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Chapter 11

LEARNING TO BECOME A CREATIVE SYSTEMS ANALYST

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The important role of creativity has increasingly been recognized in requirements engineering (RE), an early stage in the lifecycle of systems development. Although creativity plays an important role in the discovery, exploration, and structuring of the conceptual space of the requirements problem, creativity has not yet been accepted as an essential ingredient of teaching and learning in RE. This chapter describes a novel approach to learning in RE that synthesizes different dimensions of constructivist learning and creativity education theory to support creative problem exploration and solving in RE. This learning approach will be illustrated through a training environment consisting of face-to-face classroom and online activities, as well as, computer based simulation.

LEARNING CREATIVE REQUIREMENTS ANALYSIS

The development and introduction of a new information system to a business or military organization is an opportunity for innovating or reinventing that organization’s practice, processes, or products in order to leverage their benefits and create value. Requirements engineering is an early process in the systems development lifecycle where innovation plays an especially important role. In general, RE involves the creation of a vision for the future system through the discovery, analysis, modeling, and validation of user requirements. Specifically in the context of this book, RE involves the elicitation, modeling and analysis, specification, and verification and validation (see Volume 1, Section 2 Perspective) of training system requirements. During this process, the systems analyst (requirements engineer) works with various systems development teams and stakeholders often including the management, business people and users (for example, educators and learners of the training system), technology vendors, and possibly the organization’s business partners and/or customers.

The description of the requirements engineering topic is covered extensively in terms of process models, requirements elicitation and modeling techniques, support tools, approaches to validating and managing requirements, and documentation and templates. Interested readers are directed to see various textbooks.
(for example, Robertson & Robertson, 2005; Dennis, Wixom, & Tegarden, 2004; Kotonya & Sommerville, 1998; Sommerville & Sawyer, 1997) or research reviews (for example, Nuseibeh & Easterbrook, 2000; Gervasi, Kamsties, Regnell, & Achour-Salinesi, 2004; Opdahl, Dubois, & Pohl, 2004). Tremendous effort has focused on describing and supporting the systems analyst in the construction of a requirements specification that reflects the real world problem situation through understanding and solving the problem as perceived by the user. This chapter, however, focuses on an alternative view of requirements engineering—creativity—and proposes an approach to training creative systems analysts.

Recently, it has been argued that to be effective the systems analyst should also be an inventor (Robertson, 2005), and it is essential that the RE process itself is creative as well (Nguyen & SWATMAN, 2006). These two emerging arguments open a challenge to the RE community: how best to train and learn to be a creative systems analyst. This chapter addresses this challenge by describing the creativity aspects of RE, discusses advantages and limitations of current education approaches in RE, and proposes a new approach to learning to become a creative systems analyst.

TEACHING AND LEARNING IN REQUIREMENTS ENGINEERING

Overview of Current Teaching and Learning Approaches

Overall, there are three major approaches to learning RE: (1) taking an industry-intensive course (often ranging from half a day to several days), (2) taking requirements engineering as one of the subjects in a tertiary course (graduate diploma, graduate, or postgraduate degrees), or (3) workplace learning (often working alongside expert systems analysts). Each of these learning approaches has advantages and disadvantages. Analysis of these advantages and disadvantages supports the need to incorporate and promote creative thinking into these learning approaches.

Learning RE through an Industry-Intensive Course

Industry-intensive courses (or workshops) are often provided by various professional associations and consulting or training companies. These are often instructor led and sometimes can be delivered via a computerized learning system. These courses aim at providing formal knowledge (about processes, techniques, notations, and tools) over a short period of time with small illustrative exercises to allow learners to apply and acquire some practical skills. Limitations of such courses are the unrealistic setting of exercises and a condensed delivery of rich materials (RE knowledge). Due to these limitations, the learner often faces a gap between the knowledge acquired from the course and its application in practice, or a mismatch between "approved" practice and "actual" practice (Nguyen, Armarego, & SWATMAN, 2005).
Learning RE through a Subject(s) Included in a Tertiary Course

Students who are enrolled in such degree programs as Information Systems (IS), Software Engineering, or Computer Science often learn RE in a course such as Systems Analysis and Design or in a specific Requirements Engineering course. Such subjects are commonly offered in a single semester with a wide range of classroom, as well as self-paced, learning activities. Typically, lectures and tutorials (or laboratory work) allow the teacher to transfer formal knowledge (processes, techniques, notations, and sometimes tools) and allow students to apply the knowledge received through illustrative exercises or discussion questions. Assignments are often used to enable students to self-learn by drawing and applying relevant knowledge to a given problem. Common advantages of the tertiary learning approach include the acquisition of rich knowledge and opportunities to work on practical exercises repeatedly during a semester. Many problem based assignments are conducted in groups; therefore, they allow learners to interact with each other to discuss and share their learning. Common limitations of this approach include the controlled setting of class activities (especially time), unrealistic practical exercises, and assignments with predefined, teacher-designed problem space (see, for example, Minor & Armarego, 2004).

To overcome the lack of realistic practical exercises and assignments, many universities provide learners with a project based or an industry placement course, often scheduled near the completion of their qualifications. In such courses, learners are engaged in small, self-managed projects with an assigned client or work with a team of professionals at their workplaces. While such project based or industry placement courses support experiential learning, they are also a major source of problems, including inadequate provision of teaching and technical resources, elevated teaching costs, lack of available industry partners/projects, and uncertainties from the workplace environment, which may interfere with the curriculum program and course syllabus set by the teacher and/or the university.

Learning RE at the Workplace (On the Job Training)

Many practitioners learn on the job by working alongside more capable experts. Advantages of this approach to learning include the learner’s participation in realistic cases, adoption of real roles and responsibilities, and acquisition of experience in dealing with real clients in real organizational settings; all of these provide a rich experiential learning environment that enables an authentic vocational knowledge acquisition process. However, limitations of this approach include a lack of access to formal (and appropriate) knowledge, a lack of a pedagogical process taking the learner from simple to complex tasks, and a reluctance of industry participants to share their knowledge (Billett, 1995). Due to many business impediments and management’s reluctance to accept the high risks associated with innovative ideas (Cybulski, Nguyen, Thanasankit, & Lichtenstein, 2003), the workplace cannot be treated as a safe learning “playground” in which a flexible and constraint-free environment would allow the learner to try out
<table>
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<tr>
<th>Learning Approaches</th>
<th>Characteristics</th>
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<td>Industry intensive courses</td>
<td>• Instructor led, classroom activities, formal structured knowledge, unrealistic setting, and condensed materials within a short time</td>
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| Formal tertiary courses   | • Instructor led, a range of activities from classroom to project based, formal structured knowledge, and rich knowledge on a semester basis  
  • Project based learning attempts to address the unrealistic setting at the expense of providers’ resources |
| Workplace learning        | • Self-learning, real setting, and rich experiences gained                        
  • Lack of formal structured knowledge, lack of a pedagogical approach, high risk to “experiment” ideas |

different (and potentially dangerous) strategies when learning different concepts and techniques. See Table 11.1.

**Discussion**

A range of approaches to learning RE have been developed and adopted in professional training and higher education. Each comes with its own benefits and limitations. Formal education (course based learning) aims primarily at the acquisition of RE processes (analysis and modeling), techniques, notations, requirements management, and other general abilities (such as communication and team skills); however, it lacks exposure to realistic and collaborative industry projects (Minor & Armarego, 2004). A literature survey by Dallman (2004) noted a lack of learning support for creative thinking, cognitive flexibility, and metacognitive learning strategies in current formal education. Workplace learning, while providing realistic projects, lacks access to formal knowledge and pedagogical processes (Billett, 1995). At the same time, practitioners who are well positioned to effectively transfer their professional experience to the RE learners are not well informed of creativity techniques that may apply to their relevant RE practice (Maiden & Robertson, 2005).

The Creativity Problem-Based Learning framework (Armarego, 2004) was developed to integrate cognitive flexibility, metacognitive learning strategies, and constructivist learning elements; to allow the learner to learn in a situated experiential environment; and to provide cognitive apprenticeship by working with an expert coacher. Armarego’s approach provides a rich and flexible learning environment to enable authentic knowledge acquisition and encourage creative thinking. While benefits have been reported (Armarego, 2004), it is yet unclear how the framework supports the inclusion of creativity theory. Creativity processes and techniques to generate ideas and solutions, to extend the conceptual space, and to evaluate the creative outcome can be included within such a framework in an informed and structured way.
CREATIVITY IN RE

There seem to be two distinct views of the RE process within the RE community. The first view, held by many authors, considers problem solving in RE as a systematic, structured, and evolutionary process, during which the problem is gradually explored, refined, and structured into the requirements model. Various methods have been proposed to guide the systems analyst to decompose the user’s problem and compose the requirements model using different decomposition approaches, modeling techniques, and notations (for example, see Jackson, 2005; Kotonya & Sommerville, 1998; Dennis, Wixom, & Tegarden, 2004). The second—and new—view of the requirements process emerged from action research and case studies (Nguyen & Swatman, 2003; Nguyen, Carroll, & Swatman, 2000; Nguyen, Swatman, & Shanks, 1999), which reveal episodes of insight-driven reconceptualization and restructuring of the requirements model during the generally incremental development of the model. These restructuring episodes can be characterized as “Aha!” moments during which the systems analyst unexpectedly sees a new perspective of the problem and, as a result, restructures the requirements model significantly. These studies confirm the Gestalt psychology theory of insight and restructuring in ill-structured problem understanding and solving (Mayer, 1992; Ohlsson, 1984). Furthermore, this new view of the requirements process emphasizes that the problem in RE is not given (not there waiting to be elicited), but instead emerges as the systems analyst enters the situation, learns, explores, and discovers different problem areas when interacting with the situation and various stakeholders. Hence, the RE process itself can be seen as a constructivist process. Nguyen and Shanks (2006b) noted two analogical views of the design process held within the design studies community—where the design process is seen either as a rational problem solving process (Simon, 1992) or a constructivist process (Schön, 1996). These two views represent two forces of problem solving: the enforcement of a structured process to avoid chaos and errors, as opposed to relaxation of constraints in dealing with the emergent problem space by taking advantage of opportunistic cognitive behaviors and heuristics of participating professionals (Nguyen & Shanks, 2006b). Nguyen and Shanks further suggested that these two views are complementary and need to be integrated to support a collaborative process consisting of cycles of structured building of and opportunistic restructuring of the requirements model.

Robertson (2005) set a challenge to RE practice to recognize the importance of discovery and invention of new ideas in the requirements acquisition process rather than simply relying on passive elicitation and analysis of what users say they need. This challenge spurred a review of the role of the systems analyst during the elicitation process, which now has been described as the requirements discovery process. A series of creativity workshops in RE were conducted by Maiden and his colleagues at City University, London, United Kingdom (Maiden & Robertson, 2005; Maiden, Manning, Robertson, & Greenwood, 2004; Maiden & Gizikis, 2001), in which they demonstrated how various creativity techniques, such as brainstorming, domain mapping, analogy reasoning, and constraint
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removal, to name a few, can be incorporated within structured RE processes to discover and explore ideas and requirements. Other creativity techniques were also suggested to be incorporated within the requirements elicitation by other researchers (Mich, Anesi, & Berry, 2004; Schmid, 2006). Nguyen and Shanks (2006a) reviewed different characteristics of the creative processes in the creativity literature and design studies, related them to the RE process, and called for an integrated process and tool environment to support the systems analyst in adopting creative techniques and tools capable of exploring and structuring the problem space in RE. From a combination of collaborative and cognitive perspectives, a group of researchers at the University of South Australia currently investigate and develop an ICT-enabled environment to support creative team problem solving using the distributed cognition theoretical foundation (Blackburn, Swatman, & Vernik, 2006).

Another challenge in supporting creativity in RE in an organizational setting was discussed at length by RE practitioners and business and IT managers participating in a focus group (Cybulski et al., 2003). The management practice and organizational culture strongly influence not only the development, but also the appraisal and adoption of creative IT-enabled solutions to business problems. According to Nguyen and Shanks’s (2006a) creativity framework for RE, novelty, value, and surprisingness can be used as three characteristics to recognize and evaluate the creative outcome in RE. Novelty refers to the extent that the new system is different from existing systems. Value refers to the usefulness, correctness, and fit (appropriateness) of the system in the context of use. Surprisingness refers to the unexpected features of the system. Research is currently under way to define ways to assess these characteristics. To support creativity in RE, it is also important to appreciate changes to norms that have traditionally been accepted within, practiced by, and grounded in the organizational culture (Regev, Gause, & Wegmann, 2006). In a similar vein, the Creativity in Requirements Engineering framework classifies and describes various individual and organizational factors that influence creativity by the systems analysts (Cybulski et al., 2003; Dallman, Nguyen, Lamp, & Cybulski, 2005).

Overall, creativity has recently received increasing interest within the RE research community. Creativity techniques and tools can be integrated within various requirements engineering approaches to inform and support systems analysts in their collaborative effort to invent and develop requirements for new information systems, including virtual environments for training and education in the military. While such integrated approaches promise potential benefits, the primary focus of the chapter is the creative systems analyst as an expected outcome of a training environment. Creativity plays an important role for those systems analysts who want to add novelty and value while exploring and constructing the problem space and subsequently when solving the problem. However, fostering creativity in RE practice and teaching creative methods in RE education have so far received very little attention (Dallman, 2004; Armarego,

1ICT: information and communication technology.
2004; Nguyen et al., 2005). As a result, experienced practitioners and RE learners are not well informed of how to practice RE creatively.

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Learning Process

Throughout the RE literature, there has been a common agreement that the RE process can be characterized as application domain specific, technical, and contextual, that is, embedded within a specific organization and social setting (Sutcliff & Maiden, 1998; Jackson, 2005; Coughlan & Macredie, 2002; Checkland & Scholes, 1999; Goguen, 1997). Further, RE can be seen as a process of solving “wicked” problems that involve technical issues, social complexity, and dynamics (Conklin, 2006). The problem solving activity in RE requires both problem understanding as well as problem solving (Visser, 1992). The problem solver continually interprets the problem situation, constructs a knowledge representation of the problem, and forms and evaluates possible solutions. This intertwining process of problem understanding and solving is reflected in the incremental structuring and occasional restructuring of the requirements model. There are important implications for the systems analyst to be viewed as a learner.

- The emergence of the problem situation suggests that RE itself is a learning process, more specifically, a constructivist learning process during which the learner constructs his or her knowledge by structuring and reflecting upon the emergent problem (Gero, 1996; Schön, 1996; Armarego, 2004; Robillard, 2005).
- Creativity plays an important role for the exploration, construction, and expansion of the problem space. Indeed, creativity is defined as an internal process of exploration and transformation of the conceptual space in an individual mind (Boden, 1991, 1998).
- The problem in RE is of a technical as well as social nature (Conklin, 2006). Therefore the systems analyst’s learning process takes place in a domain specific, social, and collaborative context.

The above implications led us to believe that the fundamental objectives of RE education must also be reevaluated, which led us to grounding the RE learning approach in a synthesis of the constructivist learning and creativity education theories.

Based on Piaget’s (1950) theory, constructivist learning refers to the authentic and personal building up of knowledge. This knowledge building process occurs in the individual learner’s mind through two mechanisms: assimilation and accommodation. Assimilation occurs when the learner interprets and incorporates new learning into an existing conceptual framework representing his or her knowledge of a topic area. Accommodation occurs when the learner could not fit the new learning into his or her existing framework; as a result, he or she reframes (restructures) the existing conceptual framework. These two mechanisms are consistent with the structuring and restructuring activities in RE (Nguyen & SWATMAN, 2006). Vygotsky (1978) stresses the important role of a
combination of collaboration among learners (through which the learner receives feedback and coaching) and practical exercises (through which the learner constructs knowledge and gains skills). These underpinning theories of constructivist learning have been synthesized into the three dimensions of endogenous, exogenous, and dialectic constructivism (Moshman, 1982):

- **Endogenous** dimension: The learner learns through an *individual* construction of knowledge. Accommodation and assimilation are two mechanisms that enable the endogenous construction of knowledge. The teacher can play a facilitator role, but the learner takes a more active role and assumes ownership of his or her learning and knowledge building.

- **Exogenous** dimension: The learner learns from a combination of *formal instructions* and *realistic and relevant exercises* through which he or she refines knowledge through instructions and feedback received from the teacher when undertaking practical exercises.

- **Dialectic** dimension. The learner learns through *collaboration and interaction* with teachers (experts) and peers through realistic experiences. The *scaffolding* provided by the more capable collaborators is especially important.

Dalgarno (2005) developed a three-dimensional learning environment that incorporated elements from these three different dimensions of constructivist learning. His successful application of this learning environment in teaching chemistry encouraged us to pursue a rich RE learning environment in which the learner will be supported with elements from the above constructivism dimensions. The learning should take place through a range of learning activities: knowledge acquisition from formal instructions, practical exercises and project based realistic experiences, as well as collaborative and individual construction of knowledge.

While extrapolating this view of constructivist learning, we have examined the issue of creativity education, where there has been an argument about whether creativity is a domain-specific or domain-general ability. There has been a strong view that creativity is inherently associated with a certain type of intelligence and that domain expertise is required to identify to what extent a creative product extends a domain knowledge boundary (Solomon, Powell, & Gardner, 1999; Gardner, 1993). Therefore, creativity should be seen as domain specific and creativity education should be adapted to a specific domain. However, Root-Bernstein and Root-Bernstein (2004) argued that creativity should rather be seen as domain general because it is inherently associated with commonly intuitive and metacognitive capabilities; therefore, creativity education should target intuitive and metacognitive learning. Baer and Kaufman (2005) argued that creativity includes both domain-general as well as domain-specific capabilities. They developed the Amusement Park Theoretical (APT) model for creativity education. Their APT integrates both domain-general and domain-specific creativity elements. Based on this theory, domain-general creativity elements include intelligence, motivation, and environment, that is, creativity-supported culture; whereas domain specific creativity elements are categorized from a general thematic area to a domain and microdomain subarea. APT has been suggested as
having potentials in creativity education in RE (Nguyen & Shanks, 2006a). We adapt APT specifically to the RE domain:

- At the level of general thematic creativity: intelligence can be determined as problem understanding and solving and social and communication skills; individual motivation should be recognized and linked to learning objectives, and learning environment elements need to be identified and linked to the constructivism dimensions.

- At the level of RE specific creativity: business knowledge (for example, training programs and processes in military), technology knowledge, analysis and modeling techniques and tools, and creativity techniques and tools should be integrated to generate creative ideas and to recognize and evaluate creative products.

Having synthesized and adapted the above constructivism dimensions and APT theory to RE, we propose a learning environment including the elements shown in Figure 11.1 to support a constructivist learning approach that incorporates creativity learning for systems analysts.

A creativity-supported culture is identified as an element at the general creativity level in APT (Baer & Kaufman, 2005). This element is adapted in our approach as a simulated learning environment to support different constructivism dimensions (through promoting flexibility in framing and reframing knowledge and collaborative creativity). Different levels of (domain-general and domain-specific) creativity elements are integrated within this learning environment. This adaptation assists the learner in recognizing and understating constructivism.

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**Figure 11.1. Incorporating Creativity Learning within Constructivist Learning**
dimensions supported by a particular learning program and taking advantage of how the program could support his or her learning process. For example, a course based program (formal education) would potentially support the exogenous dimension of learning, in which case, the learner should apply formal instructions from the learning program while working on RE exercises. Based on the feedback from the instructor, the learner should refine and clarify the knowledge received. However, with RE workplace learning, the learner should apply the accommodation and assimilation mechanisms proactively in more realistic experiences and seek collaboration and formal approval of knowledge constructed from time to time. As different constructivism dimensions are integrated within our proposed environment, the learner needs to recognize them and take advantage of their integration (see the next section).

At the level of general problem solving creativity, our proposed approach includes the following:

- Elements for intelligence building, such as problem understanding and solving capabilities (for example, problem recognition, strategy planning, idea generation and brainstorming, solution formulation and evaluation, and so forth).
- Elements for identifying and communicating motivations. Individual learner’s motivations and learning objectives need to be identified and communicated with the teacher (or coach) to align reward mechanisms to suit individual learning objectives and motivations.
- Support for social interactions and collaboration in problem based projects, within and cross-team communication, and with facilitator(s). A combination of social software and face-to-face interactions can be used to facilitate electronic communication and collaboration to allow the learner to acquire social and communication skills (team building, negotiation, exchange of information, group collaborative support, and so forth).

At the RE specific level, our proposed approach integrates the following:

- Support for the learner to learn through relevant experiences (small exercises, case studies, and projects) through providing appropriate knowledge and instructions—processes (such as Waterfall, Rapid Application Development, Agile development, and so forth), elicitation techniques (such as scenario based interviews and observation), modeling techniques (such as use case, object oriented, data flow diagram, entity relationship, and so forth), and requirements management tools (see Volume 1, Section 2 Perspective).
- Support for individual as well as collective creativity. Creativity techniques, such as brainstorming, imagination, search for ideas, idea association, analogical thinking and play, as well as the use of creativity tools, will be integrated within the RE lifecycle.
- Support for flexible cognitive processes and support for monitoring the evolutionary structuring and insight-driven restructuring of the requirements model.

The next section will illustrate the proposed conceptual framework in a case in which creativity was incorporated within a constructivist learning approach demonstrated by students undertaking an RE subject in various master degree programs, including business, commerce, and information systems.
A Case of Learning Creative RE Using a Simulated Learning Environment

A project in RE (Cybulski, Parker, & Segrave, 2006a, 2006b) was designed to enhance and enrich the learners’ abilities to discover and elicit information systems requirements (from both business and technology viewpoints)—an essential skill of the information systems professional. While teaching requirements elicitation is common in information systems and software engineering schools, such teaching is usually limited to conducting simple interviews and formalizing the collected information into a requirements specification. The more challenging requirements elicitation skills, which unfortunately are very often neglected, include detection of conflicting and redundant information, handling omission of essential facts, and dealing with the absence of management approval and customer feedback to fully validate the collected and analyzed requirements. Through our project, the learner was engaged in various activities to overcome the above-mentioned problems, to independently and collaboratively seek solutions to these problems, and to apply some creative approaches to dealing with the shortcomings of the specified requirements. In this way, the project was designed to support endogenous and dialectic constructivism and creativity learning at a general thematic level of (business) problem solving creativity.

Our RE project (codenamed FAB ATM) required the learners to work in teams to produce specification of a banking product (a new generation of automated teller machines [ATMs]). In the initial stages of the project, the teams used a computer simulation (henceforth called FAB ATM simulation) of a virtual meeting room, where the learners had an opportunity to meet with the simulated staff of a hypothetical banking organization (FAB—the First Australian Bank). During the meetings, the teams conducted a series of interviews with a view to collecting requirements for their project. The simulated interviews allowed project teams to first design interview questionnaires and then engage simulated interview participants in a lengthy conversation (see Figure 11.2). The requirements elicited in the process of such interviews represented distinct viewpoints of the bank staff, for example, a technical officer or a branch manager. After the interviews, the learners had to analyze the collected requirements and identify redundancies, conflicts, and omissions; all of which had to be reconciled, removed, or filled in with information obtained in the process of self-directed research. Results of these activities were eventually presented to the bank manager (role-played in the real world) for validation and the final approval and subsequently sealed in the form of a consistent specification document.

Immersive educational simulations, games, and role-playing were central to the conduct of our RE project. To support different constructivism dimensions, we used a blended simulation learning environment, where some activities were conducted in classes (lectures and tutorials), some in project teams (face-to-face meetings, online discussion boards, and chat rooms), and yet others with the use of a virtual (meeting) environment—named Deakin LiveSim (Cybulski et al., 2006a, 2006b). Through formal classes (lectures and tutorials), the blended learning environment supported exogenous constructivism. Through a range of inter- and cross-team communication activities and project-related consultation
Figure 11.2. Simulated RE Interviews with Multiple Participants in a Corporate Environment

(provided by teachers), the blended environment supported dialectic constructivism. Through simulated interviews, documentation collection, and interpretation, the learners acquired general problem understanding and problem solving skills. In the provided qualitative feedback, the learners generally praised the experiences gained with the simulation; for example, they said,

The interview CD is really a very good idea, which offered us a virtual interview environment via multiple media technology.

The interview stimulation program did offer us a chance to be a part of interview, to touch it, to feel it and to experience it.

The actual interview simulation session was very informative and convenient allowing some flexibility in the actual interview technique.

To incorporate RE creativity learning, a typical RE lifecycle was adopted in the FAB ATM simulation project (see Figure 11.3). The process took the learners through the learning "funnel," which leads them from the fuzziest (completely open to imagination and creativity—for example, extending ATM with share trading, Web based, or human-touch user interfaces) to the most formal and constrained knowledge (which requires breaking of technology and business dogmas to arrive at some workable solutions). Individual learners started their project work
by investigating the problem domain (research) and then in groups exploring and planning their projects (that is, both individual and collective brainstorming and scenarios solution exploration). These were followed by gathering requirements (via a face-to-face backgrounder and interviews with simulated people), analyzing the discovered and elicited requirements (to include their formalization and scoping), and later investigating information systems requirements, alternative solutions, and possible business alignment issues (using user context and user voice analysis teaching). Their next stage involved the verification and validation of requirements (using a formal presentation and feedback collection), integration of new requirements with adapted legacy requirements (in a specification document), and finally the project completion. All learners were also asked to reflect upon, elaborate, and document knowledge and experience gained.

In the FAB ATM project, the simulation was used to confront the learner’s (often unstoppable) creativity, imagination, preconceptions, and ideas with “reality.” The information was gathered by asking questions and listening to the answers provided by the simulated people, observing their body language and
passing judgment on the degree of trust that could be vested in them, taking notes, 
working with vastly incomplete data and working under pressure of time, and en­
gaging in independent investigation and collaboration with team members and 
the simulated people.

The tasks that specifically demanded learners to invoke their creative problem 
solving can be found across the entire project and the RE lifecycle, but it could be 
specifically located in a number of problem domains, that is, in aiming at busi­
ness/IT alignment, coping with the richness of the stakeholder base, overcoming 
deficiencies of the legacy system, setting requirements for technology reuse, 
dealing with technology selection and innovation, and facing the challenges of 
the imminent business change.

While this blended simulated learning environment (such as that used in the 
FAB ATM project) cannot completely replace student placement in a real organi­
zation, it provides the learners with a safe environment in which they can experi­
ment with different possible outcomes (Cybulski et al., 2006a, 2006b). The FAB 
ATM project adopts a partial view of reality, which can be referred to as “circum­
scribed” reality. Such circumscribed reality simulations attach only key aspects 
of authenticity to their objects and environment. While they sacrifice some 
degree of reality, at the same time, they never cross the threshold of acceptability 
to the learner. The FAB ATM simulation provides learners with rich interactivity, 
which relies on a state machine implemented in Macromedia Flash and which in 
real time combines video fragments of live people to deliver conversational char­
acters with meaningful behavior. While media form and interaction are simple 
for the learner, the complexity is created in the learner’s mind rather than in the 
technology used to support the environment. Finally, any educational computer 
simulation ought to be part of a larger educational framework with many aspects 
of learner experience. Hence, our FAB ATM computer simulation supported 
endogenous constructivism.

In addition, our FAB ATM simulation provided the teacher with an opportu­
nity to be in control of educational outcomes (by defining objectives to be 
reached) and processes (by setting tasks to be undertaken, stages to be completed, 
and methods to be used by learners) and to achieve the comparability of gained 
experience, which is hard to attain in the real-life projects and student placement 
situations. The FAB ATM project provided us with many opportunities to apply 
innovative and effective learning styles (see Figure 11.4). In addition to the tradi­
tional ways of learning by “being told” in lectures, “by discovery” in tutorials and 
“by doing” in projects, the FAB ATM project also provided avenues for learners 
to learn by experiencing work and by taking on professional roles of business 
consultants and systems analysts. All these learning styles are actively pursued 
in lectures (via demonstrations), tutorials (via discussions), and projects (via a 
virtual environment). This is achieved by learners being immersed in an authentic 
and believable simulation environment (such as that used in FAB ATM simula­
tion) and by conducting realistic tasks that allow students to learn “by observing” 
person’s behavior in a complex corporate setting, “by playing” the professional 
roles, and “by communicating” and “by collaborating” with their team members
and with the simulated characters (in both virtual and real contexts). Finally, learners also took on the responsibility of teaching each other in face-to-face meetings and online discussion. The richness of the available learning styles offered RE teachers alternative paths to students’ minds, to the seamless creation of new knowledge and skills, and most importantly, to the effective development of professional experience. Through all these, our learning environment supported elements of endogenous, dialectic, and exogenous constructivism learning and teaching. While in our FAB ATM project, the simulation system simulated a technology innovation project in the banking domain, it was based on the typical RE lifecycle. Therefore, the system has the potential to simulate a requirements project in other domains, for example, to develop requirements for a VE training system.

The blended approach to educating creative systems analysts provided us with an opportunity to arrive at a compromise between educational outcomes (acquiring knowledge, developing skills, embracing creativity, and gaining experience) and environmental constraints (time, costs, labor, and quality). We relaxed the confines of the problem settings to foster students’ creativity and then confronted them with the reality of which rigidity could be overcome only by breaking technical and business dogmas in the creative fashion. By circumscribing the learner’s reality, we used a combination of simulated reality and virtuality to
immerse individuals in the authentic and believable problem situation, yet we were able to control educational outcomes and provide the safety of the protected educational context. We used a variety of media and learning approaches to support the learning process, not only to facilitate students to gain skills, knowledge, and creativity, but also to achieve these objectives creatively.

**CONCLUSION**

This chapter weaves a story of requirements engineering education. As many other good stories, the chapter provides a lesson to learn for the reader, be you a practitioner, an educator, or a student. As the nature of information systems changes, so does the role of systems analysts, who are now required to act not only as human repositories for users' wishes, demands, and requirements, but also to become inventors, innovators, and learners and be the facilitators of such innovativeness and scholarship among their clients and users. Thus, the shift from requirements elicitation to requirements discovery poses new challenges for RE practice, and a major problem is the apparent lack of the creative knack in the systems analysts’ skill portfolio. This is also a challenge for RE educators, who need to expose their students to the authentic and believable situations in which learners can be immersed in realistic problems and in which they can truly experience the processes of domain learning and problem solving and the wickedness of the social and organizational complexities, which constantly redefine the problem and rescope its many solutions. Games, role-playing, and simulations could become part of the answer to the newly posed challenges. However, yet again we may find that it is of fundamental importance for learners and educators to be inventive and open to self-improvement and learning. And so, we, too, need to take the creative path of risk and innovation and to employ new and exciting approaches to using learning and teaching technologies.

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