) makes numerous suggestions on how to identify the problem causing the unusual spikes on the graphs.	To inquire about prior experience.
2	many short segments	Brainstorming on the cause of the spikes on the graphs.	To inquire about problem-solving approach.
3	0:12:30	Talk about prior data in which a peak turned out to be a flavor carried to the sample and causing "interference."	To inquire about "untold stories."
4	0:15:05	Discussion focuses on speculating if the "interference" was due to cinnamon chips & butterscotch traces.	To inquire about prior cases and "collective experiences."
5	0:17:28	Discussion turns to a possible source of trouble that has turned out before: solvents touching the analysis instrument and causing contamination.	To inquire about prior experience within company and to determine the value of this experience for learning. To inquire about "untold stories."

APPENDIX M (continued)

Problem-Solving Video Data Log

Thomas' 1st Session

	Log (segment start)	Segment Description	Objective of my Inquiry
1	T-Tape I 0:20:10	Discussion about decision route suggested by expert that he considers acceptable.	To explore the process of employing expertise.
2	0:21:00	Situation when Thomas requested advice from the most expert member of the team but that person was not able to provide a solution.	To explore the process of problem solving when immediate expertise is not available.
3	0:22:42	Discussion briefly focuses on technique "X" as suggested by a team member for dealing with the flavor problem.	To explore the process when a peer suggests a particular solution path based on prior experiences (not personal experience).
4	0:27:26	The most expert member of the team urges Thomas to talk to the engineers before he commits on making the product in the shapes specified by marketing.	To explore problem-solving knowledge acquisition process when just factual information in the form of advice is the only argument given.
5	0:41:00	The most expert member of the team suggests putting the product in the freezer to attain the desired flavoring profile.	To inquire about the value of personal experience.

APPENDIX M (continued)

Problem-Solving Video Data Log

Thomas' 2nd Session

	Log (segment start)	**Segment Description**	**Objective of my Inquiry**
1	T-Tape I 0:53:25	Marketing manager asks Thomas for an explanation on how the prototype product provides the "cooling" sensation.	To explore process of explanation, particularly the sources of knowledge that are brought to bear, when asked to support a particular solution path.
2	0:56:30	Thomas was overruled by a more experienced team member regarding Thomas' approach for layering of flavors on a prototype product.	To inquire about the nature of an expert's timely intervention in an ongoing discussion and the learning value of these interventions.
3	0:57:48 1:13:37 1:17:20 T-Tape II 0:04:00 0:16:20 0:18:14 0:27:35 0:34:35 1:43:50	Discussion focuses on the following prior products: *TasteBud* *MintWay* ice cream candy "with terrible flavor" scooped-shaped product "dulce de leche" MarbleMints *TasteBud*-like product *Oreo*-like cookies "fruit and cream stuff" example	To explore problem-solving process when grounding discussion on a prior case.
4	1:23:57	Problem situation explained by Thomas by saying, "This happened before!"	To prompt Thomas to elicit a story with all the elements.
5	1:36:55	Marketing person engages into an intense side discussion with the consumer research person on whether to research by conducting a focus group or central location test.	To inquire about the process of learning by simply being there or learning incidentally from a side conversation.

APPENDIX M (continued)

Problem-Solving Video Data Log

Thomas' 2nd Session (continued)

6	0:00:30	A short but very intense discussion ensues between Thomas and the most expert person with regards to shaping a product like a pillow.	To explore learning process within a quick exchange of ideas as part of the problem-solving discussion.
7	0:14:35 to 0:15:55	The director for product development "bursts onto the scene" with a story that he felt provided a warning that all present should heed.	To determine to what extent Thomas is able to remember a story as told in the problem-solving session together with its elements and lesson.
8	0:39:15	Discussion centers on putting calcium in the product. The consumer research person tries to forewarn others about the risks involved with this strategy but he gets overruled without being allowed to elaborate.	Inquire about the phenomenon of "untold stories."

APPENDIX N

Sample Consent Form – School Setting

INFORMED CONSENT FORM FOR BEHAVIORAL RESEARCH STUDY

The Pennsylvania State University

Title of project: Use of a Case Library to Enhance Learning

Persons in charge:

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1. This section provides an explanation of the study in which you will be participating:

A. The study in which you will be participating is part of a research study intended to test the effect of the use of cases on learning.

B. If you agree to take part in this research, you will be asked to take two sets of tests and complete one questionnaire related to you and your experience while participating in this study. In addition, you, together with eight other participants selected at random from the rest of the class, may be asked to volunteer to participate in an interview after this study is completed (approximately two weeks after the study begins). You will be asked to read and use some material that will be put on the Web as part of the regular activities with this course for two weeks. Your answers to the tests, together with those of approximately 50 students will be used to draw conclusions about the incorporation of certain material for this course and courses similar to this one

C. Your participation in this research will take approximately 50 minutes for each set of tests. You will be notified the location and time to take the tests. After the second set of tests, you will also be asked to answer some questions regarding the study. In addition, and in the event that you are selected, you will be contacted and asked to participate in a discussion where your opinion will be requested on a series of study-related issues sometime after the second set of tests are completed. This discussion should take approximately 2-3 hours. You may be asked to participate in follow-up discussions of similar duration. During these discussions, audio/visual tape recording may be employed.

D. In return for your participation, you will receive a 10-point extra credit to be applied to your final grade.

E. If you do not wish to participate in this research, you may earn equivalent extra credit by completing a special project related to the material to be covered in class during the duration of the study as specified by your instructor. You will receive detailed information on this project upon request.

F. As stated earlier, this study will involve the use of audio/visual tape recording. Only I, Julián Hernández-Serrano, will have access to these records. These records will be destroyed approximately 4-5 months after the appropriate analysis to this data is completed.

APPENDIX N (continued)

Sample Consent Form – School Setting

2. This section describes <u>your rights as a research participant</u>:

A. You may ask any questions about the research procedures, and these questions will be answered. Further questions should be directed to Julián Hernández-Serrano and Dr. David H. Jonassen. Their contact information is found at the top of this form.

B. Your participation in this research is <u>confidential</u>. <u>Only</u> I, Julián Hernández-Serrano, will have access to your identity. In the event of publication of this research, no personally identifying information will be disclosed. To make sure your participation is confidential, you will be assigned a unique code number with which I will be able to identify the tests. With this same code you will have access to the material on the Web. Only <u>you and I</u> will have access to this code.

C. Your participation is voluntary. You are free to stop participating in the research at any time, or to decline to answer any specific questions without penalty. If you choose to stop participating in the study, you can still earn the 10-point credit by completing the special project.

D. This study involves minimal risk; that is, no risks to your physical or mental health beyond those encountered in the normal course of everyday life.

3. This section indicates that you are giving your <u>informed consent to participate</u> in the research:

<u>Participant</u>:

I agree to participate in a scientific investigation of Julián Hernández-Serrano, as an authorized part of the education and research program of the Pennsylvania State University.

I understand the information given to me, and I have received answers to any questions I may have had about the research procedure. I understand and agree to the conditions of this study as described.

To the best of my knowledge and belief, I have no physical or mental illness or difficulties that would increase the risk to me of participation in this study.

I understand that I will receive ten points that will be applied to my final grade in compensation for participating in the study, and that I am entitled to no other compensation.

I understand that my participation in this research is voluntary, and that I may withdraw from this study at any time by notifying the person in charge. If I choose to withdraw from the study, I understand that I will still be able to earn the ten points by completing a special project.

I am 18 years of age or older, and full-time student of the [suppressed, university name]. I understand that I will receive a signed copy of this consent form.

_____ _____

Signature **Date**

<u>Researcher</u>:

I certify that the informed consent procedure has been followed, and that I have answered any questions from the participant above as fully as possible.

_____ _____

Signature **Date**

APPENDIX O

Sample Consent Form – Work Setting

INFORMED CONSENT FORM FOR BEHAVIORAL RESEARCH STUDY

The Pennsylvania State University

Title of project: Use of a Case Library to Enhance Learning

Persons in charge:

Julián Hernández-Serrano
Ph.D. Candidate
Instructional Systems Program
at Penn State
1400 Martin Street, Apt. 3114
State College, PA 16803
814-867-4972
jxh323@psu.edu

David H. Jonassen, Ph. D.
Distinguished Professor
School of Information Science
and Learning Technologies
at University of Missouri
221J Townsend Hall
Columbia, MO 65211
573-882-2832
Jonassen@missouri.edu

1. This section provides an explanation of the study in which you will be participating:

A. The study in which you will be participating is part of a research intended to identify the components that make up problem-solving skills within young practitioners in a work setting, and how these components help in the learning and application of problem-solving skills.

B. If you agree to take part in this research, you will be asked to participate in an interview where you will be invited to provide your perspective on problem-solving issues as they occur in your particular work area as well as problem-solving issues in general. You will also be asked to allow me "to shadow" you as you engage in one or more activities where you will be solving problems relevant to some project or company-related activity (project meeting, lab, etc.). You will also be asked to assist me in the analysis of the data gathered as a result of your participation in the study. During these discussions, audio/visual tape recording may be employed.

C. Your participation in this research will take approximately 2-3 hours for the initial interview, 2-3 hours during the "shadowing," and 2-3 hours for the final data analysis. You will be notified in advance of the location and time when the data collection and analysis sessions will occur. There is the possibility that you may be asked to participate in additional data collection and analysis sessions.

D. As stated earlier, this study will involve the use of audio/visual tape recording. Only I, Julián Hernández-Serrano, will have full access to these records during the study. These records will be destroyed approximately 4-5 months after the appropriate analysis to this data is completed.

2. This section describes your rights as a research participant:

A. You may ask any questions about the research procedures, and these questions will be answered. Further questions should be directed to Julián Hernández-Serrano and Dr. David H. Jonassen. Their contact information is found at the top of this form.

B. I, Julián Hernández-Serrano, will keep and safeguard the data generated during this study. In the event of publication of this research, no personally identifying information will be disclosed. There may be some Hershey personnel interested in the data and the resulting analysis for understanding problem-solving

APPENDIX O (continued)

Sample Consent Form – Work Setting

processes as they take place within this organization.

C. Your participation is voluntary. You are free to stop participating in the research at any time, or to decline to answer any specific questions without penalty. If you choose to stop participating in the study, you will not be penalized in any form.

D. This study involves minimal risk; that is, no risks to your physical or mental health beyond those encountered in the normal course of everyday life.

3. This section indicates that you are giving your <u>informed consent to participate</u> in the research:

<u>Participant</u>:

I agree to participate in a scientific investigation of Julián Hernández-Serrano, as an authorized part of the education and research program of the Pennsylvania State University.

I understand the information given to me, and I have received answers to any questions I may have had about the research procedure. I understand and agree to the conditions of this study as described.

To the best of my knowledge and belief, I have no physical or mental illness or difficulties that would increase the risk to me of participation in this study.

I understand that I will not receive any compensation for participating.

I understand that my participation in this research is voluntary, and that I may withdraw from this study at any time by notifying the person in charge.

I am 18 years of age or older, and a full-time employee of [suppressed, company name and location].

I understand that I will receive a signed copy of this consent form.

_____ _____

Signature **Date**

<u>Researcher</u>:

I certify that the informed consent procedure has been followed, and that I have answered any questions from the participant above as fully as possible.

_____ _____

Signature **Date**

VITA

Julián Hernández-Serrano

EDUCATION

Ph.D., Instructional Systems, Penn State University
Projected date of graduation May 2001.
MBA, New Hampshire College
Graduated 1988.
BS, Computer Science, State University of New York
Graduated 1984.

EXPERIENCE

Assistant Professor
Business Administration Department, University of Puerto Rico at Humacao
Humacao, PR
1993-1997

Computer Consultant
Offered computer consulting services in the areas of database design and development to various businesses and schools in Puerto Rico primarily using Paradox and FoxPro.
1992-1997

Project Leader
Probursa S.A. de C.V., México City, México
Rhône Merieux, México City, México
1990-91

Computer Programmer/Analyst
Ochoa Fertilizer Co., San Juan, Puerto Rico
1988-1989

Computer Programmer
GE Government Services, US Navy, Roosevelt Roads, Ceiba, Puerto Rico
1986-1988

Computer Operator
Virginia Tech, Blacksburg, VA.
1985

RECENT PUBLICATIONS

Carr-Chellman, A.A., Choi, I., & Hernández-Serrano, J. (2000 March). Simulating the Impact of Web-Based Learning on the University. Paper presented at the Eastern Regional Adult Education Research Conference, University Park, Pennsylvania.

Jonassen, D.H., Hernández-Serrano, J., & Choi, I. (2000). Integrating Constructivism and Learning Technologies. In M. Spector (Ed.), *Integrated and holistic perspective on technology*. Berlin: Kluwer, 2000.