40
Developing Individual Computing Capabilities

40.1 Introduction

Individual computing capabilities development continues to be a rich area of investment for enhancing the productivity of individuals, with over 38% of all training directed toward IT training (ASTD 2008). With an increasing percentage of both large and small businesses using computer applications in their daily work, this trend is likely to continue. Recent surveys have found that computer literacy requirements have skyrocketed in almost every job category. For example, over 70% of the companies included in the previous referenced survey now require computer competency in their middle and senior management positions. In addition, research has also shown that development of computing capabilities has a significant effect on new technology adoption (Igbaria et al. 1995).

Considerable amount of research has been done investigating methods to develop individual computing capabilities over the years. Early research in this area focused on traditional training methods in a structured classroom environment. However, an increase in the requirements for continuous learning and growth in the geographic dispersion of trainees is creating a “demand-pull” for going beyond the classroom-based training methods. This, combined with the declining cost of hardware and increasing ubiquity of communication networks, is creating an incentive for many organizations to move toward technology-mediated training or e-learning.

Over the years, three critical frameworks have been proposed to explain the development of individual computing capabilities (Alavi and Leidner 2001; Gupta and Bostrom 2009; Olfman and Pitsaton 2000). These frameworks, however, do not provide a consistent picture of the computer training phenomenon. While two of these focus on the psychological process of learning (Alavi and Leidner 2001; Olfman and Pitsaton 2000), they ignore the role of technology-mediated learning as well as the role of individual interaction with the training method. On the other hand, the most recent framework ignores the psychological learning process, focusing instead on the role of learning systems and their interaction with the learners (Gupta and Bostrom 2009).
The goal of this chapter is to define the nature of individual computing capabilities, outline the key underlying principles based on an integrative framework, along with their practical implications, and identify key areas of future research.

40.2 Defining Individual Computing Capabilities

Individual computing capabilities represent an understanding of the principles by which a system can be applied to a business task (Garud 1997). Drawing from research in educational psychology and IS, individual computing capabilities can be classified into four categories: skill-based capabilities, cognitive capabilities, affective capabilities, and metacognitive capabilities (Gupta et al. 2010).

Skill-based capabilities focus on the ability to use the target system. It is based on two specific types of knowledge base: command-based and tool procedural knowledge. Command-based knowledge is the knowledge of the syntax (set of commands and the command structure) and semantics (meaning of the commands) of the target system. Tool procedural refers to grouping these individual commands to perform a function or task. Without this level of knowledge, users are unable to use the system or recover from errors.

Cognitive capabilities focus on the mental awareness and judgment of the user. Business procedural, tool conceptual, and business conceptual knowledge bases focus on cognitive capabilities. Business procedural or task-based knowledge is about applying tool procedures to business processes. Tool conceptual knowledge focuses on the big picture, that is, the overall purpose and structure of the target system. Acting as an advance organizer, this knowledge provides a basis for the ability to transfer learning to new situations. Business conceptual is the knowledge of the specific business processes supported or enabled by the target system. This knowledge is required to understand the interdependencies of actions in complex systems.

Affective capabilities focus on the emotional aspects of the user’s behavior. A review of the literature shows that three affective capabilities have been analyzed in IT training area (Gupta et al. 2010). The first one, motivational knowledge, is the knowledge about what the target system can do for the user’s job, the organization, etc., that is, the usefulness of the software to the organization. The second important affective outcome is satisfaction with the training process. Given the continuous need for training, training programs are designed to not only impart knowledge, but also provide a high level of satisfaction. The last affective learning outcome, perceived anxiety, has received much less attention in IS research. Perceived anxiety deals with a feeling of apprehension, tension, or uneasiness in the capabilities of using the target system.

Metacognitive or self-regulated learning knowledge refers to an individual’s knowledge regarding their own learning and information-processing processes. Among the most commonly investigated metacognitive variables is self-efficacy or users’ belief about their ability to perform a specific behavior (Bandura 1986). Self-efficacy has been shown to affect other training capabilities and to be a strong antecedent to post-training intention to use (Compeau et al. 2005).

40.3 Underlying Principles for Individual Computing Capability Development

As mentioned earlier, two distinct research perspectives have been proposed to explain the development of individual computing capabilities, especially for the contemporary environment. The first one, characterized by Alavi and Leidner (2001), models the impact of training method on training outcomes as mediated by the individual’s psychological processes. It argues for a shift in our attention to understanding the relevant instructional, psychological, and environmental factors that enhance learning. The other model, by Gupta and Bostrom (2009), uses adaptive structuration theory (AST) as a basis. AST argues that the influence of these advanced information technologies is moderated by the actions of the actors (learners in this case) (Barley 1986; DeSanctis and Jackson 1994; DeSanctis
Developing Individual Computing Capabilities (and Poole 1994; Orlikowski 2000). AST makes both technology and human agents part of the system, accounting for the interplay between people and technology, as well as the full predictability of IS use in individuals, groups, and organizations (Fulk 1993). This allows AST to preserve the predictive potential of a deterministic perspective, while accounting for interpretive flexibility of the process perspective (Gouran 1989). Researchers have also argued that AST presents a good metatheory for IS research (Bostrom et al. 2009).

Using this as a basis, the model outlined by Gupta and Bostrom (2009) outlines the impact of training methods on training outcomes as moderated by the faithfulness of appropriation of training methods. These seemingly inconsistent models have one thing in common. Both stress the importance of learning process as well as the importance of individual differences. However, these models focus on different aspects of the learning process.

The model outlined in this chapter (see Figure 40.1) integrates the two models to provide a comprehensive overview of the development of individual computing capabilities through training. The combined model highlights five distinct constructs: training methods and individual differences as inputs into a training situation, appropriation of the training method and the psychological process as a part of the learning process, and the training outcomes as the final construct. The input structures and learning process are discussed in the following sections. We have already discussed individual computing capabilities earlier.

### 40.3.1 Input Structures

Training situations involve two critical inputs. The first one is the training method, as designed by the trainer, and the second is the individual trainees themselves. From an AST perspective, these are considered as input structures into a process.

#### 40.3.1.1 Training Methods

A training method is defined as a combination of structures that guides individuals to achieve the learning outcomes. DeSanctis and Poole (1994) state that input structures can be described in terms of their features and spirit.

The spirit of a training method can be described in terms of the epistemological perspective the training method follows. Epistemology describes overarching beliefs about the nature of knowledge and about what it means to know something (Hannafin et al. 2004). It provides a design template for creating process and content structures embedded in the learning method. We utilize the most...
common classifications in both IS and education literatures: behaviorism, cognitivism, constructivism, and situationalism (Leidner and Jarvenpaa 1995; Vries 2003). Table 40.1 describes these perspectives, their underlying assumptions, traditional learning techniques, and technology-based technique used to operationalize these perspectives.

The behaviorist view is based on the assumption that human behavior is predictable. Under this theory, learning takes place when new behaviors or changes in behaviors occur as the result of an individual's response to stimuli. Thus, the end goal is defined upfront, and each step necessary to achieve the goal is given to the learners (Burton et al. 2001). For example, direct instruction, which is the most popular form of learning method, is based on this perspective.

The cognitivist perspective holds that learning is a process that is dictated by the participant's cognitive structure and the presentation of the information to the participant. Under this perspective, learning is the change in the mental model as a result of the training. Thus, training methods under this theory have a predefined goal along with information necessary to reach the goal, but the process of cognition of the information is left to the learners (Winn and Snyder 2001). Several researchers have also compared training methods based on behaviorist and cognitive perspectives (Carroll et al. 1997; Olfman and Mandviwalla 1994; Santhanam and Sein 1994), as well as conceptual model or procedural model (Mayer 1981). Sein et al. (1989) found that the effectiveness of the conceptual model depends on the individual user characteristics interacting with the conceptual model and not on the type of model alone. More recently, Coulson et al. (2003) investigated the effectiveness of conceptual models for complex systems. When controlling for initial knowledge, the research found a significant positive effect for using a conceptual model.

The most prevalent theory used to understand participant learning in education as well as in IS is Social Cognitive Theory (Bandura 1986). This theory states that it is not just the exposure to a behavior, but learner action in exploring, manipulating, and influencing the environment that counts. Two kinds of observational learning methods have been differentiated in theory: (1) observation of others’ actions, referred to as vicarious learning/modeling or behavior modeling and (2) observation of self-actions or enactive learning (Schunk 2004). Much of the end user training (EUT) literature has focused on vicarious modeling (VM) as a method of learning. Table 40.2 summarizes the literature in this area. Vicarious modeling treatment in previous research has been done by using an external actor to demonstrate actions (usually packaged in a video). Instructor-based treatment, on the other hand, uses the same content, but without demonstrations of the content being taught. A consistent finding is that VM yields better training outcomes than other methods such as instructor-based instruction or studying

<table>
<thead>
<tr>
<th>Epistemological Perspectives</th>
<th>Assumption about the State of Knowledge</th>
<th>Learning Outcomes Focus On</th>
<th>Learning Happens By</th>
<th>Traditional Learning Technique</th>
<th>Technology-Based Learning Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behaviorism</td>
<td>Objective</td>
<td>Conditioning learner behavior</td>
<td>Response to stimulus</td>
<td>Direct instruction</td>
<td>Drill</td>
</tr>
<tr>
<td>Cognitivism</td>
<td>Objective within context</td>
<td>The learner's thought process</td>
<td>Acquiring and reorganizing the cognitive structures</td>
<td>Behavioral modeling</td>
<td>Intelligent tutor</td>
</tr>
<tr>
<td>Constructivism</td>
<td>Constructed reality</td>
<td>The learner's ability to construct reality</td>
<td>Constructing new ideas or concepts based on prior knowledge and/or experience</td>
<td>Unguided case study</td>
<td>Self-regulated</td>
</tr>
<tr>
<td>Situationalism</td>
<td>Negotiated reality</td>
<td>Social construction by the learner</td>
<td>Participate and behave as a member of the community</td>
<td>Discussing, writing</td>
<td>Computer supported collaborative learning (CSCL)</td>
</tr>
</tbody>
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Current research has also tested four enhancements to VM: practice (Yi and Davis 2001), retention enhancement (Yi and Davis 2003), symbolic mental rehearsal (Davis and Yi 2004), and enactive learning (Gupta 2006). No significant impact of practice was found, but the later three enhancements have had a significant impact on learning outcomes.

The third perspective is the constructivist perspective, which states that individuals construct knowledge by working to solve realistic problems. Under this perspective, learning is the process whereby individuals construct new ideas or concepts based on prior knowledge and/or experience. A constructivist

<table>
<thead>
<tr>
<th>Study/Target System</th>
<th>Training Intervention</th>
<th>Learning Outcomes</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gist (1988): Spreadsheet</td>
<td>VM vs. instruction-based training</td>
<td>Skill: Task performance</td>
<td>VM yielded higher task performance scores for both younger and older trainees</td>
</tr>
<tr>
<td>Compeau et al. (1995): Lotus 1-2-3 &amp; WordPerfect</td>
<td>VM vs. instruction-based training</td>
<td>Skill: Task performance Metacognitive: Computer self-efficacy (CSE)</td>
<td>Subjects in the VM condition developed higher CSE and performed better than those in the instruction-based condition for spreadsheet program, but not for a word-processing program</td>
</tr>
<tr>
<td>Simon et al. (1996): MicroSnap II</td>
<td>Instruction exploration and VM</td>
<td>Skill: Task performance Cognitive: Comprehension Affective: End user satisfaction</td>
<td>VM outperformed the other two methods on all learning outcome measures</td>
</tr>
<tr>
<td>Johnson et al. (2000): Excel</td>
<td>Modeling vs. instruction-based training</td>
<td>Skill: Task performance Affective: Computer anxiety Metacognitive: CSE</td>
<td>Subjects in modeling treatment developed higher CSE and performed better than those in nonmodeling treatment. Computer anxiety was significantly related to CSE and task performance.</td>
</tr>
<tr>
<td>Bolt et al. (2001): Word and Excel</td>
<td>VM vs. instruction-based training when controlling for complexity</td>
<td>Skill: Task performance Metacognitive: CSE</td>
<td>VM outperformed nonmodeling when complexity was high</td>
</tr>
<tr>
<td>Yi et al. (2001): Excel</td>
<td>VM with practice vs. VM with retention enhancement vs. VM with retention enhancement and practice</td>
<td>Skill: Task performance Affective: Attitude</td>
<td>Subjects in the VM with retention enhancement and practice showed higher levels of learning outcomes when compared to the other groups</td>
</tr>
<tr>
<td>Yi et al. (2003): Excel</td>
<td>VM vs. VM with retention enhancement</td>
<td>Skill: Task performance Cognitive: Declarative knowledge Metacognitive: Self-efficacy</td>
<td>Subjects in the VM with retention enhancement showed higher levels of learning outcomes</td>
</tr>
<tr>
<td>Davis et al. (2004): Excel</td>
<td>VM vs. VM with symbolic mental rehearsal (SMR)</td>
<td>Skill: Task performance Cognitive: Declarative knowledge</td>
<td>VM with SMR was better than VM alone. Learning outcomes were mediated by the trainees’ knowledge structures</td>
</tr>
<tr>
<td>Gupta (2006): Excel</td>
<td>VM with practice vs. VM with enactive learning (e-learning) vs. Collaborative learning in both treatments</td>
<td>Skill: Procedural knowledge Cognitive: Declarative knowledge Metacognitive: Self-efficacy, specific self-efficacy, satisfaction</td>
<td>Overall, VM with enactive learning performed better. The learning process was mediated by the attitude toward e-learning technology</td>
</tr>
</tbody>
</table>
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The designer usually provides all the information necessary for learning, but allows the learner to absorb the materials and information in a way that is most comfortable and to arrive at their own conclusions (Duffy et al. 2001). Self-regulated learning to develop individual capabilities is an example of such a perspective; in recent studies, it has shown promise (Gravill and Compeau 2003; Kadlec 2008).

The situationist perspective on learning highlights the fact that meaning is not bound to the individual. Instead, meaning is socially constructed through negotiations among past and present members of the community involved in the domain. According to the proponents of this perspective, authentic activities, that is, the ordinary practices of the domain culture rather than traditional classroom activities, are needed for knowledge to be constructed. Computer-supported collaborative learning is a prime example of learning using this perspective. Drawing from the theory of personal relevance, Ross (1983) argued that motivation is enhanced in settings where personally relevant information can be processed and there exists a direct involvement in the message being evaluated. Olfman et al. (1991) compared training methods organized as application-based (personally relevant) or construct-based and found no significant difference in training outcomes, though there was some evidence that application-based training is best for novice users. Kang et al. (2003), investigating a similar phenomenon, suggested that training should include a broader context knowledge to be successful.

In summary, the most examined training methods in IT training are based on social cognitive theory. These methods, in general, have proven to be significantly better than traditional lectures. However, specific benefits have also been shown using training methods based on other epistemological perspectives. Thus, an important research theme would be to investigate what combination of epistemological perspectives, for example, combining demonstration within a specific situation, should be adopted in a given context: target system, individual differences, etc. In addition, how contemporary instructional technology can be incorporated in training continues to be a challenge. With the increase in the number of structures available for IT training like collaboration, learning objects, simulations, etc., there is also need for a good contingency theory in this area. Practitioners are struggling with how to create blended training methods. Systems design research (Schonberger 1980; Zhu 2002) and summary of various conceptualizations of fit (Venkatraman 1989) present a good foundation for a research stream in this area. Alternatively, design theories have argued for a theory-based design of training programs (Hevner et al. 2004; Reeves et al. 2004). Both of these areas present a very promising stream of research that will help explain inconsistent previous results, filling an important gap in the current body of knowledge.

40.3.2 Individual Structures

Individual differences have played an important role in IS (Sun and Zang 2005) as well as in education research (Lehtinen et al. 2001). In education, individual difference variables define the cognitive aspects of human activities that are often referred to as “learning ability.” These variables influence training outcomes directly, by forming mental models, or indirectly, through interactions with training methods (Olfman and Pitsaton 2000). Table 40.3 summarizes the previous research with respect to these variables.

Generally, individual difference constructs are classified as traits or states (Bostrom et al. 1990). A trait is a distinguishing feature of an individual’s nature and is relatively enduring, while psychological states are general emotion-based characteristics relating to the current context. States are dynamic; they change over time and from one situation to another.

The most examined individual differences are self-efficacy, motivation, and learning styles (see Table 40.3). More generally, in the case of both states and traits, IT training researchers have found a strong impact of individual differences on capability development. Theoretically, most IT training has focused on the direct impact of individual differences on individual capability development. This is consistent with the lower half of the model presented in Figure 40.1. The model states that individual differences affect the psychological process of content assimilation directly, which, in turn, affects learning.
Since, in most cases learning outcomes are used as a proxy for measuring content assimilation, it explains the direct effect that most of these studies found.

On the other hand, research in educational psychology (classified as aptitude treatment interaction) suggests that an individual’s aptitude has an interaction effect with learning methods on learning outcomes (Ackerman et al. 1999). However, education researchers also noted that much of the learning process research has focused on post hoc analysis of results or on opinions of the researcher rather than theory-driven empirical analysis (Rohrbeck et al. 2003). In IT training literature, Szajna et al. (1995) found that computing aptitude and achievement are related to learning performance, whereas anxiety and preexisting experience are not. However, Khalifa et al. (1995) found a significant interaction effect for anxiety; students with higher initial anxiety did significantly better in a more supportive environment. Theoretically, this can be explained by the fact that individual differences have a direct impact on how a person appropriates the learning method, which in turn has an effect on individual capability development. However, in spite of the aforementioned theoretical arguments, the impact of individual differences on appropriation of training method has not been investigated in the IT training literature.

### TABLE 40.3 Individual Differences Research in IT Training

<table>
<thead>
<tr>
<th>Study/Target System</th>
<th>Individual Difference</th>
<th>Learning Outcomes</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Traits</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sein et al. (1989);</td>
<td>Kolb learning style</td>
<td>Skill: Near transfer tests, far-transfer tests, efficiency</td>
<td>Abstract modelers performed better than concrete modeling subjects, especially in far-transfer tasks.</td>
</tr>
<tr>
<td>Bostrom et al. (1990): E-mail</td>
<td></td>
<td>Affective: Satisfaction</td>
<td></td>
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<tr>
<td>Sein et al. (1991): Email &amp; Lotus 123</td>
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<td></td>
<td></td>
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<tr>
<td>Bohlen et al. (1997): Word-processing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Webster et al. (1993): WordPerfect</td>
<td></td>
<td>Affective: Post-training motivation to learn</td>
<td>Task labeling as play is better than task labeling as work for younger participants, but this was not true for older participants.</td>
</tr>
<tr>
<td><strong>States</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Johnson et al. (2000): Excel</td>
<td></td>
<td>Metacognitive: Computer self-efficacy</td>
<td></td>
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<tr>
<td>Martocchio et al. (1997): Windows 3.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Szajna et al. (1995): Anxiety</td>
<td></td>
<td>Skill: Learning performance</td>
<td>Anxiety was not related to learning performance.</td>
</tr>
<tr>
<td>Keller et al. (1995): Basic IT skills</td>
<td></td>
<td>Anxiety</td>
<td>Anxiety has significant interaction with training method.</td>
</tr>
<tr>
<td>Cognitive: Declarative knowledge</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metacognitive: Self-efficacy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cognitive: Declarative knowledge</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metacognitive: Self-efficacy</td>
<td></td>
<td></td>
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</tbody>
</table>
Overall, more work is needed in this area to clarify the role of individual differences in developing individual computing capabilities. In this regard, more IT-specific traits and states need to be examined further. In a learner-centric era, where the learner is responsible for learning, the impact of these IT-specific traits and states is likely to grow and create significant challenges needing further investigation (Salas and Cannon-Bowers 2001). For example, one salient trait found to apply in other IS contexts, yet not examined in EUT research, is personal innovativeness in IT (Agarwal and Karahanna 2000). In addition, researchers focusing on individual differences should examine both the direct effects on learning outcomes and the effect of individual differences on learning process. The model and arguments presented earlier provide a good framework for researchers to examine the effect of individual differences and assertions stated previously.

40.3.3 Process Mechanisms

The learning process is a series of actions or cognitive development that leads to a change in an individual’s capability. Two critical activities happen during this process. First is the interaction of the individual with the elements of the training environment, and second is the development of mental models. Both are discussed later.

40.3.3.1 Structural Appropriation

The model outlined in Figure 40.1 provides AST as a basis for measuring the learning process. The learning process is viewed as an appropriation or structuration process where participants learn and adapt the learning method structures based on their interpretation of the designer’s intent. Like all perceptions, this interpretation varies among learners. Although educational researchers do not have a concept similar to appropriation, they have focused a lot on scaffolding because of its importance (Chang et al. 2009; Ge and Land 2003). Scaffolding presupposes appropriation of structures/learning methods but focuses on how to guide or facilitate appropriation instead of structural impacts. The concepts of scaffolding and appropriation complement each other and would be useful for investigating use of learning method structures.

Assuming that the learning method reflects the values and assumptions of the epistemological perspective and the learning capabilities (i.e., for well-designed structures), a faithful appropriation occurs when participants’ interaction is consistent with the spirit (Poole and DeSanctis 1992). Faithfulness is not necessarily concerned with the precise duplication of the procedures provided; rather, it is concerned with whether the structures are used in a manner consistent with the overarching intention in which the designer intended the system to be used. A participant’s unique or innovative use of the structures may well be a faithful appropriation as long as their use is consistent with the spirit that the learning method intended to promote (Chin et al. 1997). Ironic appropriation occurs when the participants’ interactions violate the spirit of the structure with or without abandoning the underlying learning method (Poole and DeSanctis 1990). In the case of well-designed learning methods, ironic appropriation could introduce internal contradictions within the structures governing interaction. Over time, these contradictions will cause tensions in interactions, which might lead to lower effectiveness of the structures. These contradictions must be addressed, detracting the participant(s) from the learning focus, leading to lower learning outcomes.

When analyzing technology appropriation, Poole and DeSanctis (1990) suggest three dimensions that indicate appropriation: faithfulness, attitudes, and level of consensus. That is, structures will only have their intended effect if the design principles are kept intact (faithfulness), if members do not react negatively to it (attitudes), and if members agree substantially over how structures are used (consensus). Considerable support for the proposition exists in AST literature, particularly the group support systems literature. Indirect support exists in the education literature, especially in the scaffolding literature. Most recently, in a follow-up to their conceptual model, Gupta and his colleagues studied appropriation as an influence on learning outcomes and found strong support (Gupta 2008).
40.3.3.2 Psychological Processes

The Alavi and Leidner (2001) model argues for a similar physiological or cognitive activity done by an individual as a part of the learning process. Their conceptualization of the learning process deals with how information is absorbed and stored in our minds, that is, content assimilation. Such a process deals with how a given content is captured to create new or modify existing mental models by the trainee. Analyzing the process, Davis and Yi (2004) found significant support for the importance of mental models on learning outcomes. Research in this area is often based on more general theories of content assimilation, such as Piaget’s theory of cognitive development, Ausubel’s theory of subsumption, or Mayer’s theory of assimilation (Schunk 2004).

More specifically, educational psychologists have generally theorized three phases of learning: preparation for learning, acquisition and performance, and transfer of learning (Gagne 1985). Preparation for learning deals with the learners focusing on stimuli to the material and orienting themselves toward the goals. The main phase of learning is the acquisition and performance phase. This deals with recognizing the relevant stimulus features and transferring them to the working memory for processing. These are subsequently encoded, and new knowledge is transferred to create new/update existing mental models. Transfer of learning deals with developing models for new situations based on what has been learned. Only one study has examined this process in an IT training context (Yi and Davis 2003). This study, done in the context of social cognitive theory, found significant positive effect of the three aforementioned learning process phases on outcomes.

In addition to this, an individual can build a mental model of the system in three different ways: mapping via usage, mapping via analogy, and mapping via training. Only one research study on directly focusing on mental model building in an IT training context (focusing narrowly on mapping via training) has been conducted (Bostrom et al. 1990). While more studies are needed in understanding mapping via training, the other two methods also represent important areas in understanding how individuals build their computing capabilities.

In summary, the model in Figure 40.1 identifies four critical elements that influence the development of individual computing capability. The training methods, based on different epistemologies, and the trainees, with their individual differences, present the starting point. Individuals learn as they go through the process of content assimilation and training method appropriation. Key practical implications and future research areas are discussed next.

40.4 Practical Implications

The review of the literature presented in the previous paragraphs has many different implications in practice. First, individual capabilities need to be more broadly defined and assessed when compared to what has traditionally been done in practice. Most assessment methods focus only on skill-based capabilities, leaving out the other three. While skill-based capabilities are the foundation, the real exploitation of an information system is dependent on the levels of the other three capabilities.

Second, trainers need to shift their attention toward incorporating learning theories into their training methods. In addition, the literature clearly states that VM-based methods have the greatest impact on developing individual computing capabilities. Whether implemented in traditional environment or e-learning environment, trainers need to focus on how the components/features of the training method enhance critical dimensions of VM. Research also shows that certain enhancements, like the ability to take notes, work in simulations, work in teams, etc., can increase the effectiveness of VM.

The third implication deals with accommodating individual differences to personalized training. Personalization deals with the delivery of content that specifically meets the learner’s needs and characteristics. Traditionally, the focus has been on the content of the training, and organizations have used job roles to define the content. However, with advances in technology, the focus is shifting to include the ability to personalize training methods using learning management systems (LMS). To personalize
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the learning method, a learner profile that captures individual differences should be mapped to different learning methods. Next, LMS can be used to link these methods, preferences, and competencies as needed (Mayer et al. 2004). As such, profiling and job-role competencies categorizations need to be developed and investigated, especially before their use in LMS.

However, this result of good training method and personalization is contingent on the faithful use of e-learning technology by the users. Higher levels of appropriation, especially a positive attitude, toward new training methods, such as e-learning, have a substantial impact on the extent of learning. A practical implementation of this is to encourage participants to continue with e-learning solutions for a longer period, as experience helps in enhancing attitudes toward e-learning. More importantly, it shows the importance of developing a positive attitude upfront. Additionally, trainers should use scaffolds to enhance overall faithfulness of the learning method appropriation.

Overall, this chapter provides a comprehensive view of designing contemporary training programs, in classrooms, as well as virtually. These outcomes can be used not only by corporate businesses/consultants/trainers but also by instructors in K-12 and universities.

40.5 Key Research Issues

The model outlined in Figure 40.1 points to a broad gamut of potential research questions. Most of the research issues deal with the input structures and the learning process. Some of these issues, such as personalization, combination of training methods, changes because of emerging technology, etc., were mentioned earlier in the chapter. In this section, we focus on four important research streams that have not yet been mentioned.

Although not specifically highlighted in research models, the creation of input structures requires a lot of pretraining activities (Olfman and Pitsatron 2000). These activities not only influence the development and design of the training method, but the rest of the training process as well. The study of how these components influence the design and development of the training method thus represents an important research topic for the future. This research will also provide an important feed into the “personalization” aspect of training—a critical input area for the training industry.

From a learning process perspective, there are two distinct ways of investigating the appropriation of training methods. First is the structural focus, concentrating on how well the training method structures are appropriated by the learner. Gupta (2006) found support for the effect of faithfulness of appropriation on learning outcomes. An important implication of this is that future researchers need to account for the level of appropriation in the interpretation of their studies. The second way of understanding the learning process, and a more enduring research theme, is the process focus involving the microlevel analysis of the learning process and the reciprocal causation phenomenon. Very limited research has been done in understanding the “moves” trainees make as a part of the learning process. “Move” studies are usually done at a microlevel analysis of the appropriation process. Poole et al. (Poole and DeSanctis 1992) have identified nine categories of such moves and provide a good starting point for the analysis. Such a research stream would provide a significant contribution to understanding the adaptive structuration process from the trainee’s perspective. In all of the previous cases, researchers have suggested that the influence of structures changes over time and thus argue for longitudinal studies (Davis and Yi 2004; Gupta 2006). However, very limited knowledge currently exists on how appropriation changes over time and the causes for the changes.

Additionally, the learning process can also be manipulated through appropriation support or scaffolding for the training. There are various forms of process appropriation (procedural, metacognition, and strategic) support that need to be further studied. Procedural scaffolding helps learners make navigation decisions, such as how to utilize available resources and tools. Metacognitive scaffolds support individual reflection on learning, such as soliciting estimates of current understanding or cueing participants to identify prior related experiences they can reference. Strategic scaffolds support learners in anticipating their interactions with the learning method, such as analyzing, planning, and making
tactical decisions. Different support forms are likely to have different influences on the learning process and would represent an important contribution to this stream of literature.

Finally, researchers also need to deal with the continuous and real-time nature of learning. Companies and vendors are incorporating learning technology into their applications and products. Given the nature of current technology evolution, IT training needs assessment will soon not be treated as a distinct event needing follow-up; rather, needs assessment using technology will be continuous, job-driven, and done on demand (Gruene 2005). In either case (whether needs assessment is done in real-time or not), an important research question is: How should organizations best assess the end user skill gap, especially using technology? In addition, as highlighted in the chapter, the capabilities of an EUT program are expanding. Different job roles using a variety of information systems need different kinds of knowledge (DeSousa 2004). Such a spread of information systems, coupled with the breadth of job roles associated with software, provides a compelling need for future study.

40.6 Concluding Remarks

Individual computing capabilities are very important productivity tools in today’s digital economy. A particularly large number of job postings highlight this need. In this chapter, we have synthesized existing knowledge on the factors that could influence the development of individual computing capabilities, presented a nomological framework for organizing extant research, and provided areas of future research on ways to improve training effectiveness.

Glossary

Appropriation of learning method: Participants learn and adapt the learning method structures based on their interpretation of the designer’s intent.

Collaborative learning: Groups of students work together in searching for understanding, meaning, solutions, or in creating a product.

Content assimilation: A process that deals with how a given content is captured to create new or modify existing mental models by the trainee.

E-collaboration technology: Technologies that offer a rich, shared, virtual workspace in which instructors and students can interact one-to-one, one-to-many, and many-to-many in order to learn together anytime and at any place.

Epistemological perspective or spirit: General intent with regard to values and goals underlying the choice of structure.

Individual computing capabilities: Individual computing capabilities represent an understanding of the principles by which a system can be applied to a business task.

IT training: IT training deals with the teaching of skills to effectively use computer applications to end users.

Learning method structures: Learning method structures are formal and informal procedures, techniques, skills, rules, and technologies embedded in a learning method, which organize and direct individual or group behavior.

Learning outcomes: Learning outcomes are the result of the learning process. These can be broadly classified into four dimensions, namely, skill, cognitive, affective, and metacognitive outcomes.

Learning process: A series of actions or cognitive development that leads to a change in an individual’s capability.

Technology-mediated learning or e-learning: An environment in which the learner’s interactions with learning materials, peers, and/or instructors are mediated through advanced information technology.

Training method: A training method is defined as a combination of structures that guides individuals to achieve the learning outcomes.
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