MODELING AND SIMULATIONS FOR LEARNING AND INSTRUCTION

Storytelling as an Instructional Method

Research Perspectives

Dee H. Andrews, Thomas D. Hull
and Karen DeMeester (Eds.)

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Storytelling as an Instructional Method: Research Perspectives

MODELING AND SIMULATIONS FOR LEARNING AND INSTRUCTION
Volume 5

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Scope
Models and simulations have become part and parcel of advanced learning environments, performance technologies and knowledge management systems. This book series will address the nature and types of models and simulations from multiple perspectives and in a variety of contexts in order to provide a foundation for their effective integration into teaching and learning. While much has been written about models and simulations, little has been written about the underlying instructional design principles and the varieties of ways for effective use of models and simulations in learning and instruction. This book series will provide a practical guide for designing and using models and simulations to support learning and to enhance performance and it will provide a comprehensive framework for conducting research on educational uses of models and simulations. A unifying thread of this series is a view of models and simulations as learning and instructional objects. Conceptual and mathematical models and their uses will be described. Examples of different types of simulations, including discrete event and continuous process simulations, will be elaborated in various contexts. A rationale and methodology for the design of interactive models and simulations will be presented, along with a variety of uses ranging from assessment tools to simulation games. The key role of models and simulations in knowledge construction and representation will be described, and a rationale and strategy for their integration into knowledge management and performance support systems will provided.

Audience
The primary audience for this book series will be educators, developers and researchers involved in the design, implementation, use and evaluation of models and simulations to support learning and instruction. Instructors and students in educational technology, instructional research and technology-based learning will benefit from this series.

Storytelling as an Instructional Method

Research Perspectives

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DEDICATION

To all the combat veterans who have shared their stories with us, and trusted us to use them in teaching others.

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PREFACE

This is the outgrowth of a workshop held at the U.S. Air Force Research Laboratory in Mesa, Arizona, sponsored by the Air Force Office of Scientific Research. The goal of the workshop was to engage researchers from university, government, and corporate research organizations in a discussion about the theoretical and empirical foundations of storytelling as an instructional method. In addition, the workshop attendees attempted to define empirical gaps around which could be organized a candidate research agenda. Other questions discussed were; "Is there a theory of storytelling as instruction?" and "If not, should there be, and can there be?"

Break-out sessions were designed to develop and discuss key research questions. For the purposes of the workshop, storytelling was broadly defined to include methods that extend far beyond just relating experiences around a campfire. Four main types of storytelling techniques were identified; scenario-based, problem-based, narrative-based and case-based methods of instruction. Over two days a variety of presentations were given by participants with diverse backgrounds in military training, education, law, aviation, and business who then gathered into break-out groups to discuss questions relating to each of the four methods of instruction. The groups also examined and/or developed instructionally relevant definitions for the different types of storytelling approaches. The last day was devoted to research gaps and possible next steps.

Section 1 provides a theoretical overview of the power of stories in teaching and identifies some of the themes scattered throughout the other chapters. Chapter 1 describes the four story types identified in the workshop. It also discusses the need for a theory of instructional storytelling, and outlines the ideas of mythologist Joseph Campbell as an example of one possible source of such a theory. In chapter 2, the four sub-groups of storytelling are presented in light of a consideration of Contextually Rich Learning (CRL) versus Contextually Impoverished Learning (CIL) and their relationships to research on cognition. Chapter 3 introduces the link between analogical reasoning and storytelling, and explains how System Dynamics Modeling can be of help in our study of the instructional characteristics of storytelling.

Section 2 is the first of three sections that focus on one of the sub-groups. Chapter 4 presents a thorough overview of scenarios in training and the benefits of using scenarios in telling stories through active learning and the dispersion of operational experiences, as well as their use in structuring and organizing knowledge for the trainee. Chapter 5 discusses the advantages of scenarios for developing expertise, as first principles of instruction, and through the incorporation of instructional games.

Section 3 demonstrates the applicability of narrative as an instructional method in a wide variety of fields. Chapter 6 considers the popularity of video games and their use of narrative forms in light of the current disagreement about the implications of blending interactivity into definitions of narrative and Narrative Learning

Environments. Chapter 7 is an interesting look at the use of narrative in preparing soldiers for, and helping them overcome, combat stress injuries. Chapter 8 presents the use of ‘Dynamic Stories’ in scaffolding the training of management in information security.

Section 4 focuses on storytelling and its relationship to problem-based learning (PBL). Chapter 9 discusses similarities between the characteristics of PBL and storytelling as demonstrated in their use by clinical practitioners and physicians. Chapter 10 builds on the previous chapter’s presentation of PBL and storytelling but from the unique perspective garnered from incorporating fundamentals of narrative theory, macrocognition, and naturalistic decision making in team training and performance.

Lastly, Section 5 concludes the discussion with a final chapter that returns to the search for tools capable of articulating a theoretical approach to storytelling and aims to tie together themes of the book.

We hope that the reader will leave this volume with a better grasp of the breadth of research perspectives and instructional applications for storytelling. The work presented here draws on diverse bodies of literature and is a helpful resource for those thinking of pursuing research of their own related to storytelling. As you read through this book, we hope that it will provide you with new and valuable insights into your own training and research activities, as it has for us.

D.H.A.
T.D.H.
K.D.

SECTION 1:
ABOUT STORYTELLING AND INSTRUCTION

DEE H. ANDREWS[1]

1. STORY TYPES AND THE HERO STORY

For thousands of years societies have taught key principles through storytelling (Brady, 1997; MacDonald, 1998). In some cultures without a written language storytelling was the only way to convey a society's culture, values, and history. Instructional tools have been used by great teachers and leaders in the forms of parables, legends, myths, fables, and real-life examples to convey important instruction (Benedict, 1934; Brown & Duguid, 1998; Davenport & Prusak, 1998; Leonard-Barton, 1995). Fictional and non-fictional examples have always been powerful teaching tools. Storytelling as instruction is still heavily used today. The military, aviation, medical, law, and business communities are just a few groups which rely heavily on storytelling as methods for teaching key principles of their discipline and to help build analytical prowess in students and trainees.

While many definitions of "story" can be found in the literature, this author is partial to two of them. Labov (1972) defines a story or a narrative "as one method of recapitulating past experiences by matching a verbal sequence of clauses to the sequence of events" (p. 359–60) and at a minimum a "sequence of two clauses which are temporally ordered" (p. 360). Denning (2009) states that, "A narrative or story in its broadest sense is anything told or recounted; more narrowly, and more usually, something told or recounted in the form of a causally-linked set of events; account; tale,:[sic] the telling of a happening or connected series of happenings, whether true or fictitious."

There are many publications that give guidance about how best to formulate and use stories for use in instruction. Many of these offer prescriptive guidelines to those who teach using storytelling. Examples include: Gershon and Page (2001), Harries, C. (2003), Hill, Gordon, and Kim (2004), Merrill, (2002), Preczewski, Hughes-Caplow, and Donaldson, (1996). However, there is not a large theoretical foundation or empirical evidence about the storytelling technique. As have teachers and instructors for thousands of years, we know that storytelling is a very effective instructional method. However, the key questions are, "Why do stories work so well in instruction? What are the features and characteristics of stories that make them work? How can stories be improved for instruction?"

This book stems from a workshop organized by the U.S. Air Force Research Laboratory[2]. The military is interested in better instructional storytelling because military instructors have historically relied heavily on that technique. Whether the instruction is done from the platform, through texts, via computer-based instruction, in simulators, or in the field, stories are told. In fact, storytelling does not stop in the classroom or in a formal training setting. Much of the culture and tradition of the military is passed along in stories as military personnel stand watch,

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socialize after hours, and interact while traveling to and from missions and exercises. In most cases these instructional stories stem from actual experience in combat operations or in training exercises.

They may be "there I was, in danger" stories where individual instructors tell stories from their personal experience, or they may be scenarios for simulators or field exercises that come from third person accounts of battle, but stories have proven for thousands of years to have a positive instructional effect. Hence the military interest in better instructional storytelling. One of the workshop's major goals was to explore different ways to produce more instructionally effective stories.

Over the course of two days at the workshop, a variety of presentations were given exploring four techniques using stories in instruction; case-based, problem-based, scenario-based, and narrative-based methods of instruction. The group examined and/or developed instructionally relevant definitions for the different types of storytelling approaches. Another goal of the workshop was for attendees to develop and discuss key research questions related to the theme of the workshop.

The first section of the chapter describes the four types of stories considered by workshop participants. What are their definitions and how are they used in instruction? The chapter then examines some of the research questions that emerged from the workshop. A major goal was to develop a set of questions that might lead to the development of a more empirical foundation for instructional storytelling than currently exists. Theories help explain and predict phenomena. As the workshop did not identify a strong theoretical base for instructional storytelling, the chapter is concluded by briefly examining the ideas of scholar, Joseph Campbell, who spent his professional career theorizing about the place of stories (myths) in cultures. He believed that mythical stories are much more than just entertainment, but are actually a deeply engrained part of our psyches that are often used as learning tools. It is but one example of what might provide a theory foundation for storytelling as a method of instruction.

FOUR STORY TYPES

While all four main storytelling instructional methods (case-based instruction, problem-based instruction, scenario-based instruction, and narrative-based instruction) share a common element – stories – the four do have differences in definition, purpose, use of the story, and outcomes. Each method presents learners with a temporally ordered sequence of information and employs an attention-focusing mechanism. Uniting these methods through a common characteristic enables researchers to draw on one another's work for insights into the learning process. Andrews, Hull, and Donahue (2009) describe these story types in greater detail and provide concrete examples. This book is organized around these four story types.

Case-Based Instruction

Cases are stories that have occurred in the past. They are widely used in contexts such as medical, law, and business schools. Case-based instruction fixes the problem and solution, but the learner is placed outside the story context (Barnes,

Christensen, & Hansen, 1994). The learner must discover the key facts and events as they occurred; hence case studies have a historical nature. Because they are historical, cases do not allow a learner to alter their outcome or processes. Rather, the student must apply critical thinking and theories to the existing facts to be able to form hypotheses about why the facts of the case occurred as they did. A major advantage of cases when compared to the other three types of stories is that they are imbued with authority which comes from the actual facts of the stories (Abbot, 1992).

Narrative-Based Instruction

Narrative-based instruction fixes the problem, the solution, and the learner all within the context that the story frames (Cobley, 2001). The storyteller or narrator controls all of the information received by the learner. Narratives can be either fictional or non-fictional. They seek to emotionally immerse the learner in the narrative's situation; probably more deeply than any of the other three story types. For this reason, narratives often are told for entertainment's sake, often without pursuing an instructional objective. A narrative seeks to express a series of events; however it does not necessarily have to tell the events in a chronological sequence.

Scenario-Based Instruction

Scenarios state fixed solution criteria, but not necessarily fixed solutions. The learner is positioned in a place that allows them to interact with the scenario and produce different outcomes depending on their decisions and actions. They can be fictional or non-fictional. However, for purposes of instruction they often come from history (Salas, Wilson, Priest, & Guthrie, 2006). Scenarios are heavily used in operational training such as the nuclear power industry and the military because they require active interaction by the learner and can be given operational characteristics. While many scenarios are drawn from actual cases, they can be altered (sometimes significantly) to suit the purpose of instruction and evaluation measurement. This ability to accurately measure learner responses in a scenario-driven simulation, simulator, or instructional game makes scenarios effective places to try out new theories, approaches, and procedures for solving operational problems. Learners can gain valuable lessons from the experience. The main goal of scenario-driven instruction is to improve performance.

Problem-Based Instruction

The final story type is especially suited for teaching learners about how to best solve ill structured problems that do not have optimal solution criteria or parameters (Hmelo-Silver, 2004; Savery, 2006). Problem-based instruction requires, or at least allows, the learner to take charge of their own learning process and activities. This uses the problem (fictional or non-fictional) as a mechanism for conveying knowledge to the learner. The learning is usually done in a team setting, where each team member must provide collaborative help in

finding a solution (Boud & Feletti, 1997). A key is that while a teacher might help the learning, each learner and the learning team must take responsibility for defining a path to solving the problem and then applying facts and skills to reach a solution (Savery, 1998).

KEY INSTRUCTIONAL STORY RESEARCH QUESTIONS

Regardless of the type of story, there are many research questions about instructional storytelling whose answers might help in developing more instructionally effective stories. Following are a few examples of research questions that resulted from the Air Force Research Laboratory workshop:

- How much impact does the individual storyteller have on the instructional effectiveness of the story, and more importantly, what about the storyteller makes him or her effective? Can instructors be taught how to be better storytellers, or are some people just born storytellers and others are not?
- How long are lessons learned from stories retained by the learner versus learning via other methods? All of us can likely remember instructional stories from our early childhood, but are there characteristics of some stories that lead to longer retention than stories lacking those characteristics?
- Do different types of stories have different effects on different learning styles? Stated differently, do certain learning styles respond more effectively to different story types?
- Are there material differences in the genesis, form, and effectiveness of case-based vs. scenario-based vs. problem-based vs. narrative-based instruction? That is, are these just different names for the same method or are they really different in some important ways? If so, does it matter to the learner? Continuing along that same line of questioning, do different storytelling techniques have differential effects on different learners?
- Why do stories work from a cognitive standpoint? It seems they certainly have associative properties that can make the learning relevant to the user, but can that association be empirically analyzed and modeled so that more effective stories can be developed?
- Is it better to (a) first present examples via storytelling and then extract a general principle from examples, or (b) first learn a general principle and then listen to examples via storytelling? What does theory and evidence tells us about this question that could be applied to improving storytelling as instruction?

CAMPBELL AND THE HERO STORY

The Air Force Research Laboratory workshop examined the questions, “Is there a theory of storytelling as instruction? If not, should there be, and can there be?” Those questions were addressed but not really answered in the workshop, largely because of the brief time the participants had to discuss the issue. One direction to turn for a possible theory might be to the ideas of a thinker who believed that stories have a special place and purpose in every culture around the world, including for pedagogical purposes. The mythologist Joseph Campbell spent his

career exploring myths from many cultures (Campbell, 2008; Campbell & Moyers, 1991). He concluded that virtually all myths have similar structures that revolve around a hero. A writer, Christopher Vogler, (2009) provides a brief overview of Campbell's findings about the hero myth.

> *The hero is introduced in his ordinary world, where he receives the call to adventure. He is reluctant at first but is encouraged by the wise old man or woman to cross the first threshold, where he encounters tests and helpers. He reaches the innermost cave, where he endures the supreme ordeal. He seizes the sword or the treasure and is pursued on the road back to his world. He is resurrected and transformed by his experiences. He returns to his ordinary world with a treasure, boon, or elixir to benefit his world.*

Campbell posits the existence of a *Monomyth* (Joyce, 1995), which is a clearly defined pattern that seems to fit every well known myth from every culture. He believed that humans resonate with the themes and the imagery of myths because the stories are a metaphor for life. That is why they have such a powerful educational value. Campbell believed that myths are psychologically "true". Even when the myths portray fantastic events and creatures, we still respond to them because they map to our psyches.

Campbell drew inspiration from the ideas of noted psychiatrist and critical thinker, Carl Jung. Jung developed the concept of the "Archetypes" (Jung, 1981). He believed that there are characters which repeatedly populate the dreams and myths of all mankind across cultures. He postulated that the mind is reflected in these Archetypes. He believed that myths and stories map to the archetypes of our minds and that is why they have such power in every culture. They tap into a collective unconsciousness and map on to our psyches.

Campbell's generalized hero myth concept is not without its critics. Some scholars who study myths believe his twelve stages are too formulaic, and their use squeezes from myths the true nature of what makes cultures different.

Campbell (1990) believed that mythology had four major functions; mystical, cosmological, sociological, and pedagogical and that myths and stories have significant contributions to learning in all cultures. It is because of his interest in the pedagogical nature of myths that we find interest in the possible use of his ideas for laying a theoretical foundation for research of instructional storytelling.

Campbell believed that the hero myth helps us cope with, if not answer, the key universal questions humans have about the universe and their existence. Questions such as, "Where have we come from?", "Why are we here?", and "Where are we going?" The myths can be real or fictional and still have the same powerful teaching influence. He believed that these stories are ways for entire cultures to express their identity and answer questions about their beliefs. As long as the pattern of the hero myth is adhered to these myths and stories can teach for many generations.

Campbell identified twelve stages of the hero myth:

1. Hero introduced to his ordinary world
2. Call to adventure
3. Reluctant hero

4. Hero encouraged by wise old man
5. Hero passes first threshold
6. Hero encounters tests and helpers
7. Hero reaches perilous place
8. Hero undergoes serious test
9. Hero takes control of the prize
10. Hero makes final escape
11. Hero is transformed by the quest
12. Hero uses prize to benefit mankind

Many military training instructional stories follow Campbell's twelve step model. The instructor recounts a tale, either first or third hand, about a military member or team (hero) that has a mission to complete (quest or prize). Along the way, many obstacles are encountered. These obstacles may be the enemy, the weather or failing equipment. The hero overcomes the obstacles, accomplishes the mission, and benefits the larger military mission, which will benefit a particular group (the hero's military forces in the field or nation, and eventually the entire world).

Perhaps the educational influence of myths and stories will have a stronger emotional influence if they use the steps as a pattern. Campbell's ideas could provide theoretical underpinning for developing better instructional stories. If his theoretical twelve-step model is correct, then perhaps we should start with that model to construct many of our instructional stories. Research in this area could offer evidence about the efficacy of Campbell's model as it applies to instructional stories. While his ideas are but one explanation for the power of instructional stories, his views have received considerable attention from both the scholarly world and the popular press. Campbell's concepts can help researchers as they explore the storytelling questions described in the previous section.

We ask the reader to consider other possible foundational theories for instructional storytelling as they read this book. It is vital that instructional storytelling be founded on well developed theories so that it can take its rightful place alongside other proven instructional methods that have strong theoretical bases.

CONCLUSION

Stories used for instruction have a history as long as the spoken word. They will continue regardless of whether theory bases for instructional storytelling are constructed or not. In like manner, the use of instructional stories will remain a part of instruction regardless of whether empirical research is focused on the domain. What theory building and empirical research should contribute is a better understanding of how to best construct and use such stories.

The four story types are not mutually exclusive. Their construction and use overlap. However, their differences are important enough to treat separately. Empirical research might help build a prescriptive guide for when and how each type can be optimally used in education. Perhaps Campbell's ideas are correct and all humans have an innate understanding of the power of stories. Research might also help us understand when and how to use the different story types in

combination. If so, research can help the instructional process by proposing underlying story theories that help explain and predict their optimal use for instruction.

NOTES

[1] The opinions expressed in this chapter are those of the author and do not necessarily represent the official views or policies of the U.S Department of Defense.

[2] *Storytelling as an Instructional Method Workshop: In search of Theoretical and Empirical Foundations*, November 7 - 8, 2006, Mesa, AZ. United States Air Force Research Laboratory, 711th Human Performance Wing, Human Effectiveness Directorate, Warfighter Readiness Research Division.

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RUSSELL J. BRANAGHAN

2. WHAT IS SO SPECIAL ABOUT STORIES? THE COGNITIVE BASIS OF CONTEXTUALLY RICH LEARNING

INTRODUCTION

Ask any high school kid, any college student, any parent, any employee forced to spend an interminable afternoon in corporate training, and they will tell you that the prevailing methods of education are broken. The complaints are as numerous as they are predictable; too boring, irrelevant, old wine in new bottles. More troubling, these criticisms are hurled at the same time knowledge and technologies are growing at an increasingly rapid pace. It is more important than ever for students and workers to learn new content and skills effectively, and on a lifelong basis. In fact the skills of many students are well below those needed for today's technical workplace (Berryman, 1993).

Lectures and rote memorization, motivated by instructor convenience rather than pedagogical effectiveness, are particularly ill suited for training lifelong learners in a knowledge-based economy. Besides the boredom, these techniques yield little advantage in terms of generalization, duration and speed of acquisition. The hallmarks of effective learning are that knowledge acquisition happens quickly, knowledge can be applied readily, knowledge is retained and the experience motivates further learning. Yet the prevailing methods of learning do little to promote any of these goals. Many students do not even understand the purpose of the lesson they are engaged in at the time. Recognizing this situation, and desiring methods that meet these criteria, has prompted many researchers to pursue methods that capitalize on the social and contextual aspects of learning, as well as the conditions in which these methods are appropriate (Lave & Wegner, 1991; Rogoff, 1990). The premises of this approach are that learning is most effective when it takes place in a social environment that provides authentic contextual cues about how the knowledge is to be applied. Then that learning is discussed, compared, and contrasted with other learning to facilitate generalization and the knowledge of the conditions in which generalization is appropriate.

As an example, conventional wisdom holds that the best training is on-the-job training. It is authentic and relevant because it relates directly to what the learner will do for a living, provides a context that the learner will encounter frequently, and uses terms, concepts and problem solving strategies that the learner will employ over and over. How many of us would feel comfortable going to a physician who had not completed internships and residencies in their field of

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specialty? How many of us would even take our automobile to someone who has not had a reasonable amount of on-the-job training? These real-world benefits have served as the basis for the apprenticeship model, practiced for centuries (Rogoff, 1990). It is one of the reasons we encourage student internships, and the main reason that students with internship experience are at a substantial career advantage over those without. Clearly, learning in a rich context provides real value.

The importance of learning in a more authentic and rich context, emphasizing collaboration and discovery, has led to a number of innovations in teaching including situated (Lave & Wegner, 1991), case-based (Barrows, 1985), problem-based (Hmelo, 1995), narrative-based (Skehan, 2003) and story-based instruction (Williams, 1992). Although these approaches vary in their execution, their underlying philosophy is the same: people learn best by actively participating, questioning and collaborating in an authentic and contextually rich setting. In such situations, learning is often unintentional, rather than deliberate. Even people who do not consider themselves particularly good students learn well in these conditions. Potentially, these approaches can enable students to learn content knowledge and problem-solving skills at the same time (Williams, 1992).

The workshop, on which this volume is based, referred to these techniques as storytelling, but I am not sure that this name captures the essence of these methods and what separates them from other methods. The differences between these methods and what most of us experienced in school involve authenticity, activity, problem solving, collaboration, discussion, comparison and contrast. That is, the benefits these methods provide really derive from context. As a result, I will refer to these techniques broadly as contextually rich learning (CRL) and contrast them with contextually impoverished learning (CIL), including the common methods of lecture and rote memorization. This paper describes and summarizes three methods of CRL; narrative, case-based and problem-based instruction. Then, drawing on the scientific literature in cognitive psychology, it discusses how and why CRL methods are likely to be superior. The paper emphasizes how CRL may help learners encode new knowledge in memory better as well as how that knowledge can be retrieved better under these conditions. Of necessity, the treatment of each topic will be brief, however, examining these contributors collectively may illuminate similarities and complementarities among them that yield substantial instructional advantages for CRL.

Narrative

Simply, a narrative is a story, a recounting of a sequence of events. Narratives typically have: 1) a storyteller or narrator; 2) a geographic, temporal, and social context in which the story is set; 3) a set of occurrences that unfold in a specific sequence; 4) an audience with certain qualities for which the narrative must be customized; and 5) a message, intent or moral of the story, that the narrative is trying to convey.

The components provided by narratives offer many advantages for teaching. Engaging narratives hold attention. Story lines can be compelling and the events can be humorous or surprising. Further, the typical structure of the narrative

itself including a problem, build-up of tension and eventual resolution can be anticipated, enabling the student to know when to focus attention and what to focus on. Finally, stories are fun for the teller as well as the listener, and many listeners have an interest in retelling the story eventually. As a result, listeners often pay close attention, anticipating a time when they may assume the role of storyteller.

Cases

For decades, case based instruction has been indispensable in the training of lawyers and business students. Cases are examples of authentic situations in real world contexts that illustrate important lessons. Typically, instructors take great care to ensure that each case is timely, relevant, and teaches about the processes involved in solving the problem and not just the factual details of the situation. In that way, students learn problem-solving techniques as well as factual knowledge. Students are prompted to consider what they would have done differently in the situation, and how their approach might have provided different results.

The power of cases derives from authenticity. Not only are the cases real, often they are quite famous and include quotes and opinions from the people who were involved. Students from different business classes across the country from one another debate the details of these cases over beer in taverns, on business trips and at conferences. They really have an impact on application-oriented business people and lawyers, who seem to appreciate the fact that these stories are not contrived. Discussions of each case are aimed at creating emotional engagement, improving generalization through comparison, contrast, and practice in problem-solving. In this way, students are taught how to learn from the past.

Scenario-based learning is slightly different, and more interactive than case-based learning. It describes a task from the perspective of the worker. It includes a series of problems and choices. Outcomes arise from the choices and depend on the selections that the learner makes. This provides opportunity to make mistakes and entertain multiple situations. The scenarios are designed to be realistic and focus the learner's attention on making choices and understanding the consequences of various alternatives.

Problem Based Instruction

Problem based instruction is ubiquitous in medical training, and is similar in many ways to case based instruction. For example, it provides an engaging and authentic context, and it involves substantial discussion with an instructor acting as a facilitator rather than a lecturer. There are however important differences between cases and problems. For one, problem-based instruction need not be based on true stories; problems can be completely contrived. For example, the National Aeronautic and Space Administration (NASA) frequently trains astronauts on problems that could happen, but in fact never have happened and are unlikely to happen in the future. Why would they do this? It turns out that even unlikely problems provide

many benefits in training astronauts in contingency planning, reasoning about novel situations, understanding interactions among systems, looking for common underlying causes, and prioritization. This makes their training more robust, less rigid, and less likely to break down in the face of a previously unforeseen situation.

Another difference is that case-based instruction includes a known outcome, whereas this is not necessarily true of problem-based instruction. It is quite possible that there is no known solution to the problem presented. Instead benefits may be derived from generating potential solutions and thinking in novel ways, as well as in quickly thinking of satisficing (Simon, 1957) approaches that improve the situation rather than generating some optimal solution.

The main difference between problems and cases, though, are that cases do not involve active attempts at solution, whereas this is the most important feature of problem-based instruction. Activity is crucial to problem-based instruction. The student must make an active attempt, often in collaboration with others, to solve the problem at hand. The problems themselves are selected so learners gain appropriate knowledge, strategies, and team participation skills, simulating the real world challenges that one encounters in his or her career. The role of the instructor is not to lecture or to serve as an expert, but to facilitate problem solving and to guide introspection. In this sense, the instructor is a tutor, discussant and evaluator rather than a final authority.

Relationships Among the Types of Learning

If it is true that CRL improves learning, a topic that is addressed throughout this volume, it is useful to understand why. By what cognitive mechanisms does CRL work to improve the acquisition of skill, the encoding of information and the eventual retrieval of this information? There are similarities and complementarities among the three forms of CRL discussed, and Table 1 maps the mechanisms by which the three CRL forms facilitate learning. The forms of CRL, narrative, cases and problems, are listed on the columns of the table. Cognitive strategies that are well documented in the literature to improve learning are listed in the rows. These strategies, guiding attention, encouraging elaborative encoding, facilitating knowledge organization, encouraging self reference, and inspiring emotion are discussed in detail later in this section. The contents of the cells themselves list the mechanisms by which each CRL form achieves each of these strategies. These mechanisms include:

– Authentic context (Au) – CRL provides rich and authentic context, including background about why the student is learning what they are learning. The context provides many ways to think about the lesson and how the lesson is connected to the real world (Merrill, 2002).
– Engagement (En) – CRL engages the student by involving them personally, intellectually and emotionally. As a result, the student is motivated to pay attention and stay interested (Merrill, 2002).
– Action (Ac) – CRL provides opportunities to occupy the student with action as part of their instruction. It is hands-on (Mayer, 1992; Schank, Berman, & Macperson, 1999).

– Collaboration (Co) – Some CRL methods require students to work on teams to solve problems. This simulates real-life conditions, improves communication skills, teamwork skills, and exposes the learner to multiple problem-solving approaches (Nelson, 1999).
– Discussion (Di) – CRL methods involve substantially more discussion among students and with the instructor than traditional methods (Palinscar & Brown, 1984).

The remainder of this article develops the details of this mapping. Understanding the nature of the mapping should help us determine which types of instruction provide benefits for various types of learning and learners. Perhaps it will even encourage us to think of new CRL forms that exploit these benefits further.

Table 1. Method-benefit framework for mapping CRL instructional mechanisms onto cognitive learning strategies

	Contextually Rich Learning (CRL) Form		
Cognitive Strategy	***Narrative***	***Case***	***Problem***
Attention	Au, En, Di	Au, En, Di	Au, En, Ac, Co, Di
Elaborative Encoding	Au, En, Di,	Au, En, Di	Au, En, Ac, Co, Di
Knowledge Organization	Au, Di	Au, Di	Au, Ac, Co, Di
Self Reference	Au, En, Di	Au, En, Di	Au, En, Ac, Co, Di
Emotion	Au, En, Di	Au, En, Di	Au, En, Ac, Co, Di

CRL instructional mechanisms: Au=Athenticity, En=Engagment, Di=Discussion, Ac=Action, Co=Collaboration, Di=Discussion

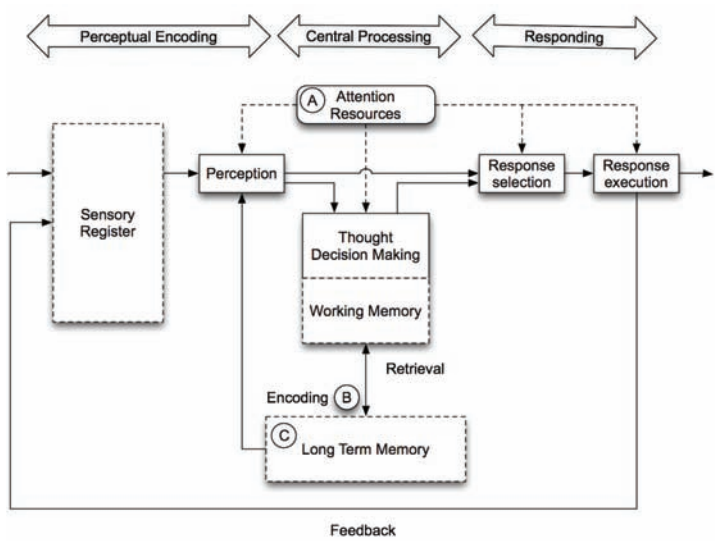

Figure 1. A model of human information processing. Adapted from Wickens et al., (2004).

Figure 1 illustrates a model of information processing adapted from Wickens and his colleagues (Wickens, Lee, Liu, & Becker, 2004). In the diagram, memory stores are shown in dotted boxes. Other boxes indicate cognitive processes, and arrows refer to the flow of information. As various topics are discussed, I will frequently refer to components of this information-processing model.

Guiding Attention

Our ability to remember depends largely on how we encode new information to begin with (Matthews, 1977). Fortunately, there is a sizable literature focused on what factors improve our encoding of new information, and many of the topics are directly relevant to CRL. Below, I review the processes that are known to influence the process of encoding. After describing each topic, I discuss ways in which CRL may provide advantages by exploiting these processes. We begin with attention.

Figure 1 part A illustrates the centrality of attention. It is involved in perceiving and thinking about stimuli, as well as selecting and executing actions. The challenge is that human attention is known for two characteristics: it is limited and it is selective (Shiffrin & Dumais, 1981). Because attention is limited, people have difficulty focusing on two or more things at once. Instead, we tend to select one thing to focus on at a time. The challenge is that you cannot encode what you do not attend to; at least you cannot encode it very well. Attended information is most likely to get encoded in memory, and be available for later retrieval. So, it is important not only to be able to keep our students' attention focused on the lesson, but to be able to guide that attention to the points of the instruction that we think are most crucial for skill, knowledge acquisition and performance.

Fortunately, CRL provides several mechanisms to do just this. For example, in narrative, a storyteller varies his or her pacing to emphasize certain points and to keep the student engaged. Often, the storyteller will pause just long enough to snap people back to attention before hitting a point that is crucial to the story. This sense of timing is one of the hallmarks of a great storyteller. These pauses can provide a sense of anticipation that makes the learner more vigilant for a brief period of time, long enough to grasp the point of the lesson.

Further, variation in tone of voice and volume provide important cues about what parts of the lesson are most important. The human perceptual system is exquisitely sensitive to changes in the environment. Not only do we perceive changes, but we even exaggerate these changes. As a result varying tone and volume is an extremely effective way to focus student attention.

The structure of a typical story - plot, conflict, rising action, climax, resolution and falling action all provide cues about what is important and what is not. In short, the structure guides attention. Even the characters offer an opportunity for empathy, a way to relate to them so people stay focused.

Cases are, in fact, narratives of true stories. Consequently, they offer many of the advantages of what we normally think of as a narrative. Yet, their credibility as a true story may make them even more compelling. Moreover, since the stories and often the characters are famous, people may pay close attention.

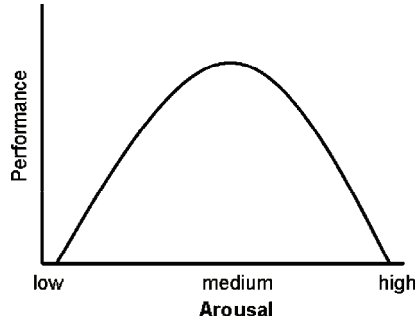

Figure 2. The Yerkes-Dodson law illustrating the relationship between arousal level and cognitive performance.

Problem solving, on the other hand, provides even more mechanisms that encourage focused attention. Figure 2 shows an idealized curve depicting the Yerkes-Dodson law (Yerkes & Dodson, 1908) which indicates that human performance tends to follow a bell shaped curve as a function of arousal. If we are not aroused enough, for example when we are fatigued or sleepy, our performance suffers. When we are aroused too much, for example when we are in a state of fear or alarm, our cognitive performance suffers as well. The middle state is just right. This is when we are aroused enough, but not so aroused that we are jumpy or nervous. Interestingly, activity seems to provide just the right conditions for us to achieve this state.

Activity itself requires attention, since one generally needs to attend to what he or she is doing. As a result, encoding of information is improved when we manipulate that information in some way. This is precisely what is required for problem solving. Further, since problem-solving activities are usually conducted collaboratively, we focus even more on what we are doing and how to convey that to others. After all, it is important to keep your colleague informed and to attend to what he or she is doing when you are working together. Finally, the simple process of discussing topics with other students as well as the instructor improves the attention that people pay to the lesson. All of these mechanisms serve to guide and focus attention in ways that CIL simply cannot.

Elaborative Encoding

Encoding (Figure 1 part B) entails the transfer of information from working memory to long-term memory. Every student knows that recognition tests like multiple-choice exams are easier than recall tests. Further, simple rote memorization can improve performance on recognition tests, but is not so good at improving performance on recall tests. It seems that rote memorization and rehearsal improves recognition by ensuring that the information to be learned is thoroughly processed to begin with. That is, if material was not completely encoded on the first encounter, it may be encoded more completely on the second or third encounter.

It turns out that there are really two types of rehearsal: maintenance rehearsal and elaborative rehearsal. Maintenance rehearsal is most similar to rote memorization, just repeating the material over and over. Elaborative rehearsal, on the other hand, requires the learner to elaborate on the meaning of the material, to associate it with other information and to think about its semantic content. This is a deeper level of processing that improves both recognition and recall performance.

A common finding in experimental psychology is that memory durability is largely independent of processing time. That is, increasing the duration of study does not necessarily improve memory for the material. Instead, the key to successful memorization, including successful recall, depends more on how the material was rehearsed rather than how long it was rehearsed. This provides the basis for the levels of processing theory (Craik & Lockhart, 1972).

Levels of processing theory posits that how well information is recalled from memory depends on how the information was processed to begin with. A superficial treatment of the material to be learned, such as repeating it over and over, does little to aid later recall, whereas a deep analysis, focused on the meaning of the material and how it relates to other material, yields robust and retrievable memories. This is one of the reasons that students find it beneficial to reorganize and rewrite lecture notes. Rewriting forces them to integrate the material with other knowledge, compare and contrast various pieces of information, creating deeper semantic processing and better memorization.

Interestingly this benefit is shown whether the learner is trying to memorize the material or not. That is, elaborative rehearsal improves retrieval performance equally under incidental learning and intentional learning conditions. As a result, students do not even need to try to learn the material if they are encoding it in semantically meaningful terms.

Craik and Lockhart (1972) proposed a continuum of deeper and deeper processing. Each level of processing refers to more semantic association with previous knowledge, and as the analysis and processing goes deeper it requires more background information to carry out. Consider the following example. Jacoby, Craik, and Begg (1979) showed people pairs of common nouns (e.g. horse-goat). These participants were then asked to evaluate these pairs according to the differences in their size on a scale of 1 to 10. Following that task, the participants were given an unexpected recall test. The results of the recall test showed a negative correlation between the size differences of the noun pairs and the likelihood of successful recall. That is, participants were more likely to recall a pair of items when the size difference was small. This was probably because the participants needed to process the stimuli more and think about them at a deeper level to consider the sizes of the similar sized nouns than the differently sized nouns.

Sitting passively, listening to a lecture, or repeating the same fact over and over, is ineffective. These activities provide little opportunity for elaboration, and they do not match the conditions under which you will someday need to apply the information. Contrast this with narratives, which provide an authentic context, engagement in the story, and ample opportunity for discussion of the topic. The engagement that narratives provide invite comparisons of the story with the

experiences that students encounter in their own lives. This also happens when students identify with a character in the story or notice similarities between the character and people they know. This is true of plots and situations as well as characters. People spontaneously notice parallels between what happens in a story and what happens in their lives. This identification is one of the things that make the stories so engaging. Each comparison, each association, each time someone relates to a component of the story, is an incidence of elaboration. The story's context provides the opportunity to make deeper and deeper associations.

Even anticipation of what is coming next in the story activates associations that would otherwise remain dormant in a standard lecture. Finally, the discussions provided by these methods often provoke conflict, providing even more opportunity for elaboration. Argument requires reasoned thought, examples, anticipation of counterargument, and so on. It is a cognitively rich endeavor requiring participants to call upon large stores of information and firm up connections that were previously tenuous. All of theses activities facilitate elaboration.

Problem-based instruction adds even more opportunities for elaboration. In addition to being engaged in an authentic context and discussing it afterward, problem solving students need to actually collaborate to get something done. The application of knowledge requires learners to make associations among many pieces of information. Learners diagnose problems by reasoning about cause and effect relationships. As a result, they need to know that certain problems entail certain pre-conditions. They need to learn how to recognize similarities and differences among the problems they encounter, as well as similarities and differences among the potential approaches to solving those problems. They need to learn what problems are most severe so that they can prioritize their activities accordingly. They also need to learn how to determine the root cause of a problem with many symptoms. Often many symptoms result from just one issue. As you can see, this is cognitively complex, requiring the formation of many associations in memory at ever-deeper levels. This is elaborative encoding at its best.

Finally, the collaborative nature of problem-based learning requires students to communicate their thinking and approach to colleagues who are also trying to learn the information. The colleagues often provide new ways of thinking about the problem, providing even more associations.

Knowledge Organization

It is little wonder that simply trying to teach students a pile of facts is ineffective: humans do not store knowledge as piles of facts. Though there are various theories, many modern theories of long term memory (Figure 1 part C) contend that knowledge is structured according to relatedness in highly organized associative networks (Anderson, 1983; Collins & Loftus, 1988). In these networks concepts are represented as nodes and relationships among concepts are represented as links among nodes. The more related two concepts are, the more likely they are to be linked directly.

These knowledge structures, often referred to as mental models (Gentner & Stevens, 1983; Johnson-Laird, 1983), are used to organize knowledge, help people make sense of their world, explain phenomena and make predictions. Although they tend to be incomplete, constantly evolving, and even contain errors and contradictions, they are nevertheless quite useful (Schumaker & Czerwinski, 1992).

From the perspective of mental models, learning involves the acquisition of new nodes or concepts and the formation of new connections among these concepts. However, it is not quite as simple as this. In fact, the learner's mental model itself contributes to the understanding of the new material by providing expectations of what information is coming next, surprise when some information disagrees with their current thinking, and preconceptions based on what they already know. So learning does not proceed merely in a bottom up fashion, with new material added to old, but also proceeds in a top down fashion with old knowledge guiding what we attend to, how we interpret what we encounter and what information we deem important. Mental models then provide a framework for understanding, remembering, and interpreting everything we encounter.

The majority of what we know about mental models is provided by studies of context effects. Consider the following example, which uses ambiguous words as stimuli. Light and Carter-Sobell (1970) showed people sentences in which certain word pairs were emphasized. For example, the sentence might read, "the boy earned a GOOD GRADE on the test". Later, participants were given a memory test asking them to recognize the emphasized noun but not the adjective. These sentences were presented with many distracter sentences, which had not been presented previously. In one condition they were shown the same noun-adjective pair (e.g., GOOD GRADE). In another they were shown a different adjective but the same noun (e.g., BAD GRADE) and in a third they were shown not only a different adjective, but a different semantic context such as STEEP GRADE. The results showed that 64% of the participants recognized the noun (e.g. GRADE) when it was shown in it original context (e.g. GOOD GRADE or BAD GRADE), but only 27% of the time when it was shown in a different context (e.g. STEEP GRADE). This provides strong evidence that context affects how we store and retrieve information.

Context benefits are often provided in narratives in the form of titles, summaries, or illustrations. For example, Bransford and Johnson (1972) showed people ambiguous passages of text. In one condition a cartoon that provided some clarification preceded the text. In another condition the cartoon was shown after the text. On a recall test following the reading, participants who saw the cartoon before reading outperformed participants who saw the cartoon after. In fact, those who saw the cartoon after reading performed no better than participants who were shown no cartoon at all.

Another strong context effect is state dependent learning, as illustrated by Godden and Baddeley (1975). In their experiment they asked scuba divers to learn a list of 40 words either on shore or under water. After the learning trials, the participants were asked to recall the words in one of those two environments. Participants who learned and recalled words under water performed about fifty

percent better than those who learned the words under water but were asked to recall them on land. This demonstrated that recall tends to be best when the context of retrieval matches the context of encoding. There are likely retrieval cues available in matching contexts that are missing in different context. Surprisingly, these context effects extend even to the mood of the participant when learning. That is people can recall information better when they are in the same mood as when they encoded it to begin with, a phenomenon known as mood congruent memory (Bower, 1981).

People learn better when knowledge is organized. Narratives and case studies provide a built-in structure for organizing knowledge. As mentioned previously, stories have predictable plots, characters, components and resolutions. These serve as aids for encoding as well as retrieval. Further, authentic contexts are more likely to match the mental models that students already have from simply interacting with the world. The more knowledge that students have in their structured mental models, the easier it is to interpret new knowledge and to recall that knowledge when it is needed. So an authentic context improves that learning.

Active participation in discussion also serves to make mental models more robust. Students that need to convey their mental models to others using examples, metaphors and analogies are likely to reinforce and elaborate on those mental models in ways that simply do not happen when passively listening to lectures. The active problem solving and collaboration involved in problem-based instruction are probably quite helpful in making use of the mental models that students have, as well as in updating these models to be current with new material. Finally, collaborative problem solving involves not only applying your own knowledge structures, but also interpreting the knowledge structures of others, providing even a wider variety of input to your knowledge. It seems likely that this would produce very robust mental models indeed.

Self Reference

When will I ever need to know this stuff in the real world? How many of us have heard this question before? Perhaps you have even said it yourself. Well, it is a good question. Material that is personally important to us tends to be well remembered because it is encoded more thoroughly and provides more paths to retrieval. Consider this example from Rogers, Kuiper, and Kirker (1977). They showed people descriptive words like happy along with different types of encoding questions according to one of three conditions – superficial processing, deep processing or personal reference processing. The personal reference-processing question asked about the degree to which the target word described the participant. The results showed that participants in the self-reference condition recalled the target words better than participants in either the superficial or deep processing conditions. This finding demonstrates that making material personal in some way provides a particularly deep level of semantic processing. This is probably because we already have such a rich and developed mental model of ourselves. As a result, self-referencing provides great opportunity for elaboration and organization.

Narratives often take advantage of this feature of self reference. For example, some narratives actually place the learner as the central character in the plot of a story. This makes the narrative highly personal. Even when the story is about another person, learners tend to spontaneously search for similarities between themselves and the story's characters. Instructors may facilitate this personal relationship directly by asking the student how this situation relates to his or her own experiences, to describe a time they have been confronted with a similar situation or how they would respond if they had been faced with this situation. All of these characteristics encourage the student to draw parallels between their lives and the situations of the characters in the stories, making the lesson personal and memorable.

Problem-based instruction answers the questions posed by our students more directly. When will you ever need to know this stuff? Right now! You will need to know it to solve *this* problem. In fact, if you do not master this material, you will not be able to successfully complete the task at hand. Suddenly the material becomes very personal, and one does whatever is required to learn it, including discussing and collaborating with other students. In many ways our student's question is one of relevance; is this material really relevant for my life? Problem-based instruction demonstrates immediately the relevance of the material. You will use it to collaborate or argue with your colleagues. You will use it to compare and contrast the current problem with similar or different cases. And, you will use it to solve the problem at hand.

Emotion

Another cognitive strategy that improves encoding and retrieval is emotion. Like many people, you may have vivid memories of the moment when you heard about airplanes crashing into the buildings of the world trade center. These types of memories, in response to an event that is surprising and consequential are called flashbulb memories. They tend to be well remembered for a very long period of time. Flashbulb memories from a wide range of domains possess several commonalities, including information from five categories: 1) location, where you were when you first heard about the event; 2) activity, what you were doing when you first heard about the event; 3) source, who told you about the event; 4) emotion, how you felt about hearing the news; and 5) aftermath, what you did next (Brown & Kulik, 1977).

These emotional memories seem to be given priority status in the brain. They are encoded effortlessly and retrieved just as easily. In fact, in the case of post-traumatic stress disorder, it can be quite difficult to suppress the memory and keep it from intruding into daily activities. From an evolutionary perspective this priority status makes good sense. Organisms that remember salient events, especially things that may affect their fitness or likelihood of reproduction are likely to be selected for. Having a short memory for some material may be acceptable, but having a short memory for events that are crucial to survival would be tragic. Further, the more important and surprising the event, the more rehearsal that memory is likely to receive as we recount the event to others.

The authenticity, engagement and discussion provided by stories and cases are likely to increase our emotional state. Authentic stories are salient to us because they are realistic and likely to relate to our lives. One of the things that make stories engaging is that they can be quite emotional. We become caught up in the events and feelings of the characters, empathizing with them. If the stories are relevant to us, we tend to share them, as well as our feelings and opinions about them, with others. When we do that, the stories are likely to be remembered quite well. Anticipation, surprise, the feelings one experience when relating to a proponent in a story all can provide strong benefits for learning and memory

Clearly, this is the case with problem-based instruction. Problem solving can sometimes be frustrating and other times exciting. Both situations, however, are emotional. The relief and joy you experience when you finally crack a challenging problem makes for a memorable experience indeed. So it should be no surprise that problem solving leads to strong learning and memory.

Summary and Discussion

CRL provides benefits for learning and memory that cannot be found in more common types of education and training. Narratives and cases provide authentic and engaging contexts that guide attention to components of the lesson that are most important to learn. They facilitate elaboration, providing more robust, deeply processed and accessible memories. They aid in knowledge organization by creating new associations, and strengthening associations that exist already. They prompt the learner to self reflect, to think about how the story is relevant to his or her situation, and how the characters are like them or people they know. This self-reference tends to improve memory performance. And, the emotion that narratives and cases promote tend to be especially useful in ensuring that learning takes place to begin with and is remembered for a long period of time.

Problem solving takes these benefits even further. Action and application themselves are engaging and more memorable than non-action. Collaborative planning, discussion, prioritization, argument and negotiation all require deep cognitive processing, are personal in nature and can be quite emotional, as one defends their ideas and stretches their minds to understand the ideas of others.

Further, problem solving usually requires the acquisition of new skill or procedural knowledge rather than just declarative knowledge. If declarative knowledge means “knowing that”, then procedural knowledge means “knowing how’. Procedural knowledge tends to be more resistant to forgetting than declarative knowledge. For example, you never seem to forget the skills of riding a bicycle or swimming. Once you have learned these, you have learned them for good. Not all skills are quite this resistant to learning, but many are, especially ones that provide continuous feedback and immediate performance cues.

For example, McKenna and Glendon (1985) tracked how long people retained various components of the skills required for cardiopulmonary resuscitation. They found that the technique of actually doing chest compressions correctly was most

resistant to forgetting, whereas the information required for diagnosing the patient was least resistant. Even though both types of skill knowledge were remembered quite well, it was the knowledge that had required the most activity that was remembered best. Activity and closed loop feedback seem particularly important for skill learning and retention.

Directions for Future Research

This article has focused on the commonalities among three types of CRL, narratives, cases and problem-based learning. Narratives and cases benefit from authenticity, engagement and discussion to achieve superior learning and memory. Problem-based instruction, on the other hand, adds the dimensions of action, and collaboration to the mix. Problem-based learning is also more likely to teach skills, which have the advantage of being quite resistant to forgetting.

One promising topic for future research is to determine which types of CRL methods are best for which types of learning domains. Perhaps some domains have qualities that lend themselves more to case-based than problem-based learning. Further, the amount of time available for training may affect what types of training are most advisable, Research could be directed at generating and validating guidelines which provide direction on which type of instructional method to use. Also, the choice of method may depend largely on how the knowledge will be applied. Potentially, a taxonomy of CRL methods, mapping conditions to techniques could be provided for trainers and instructors trying to optimize their lessons. This would be a valuable contribution indeed.

Another line of research involves the development of new CRL methods. There is an infinite number of ways to introduce rich context into our lessons. Some promising approaches may involve participatory design, role-playing and so on. Innovation often involves the repurposing and recombination of established ideas and their application in new ways, so these methods might borrow the best components of each method and apply them to a particular area of learning. It would also be useful to explore opportunities in completely different fields.

Plenty of work remains to determine the effectiveness of each of these methods, and how the compare to each other. Kirkpatrick (1998) discusses four levels of criteria related to the effectiveness of training. The first, reaction criteria, relate to students' impressions of the training, specifically how much or how little did they enjoy the training. Students are more likely to continue training with which they are satisfied. The second level, learning criteria, focuses on how well the student learned the material presented. Some methods will help students encode information better than others. The third level, behavioral criteria, measures how well the training transfers to the job environment. Does the training actually make the student a more capable practitioner? And the final level, results criteria, refers to how well the training yields benefits in terms of organizational outcome. All of the training methods we have discussed, whether CRL or CIL, should be studied from these perspectives.

An important program of research will be dedicated to understanding how CRL can be delivered through the wise use of technology. Specifically, technological innovations have made it practical to provide this type of context through models, simulations and games. Though this is a tremendous opportunity, it needs to be done in a way that engages attention, encoding, knowledge organization, emotion and self-reference described in this paper. To be motivating, the context will need to feel natural rather than contrived. And, these qualities will need to be designed into the system employing a user-centered paradigm, rather than a technology-centered approach.

A final line of investigation could focus on evaluating various training methods from a financial perspective (Goldstein & Ford, 2002). Certain methods may be more expensive than others, prompting us to ask which methods will be most cost effective. Finances are always a crucial factor in determining which approaches make sense and which do not.

Challenges and Limitations

This research domain is certain to have its share of challenges. For example, the typical scientific approach is one of reductionism, divide and conquer. We analyze the components of a phenomenon by breaking them down into their parts and study them in isolation from the other parts. This approach may not work for contextually rich learning strategies. These components may not be easily separated and studied under controlled conditions. For example, how would you study the effects of authenticity after you have removed the quality of engagement? Could engagement be effectively separated from authenticity? Similarly, how do you study engagement in the absence of emotion? It becomes very difficult to tease these apart. If components are removed you may remove more than just the benefits of that one component. Perhaps the whole is worth more than the sum of its parts. This will make the typical reductionist approach of divide and conquer difficult to employ and may require a continued focus on more naturalistic research.

Nevertheless, the potential benefits of employing contextually rich learning on a broad scale seem worth the research challenges. These methods have potential for substantially improved education. They are motivating, interesting, authentic, memorable and effective. They provide an opportunity to change our educational landscape to one of motivated students, effective teaching and eventually more competent workers.

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