Introduction to Educational Technology

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Chapter Outline

- Introducing educational technology
- A brief history of educational technology
- The scope of educational technology
- Dimensions of educational technology
- Educational technology perspectives
- Emerging technologies and changing contexts
- Roles of educational technologists.

By the End of This Chapter, You Should Be Able To

- Classify the key concepts and principles of educational technology
- Recall the history of educational technology
- Clarify the scope, dimensions, and perspectives of educational technology
- Reflect on the roles of educational technologists.

Main Learning Activities

1. According to Merrill, Tennyson, and Posey (1992), to teach a concept involves pointing out examples and non-examples, citing a rule or principle or criterion to distinguish examples from non-examples, and providing opportunities to practice and get informative feedback. Given that context and the challenge to teach curious Cathy (an imaginary student) the concept "educational technology," cite three examples and three non-examples of educational technologies that you could show Cathy, and also provide a rule, principle, or criterion which she could use to distinguish the examples from the non-examples.
2. Select six additional items (some example and some non-examples), and ask Cathy to identify which are and which are not educational technologies. In each

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case, write down the formative and supportive feedback you would provide for both a correct and an incorrect response.

3. Suppose you are teaching a group of preservice teachers the first course on technology integration in learning and instruction and the first unit of instruction is on the history of educational technology.

   a. List the topics and concepts that you would include in that unit of instruction. Provide several examples and explain why you would include them.
   b. List the resources that you would make available to those preservice teachers? Provide several examples and explain why you would include them.
   c. State the purpose, scope, objectives, and expected learning outcomes of that unit of instruction.
   d. Indicate how you would determine if the expected outcomes are achieved.
   e. Which pedagogical approach, instructional strategies, and technologies would you prefer to use and why?

1.1 Introducing Educational Technology

1.1.1 Purpose and Scope

Educational technology refers to the use of tools, technologies, processes, procedures, resources, and strategies to improve learning experiences in a variety of settings, such as formal learning, informal learning, non-formal learning, lifelong learning, learning on demand, workplace learning, and just-in-time learning. Educational technology approaches evolved from early uses of teaching tools and have rapidly expanded in recent years to include such devices and approaches as mobile technologies, virtual and augmented realities, simulations and immersive environments, collaborative learning, social networking, cloud computing, flipped classrooms, and more. This chapter provides a historical overview, key definitions and principles, various perspectives and representative developments, all of which will be explored and elaborated in subsequent chapters.

The basic approach in this volume is competency-based. A competency is a collection of related knowledge, skills, and attitudes (KSAs) that enable a person to perform a particular task. There are many tasks that educational technologists perform as part of their role and responsibilities. This primer provides an elaboration of many of these tasks and the associated KSAs that are common in the twenty-first century, while building a grounded rationale for them on the basis of prior work in learning psychology, computer developments, and human–human and human–computer interaction.

Previous educational technology textbooks have focused primarily on knowledge and skills and have not emphasized attitudes and values as strongly as they are emphasized herein. The reason for emphasizing attitudes and values is that they play a critical role in motivation, and motivation is critical to success in nearly every human endeavor and especially critical in the challenging domain of educational technology. The hope is that those who use this primer will develop an attitude exemplified by this statement: "I know we can improve learning, instruction and performance in this situation."

1.1.2 Initial Motivation

Stories and other forms of narrative can be useful in providing context as well as motivation. Here is a story that actually occurred.

This story involves a middle school student (Charlie) who was blind and partially deaf from birth. Charlie wanted to learn to swim during his summer vacation. A volunteer high school student lifeguard agreed to work with this student over a two-month period, three days a week, an hour or two each day. The student lifeguard was told that Charlie probably never would learn to swim but just being in the pool and doing something enjoyable would be good for him. The first week or two served to confirm that advice. Charlie enjoyed being in the cool water on a hot summer day and spent most of the time walking around in the shallow part of the pool, occasionally dunking his head under water with the help of the lifeguard.

After two weeks of getting used to being in the water, Charlie asked in difficult to understand broken words and gestures when he was going to learn to swim. Charlie wanted to swim. The lifeguard then decided to take Charlie's desire seriously, in spite of the parents saying not to try something so difficult for Charlie. The lessons started with kicking strokes with Charlie holding on to the edge of the pool and the lifeguard holding Charlie in a horizontal position. The following week, this was practiced in deeper water away from the edge of the pool. At the end of the first month, Charlie had learned how to say afloat for a few minutes by kicking his legs while in a vertical position in deeper water, with the lifeguard nearby to encourage him. The adult supervisor of the swimming lessons was somewhat surprised at Charlie's progress and encouraged the lifeguard to continue.

To shorten the story, at the end of the second month, Charlie was able to swim, somewhat awkwardly, from one side of the pool to the other—not the length of the pool, just the width which was about 10 m. The last day involved the parents of the children who had been taking swimming lessons. Charlie's parents came and were amazed to see him swim the width of the pool, which was something that no one really thought he would be able to do. Sometimes, one can do more than is expected by others. In this case, the local swimming community (including the lifeguard and swimming supervisor) supported Charlie's strong desire to learn to swim.

The point of this story is to emphasize the role that *desire* plays in achieving outcomes. Desires need to be heard, accommodated, and supported to the extent that is reasonable in a given situation. From the instructor's perspective, the relevant attitude was to help the learner, Charlie, achieve his goal. Teachers and trainers can help learners develop an appropriate attitude—in this case, the desire to master a specific skill (swimming). Teachers and trainers then need to have a relevant attitude as well—namely, "I can help the learner achieve this goal." The challenge is doubly complex for a person training swimming instructors as that person needs to understand and motivate the trainee keeping in mind the variety of students the trainee will need to understand and motivate.

That kind of complexity is what often confronts educational technologists and instructional designers who deal with multiple kinds of people, resources, and situations. The challenges are real, and one goal of this book is to help develop the capacity to respond effectively to many challenges that will occur in a real-world setting.

For the reader or learner: Find and read the "Learning Stories" on the Learning Development Institute Web site located at www.learndev.org (on the left menu, select Focus Areas of Activity and then select MOL or Meaning of Learning, and you can then select Learning Stories). Describe an engaging learning experience of your own [the instructor may ask you to share that experience with others].

1.1.3 Key Concepts

- Attitude—a mental disposition or way of thinking about something (place, person, event, activity, etc.); attitudes are linked to particular believers and their willingness to engage in particular activities
- Competency—a set of related knowledge, specific skills, and attitudes that enable a person to effectively perform a particular task
- Education—systematic efforts to develop (a) basic and specialized knowledge and skills, (b) problem-solving abilities, (c) productive workers, (d) higher-order reasoning capabilities, (d) responsible citizens, and/or (f) lifelong learners (Spector, 2015)
- Educational technology—"the study and ethical practice of facilitating learning and improving performance by creating, using and managing appropriate technological processes and resources" (AECT definition; Januszewski & Molenda, 2008, p. 1); the disciplined use of pedagogical approaches, instructional strategies, media, tools, and technologies to consistently improve learning, instruction, and performance
- Learning—characterized by stable and persistent changes in what a person or group of people believe, know, and are able to do (Spector, 2015)
- Formal learning—structured sequences of instruction in support of intentional learning typically set in an institutional context with explicit goals and objectives (see http://www.oecd.org/education/skills-beyond-school/recognitionofnon-formalandinformallearning-home.htm)
- Informal learning—learning that occurs outside the context of a formal setting; examples include field trips, museums, and incidental learning in the context of everyday activities; some informal learning activities and experiences are intended to complement or supplement formal learning experiences and activities (Spector, 2015)

- Instruction—which is intended to support, facilitate, or enhance learning and performance (Gagné, 1985; Spector, 2015)
- Instructional design—the planning, creation, refinement, selection, sequencing, managing and evaluating activities and resources in support of targeted goals and objectives (Spector, 2015)
- Intentional learning—goal-oriented, purposeful learning common in formal learning, and workplace learning situations
- Lifelong learning—learning that is ongoing through an individual's life; it is typically voluntary, self-selected, and self-regulated; such efforts may be associated with personal interests or professional goals (sometimes called life-wide learning)
- Media—a means of representing, presenting, disseminating, and storing information in a variety of formats, some of which may be digital
- Multimodal resources—resources that exist in multiple formats and modalities including text, audio, video, animations, graphics, simulations, and virtual and augmented realities; also known as multimedia resources; the explosion of multimodal resources in the digital era has created a need to develop information, technology, visual literacy, and digital literacy in addition to traditional language literacy
- Non-formal learning—a form of learning that exists between formal and informal learning that is typically somewhat structured, may have goals, and is often associated with organized activities; much adult learning falls into this fuzzy category which includes such activities as cooking, dance, and reading clubs (see http://www.oecd.org/edu/skills-beyond-school/recognitionofnon-formalandinformallearning-home.htm)
- Technology—the practical and purposeful application of knowledge (a traditional definition linked to the etymology of the term from the Greek—*techné*, or skill, and *logos*, or reason); popular usage involves physical things as in smartphones, tablet computers, interactive whiteboards, and so on; in the context of educational technology and consistent with the AECT definition, it is the use and application of knowledge in the form of technology, media, procedures, and resources to support various aspects of learning, instruction, and performance that comprise the focus of educational technology.

1.1.4 Relevant Principles

- People learn what they do; this principle is derived from behavioral psychology (e.g., reinforcing a desired behavior makes it more likely to recur) and finds support in neural science (e.g., when an action is repeated often, the neural connections in the brain associated with that action are strengthened, making it more likely to recur in the future); an implication of this basic principle is that learning activities should be designed with desired future performance in mind.

- The more time a person spends on a learning task, the more likely that person is to master the task.
- Providing timely and informative feedback while a learner is engaged in a learning task is likely to facilitate mastery of the task.

These principles are integrated throughout this book and will hopefully become second nature to you as an educational technologist. In addition, it is well established that prior learning is generally predictive of future learning—that is to say, that learners who have struggled with a subject in the past are likely to continue to struggle. This implies that being aware of a learner's prior experiences and performance can help an instructor develop appropriate learning activities for that learner. Moreover, technology can play a key role in helping an instructor develop personalized and individually appropriate learning activities, as will be discussed in a later chapter.

1.1.5 Defining Educational Technology

The term "educational technology" is widely used within the education profession as well as in the general population. It might seem like there is no need for a definition of such a commonly used term. However, such an assumption might be made for the everyday use of the term "philosophy" and many other terms that identify areas of scholarly pursuit. As it happens in most of those cases, the various professional and scholarly communities have provided a specific definition of the term as a way to clarify the aims and scope of the discipline. In this case, we begin with the definition provided by the Association for Educational Communications and Technology (see www.aect.org): "the study and ethical practice of facilitating learning and improving performance by creating, using and managing appropriate technological processes and resources" (Januszewski & Molenda, 2008, p. 1).

In elaboration of the AECT definition, we note that designing, adapting, customizing, implementing, testing, deploying, and evaluating resources, activities, and learning and instructional tools intended to facilitate learning, performance, and instruction are included within the scope of the discipline. In addition, we emphasize the notion of *practice* in the definition for two reasons. First, it is directly aligned with the basic Greek derivation of the first term, *techné*, involving the notion of skill. Second, throughout this volume there will be an emphasis on the *effective use* of a technology to support or facilitate learning, performance, and instruction. That notion aligns particularly with the second term, *logos*, involving the notion of reason. In ordinary terms, one might then say that educational technology involves the reasoned and effective use of technology to support or facilitate learning, performance, and instruction.

For the instructor: Ask, for examples, of educational technologies and then ask how an example satisfies or fits the definition above.

The popular use of "technology" is in reference to physical things or things that one can touch, see, hear, taste, or smell. In computer science, the term "technology" often refers to both hardware and software, both of which can in principle be perceived one way or another. The AECT definition is not restricted to physical things or things that are perceivable as it refers to both processes and resources. Both will be discussed in this volume, consistent with the AECT definition. In many cases, however, we will use a separate term to refer to a process or collection of processes, such as *instructional design* or a *pedagogical approach* or a learning strategy all of which can be considered specific kinds of processes, with examples such as problem-based learning or flipping the classroom or hands-on training

While many will associate *learning* and *instruction* with education, some might wonder why the definition includes *performance*. Definitions of "learning" and "instruction" are needed to make the inclusion of performance obvious. Learning is characterized by stable and persisting changes in what a person or group of people believe, know, and are able to do (adapted from Spector, 2015). Intentional learning is purposeful and goal-driven, which is common in formal learning situations. Instruction is comprised of those things and processes that are intended to support, facilitate, or enhance learning—intentional learning in this context (Gagné, 1985; Gagné & Merrill, 1990; Merrill, 2002, 2013; Spector, 2015).

The performance of learners is used to establish that a stable and persisting change has occurred, which is one reason to include performance within the purview of educational technology. It is an effective use of a technology that matters, and improving what learners know and can do is an indication of an effective use. Moreover, because an instruction consists of all those things aimed at improving learning, including those involved in designing and supporting learning, their performance is also relevant to the discipline of educational technology (Merrill, 2007, 2013). A well-designed device or artifact used poorly or improperly by a teacher is not likely to support learning. Teacher performance and, as a consequence, teacher preparation and professional development in technology use are important. Likewise, a poorly designed learning environment may contain a wealth of information and resources, but a poor design can easily inhibit an effective use. As a consequence, the performance of instructional designers is also relevant to educational technology. Moreover, there is a discipline called "performance technology" associated with human resource management (see http://www.bptrends.com/publicationfiles/02-06%20WP%20HPT%20-%20Tosti.pdf).

Associated with the notion of performance in the context of effectiveness is the notion of efficiency, which can be linked to productivity. Both effectiveness and efficiency can be applied to learners, teachers, and designers (also to administrators, support personnel, and policy makers). Later in this volume, a great deal of emphasis will be placed on effective learning and things that are likely to contribute to effectiveness, such as learner motivation, engagement, empowerment, and timely and meaningful formative feedback.

For the learner: Start an educational technology journal or diary (on paper or in digital format), and entitle a first entry "a memorable learning experience that I consider effective, efficient, and engaging." Identify things in or about that experience that are likely linked to its effectiveness. Can those things be introduced into

Table 1.1 An elaboration of educational technology

Education	Technology	Resources and processes
Aimed at developing basic knowledge and skills, productive workers, effective problem solvers, reflective thinkers, and/or lifelong learners	The reasoned and effective use of resources and processes to support learning, performance, and instruction—broadly understood to comprise education	Tools and techniques as well as devices, artifacts, learning environments, and the processes involved in designing, developing, deploying, evaluating, and managing are included

other learning experiences for other learners in different situations? If so, briefly elaborate and give an example.

In summary, it is the effective use of technologies, tools, techniques, resources, and processes to support learning, performance, and instruction that is the focus of the discipline called educational technology. Table 1.1 provides an overview of this discussion.

For the instructor: Ask students whether or not the slide rule is or can be an educational technology (see http://www.computerhope.com/jargon/s/slide-rule.htm).

1.1.6 A Brief History of Educational Technology

Learning is a natural ongoing process that occurs in organized situations as well as in everyday activities. As such, the history of learning is coincident with the history of human beings. Teaching also has a long history that is roughly coincident with the history of human families and tribes. Various tools and techniques have been used to support teaching and learning throughout the ages, so one can also conclude that educational technology has a very long history (Spector & Ren, 2015). It is common to divide human history into broad periods or epochs such as the primitive period, the agricultural period, the industrial period, the information age, and the emerging era of the intelligent society (see the last chapter in this volume for more on this emerging era).

Early in human history, it is likely that actual objects were used to support learning. For example, an elder teaching a young child to hunt might use an actual spear to support helping the child learn to aim and throw, perhaps initially at a tree rather than at an animal. The abacus was an early calculating device used to keep track of inventories, and its use had to be trained as responsibility shifted from one person to another.

For the learner: Compare the abacus (see Fig. 1.1) and the slide rule (see https://en.wikipedia.org/wiki/Slide_rule) with regard to functionality and periods in which they were introduced. Reflect on their use and how others were trained to make use of them. What is especially noticeably different about using an abacus to make a calculation and using the slide rule to make the same calculation?

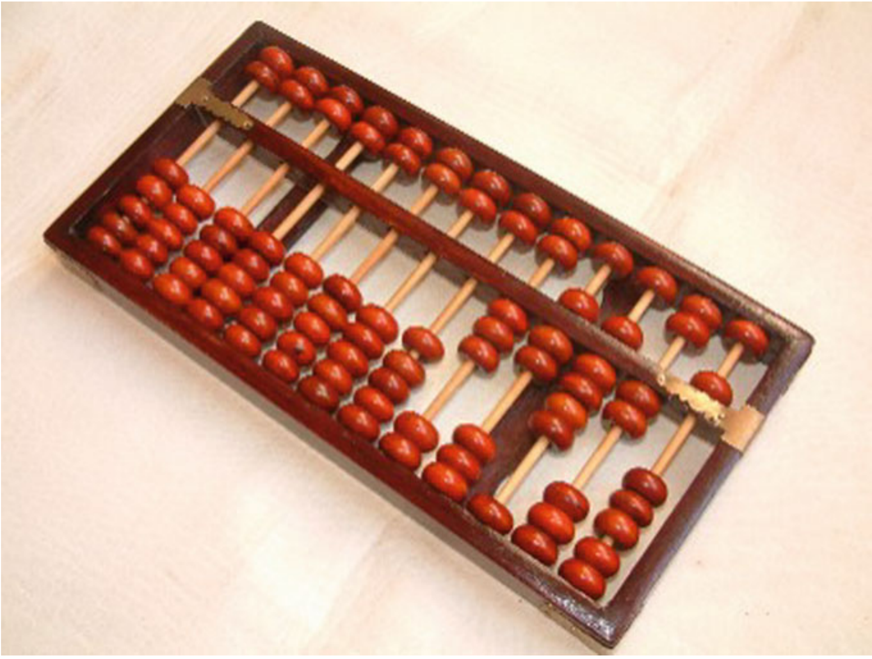

Fig. 1.1 A typical abacus calculating device

From very early times, records were kept and histories were recorded on scrolls and in pictographs that were used to teach each new generation things that had transpired and that might affect their futures. People learned trades on-the-job using actual tools for many years; apprenticeship and on-the-job training remain in use in many fields.

The invention of the Gutenberg printing press in the fifteenth century made it possible to share information and knowledge with a much wider group of individuals than had previously been the case. Its use had become widespread in Europe by the sixteenth century, and books became a primary resource used in many educational settings. It is worth noting that it took a hundred years or so for the printing press technology to be widely adopted. How long did it take smartphones to become widely adopted? The printing press transformed learning and instruction as well as social, political, and economic arrangements, although it took a couple of hundred of years for those transformations to occur. Are similar transformative effects likely to occur on account of new and emerging technologies?

For the instructor: Conduct an in-class or group discussion of the rate of adopting a new technology in terms of planning for a new technology and then its introduction into a context to the time it takes to make an effective use of that technology.

In the nineteenth century, non-text media arrived with the invention of the daguerreotype (early camera) in 1839 and wireless transmission of electromagnetic waves (early radio) and the kinetoscope (moving pictures) in the 1890s (Spector & Ren, 2015). The twentieth century is when technologies to support learning, performance, and instruction rapidly increased, with television and animations in the first half of the century and computers and the Internet in the second half of the century (see Fig. 1.2).

What can be concluded based on this brief history? It is obvious that technologies change. Technologies are changing at an ever-increasing rate. Will this rapid rate of change continue? If so, what are the implications for educational technology in the remainder of the twenty-first century?

Technologies change what people do. Many have said that the printing press changed education. Prior to the introduction of printed books, education was limited to small groups of specially selected people, and training was conducted in a one-to-one or a one-to-a-few setting, typically in the workplace or in the presence of a teacher/mentor. Books brought information to the masses and made it possible to have larger groups involved in education and to supplement training with materials that could be studied outside the workplace. Formal learning became more standardized as well as more available. From Plato's Academy established in Athens circa 387 BCE with a small number of students to the Martin Luther University of Halle-Wittenburg established in 1502, there was a change from a small group of students following one teacher's oral teaching to a public institution with students following multiple teachers and using standard texts.

Technologies change what people can do. As new technologies emerged, it became possible to represent information and knowledge in many forms, including pictures, graphics, animations, and movies. Multiple modes of representation have emerged. In addition, multiple forms of communication have also emerged. In addition to one-to-one and one-to-many face-to-face communication modalities, there are multiple forms of digital communication, including Internet chat rooms, videoconferencing, discussion forums, social networks, and more.

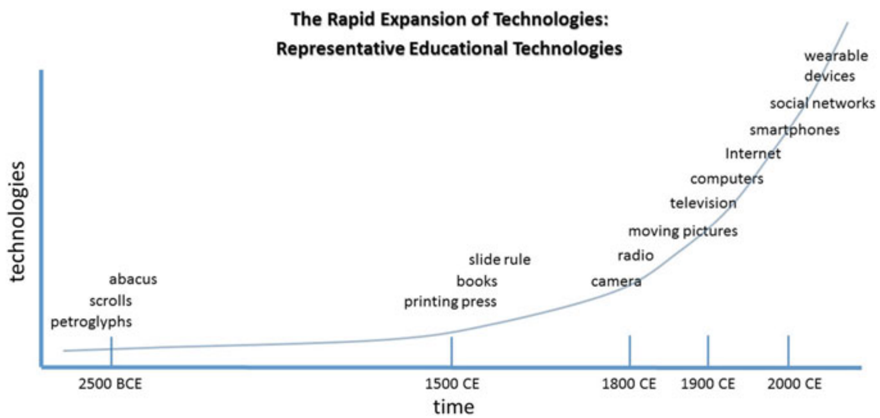

Fig. 1.2 Rapid expansion of educational technologies

For the learner: Make and date an entry in your educational technology journal entitled "Leading Educational Technologies in Use Today." Then, make a second entry entitled "Anticipated Educational Technologies of the Future" and describe at least one of those (read recent Horizon Reports from the New Media Consortium located at www.nmc.org).

Technologies also change what people want to do. As more and more resources became available, especially at the end of the twentieth century, many people began pursuing areas of personal interest, and there has been a steady growth in informal learning as a consequence. Many students now want to experience things in school that are relevant to the kinds of jobs and careers they plan to pursue. Students who have smartphones and use them outside school want to be able to use them in school as well, often to the dismay of teachers and possible disruption of intentional learning activities.

In keeping with the principle that people learn what they do, David Merrill (2002, 2007, 2013) has described instructional things that are likely to promote desired learning outcomes. Merrill argues that instruction should be centered on meaningful and realistic problems, which was probably the case for those being trained to use an abacus or slide rule. In addition, the instruction can be described in terms of four kinds of things: telling, asking, showing, and doing.

For the instructor: Conduct an in-class or group discussion relating Merrill's first principles of instruction to Gagné's (1985) nine events of instruction (see http://edutechwiki.unige.ch/en/Nine_events_of_instruction). Which of Merrill's principles and Gagné's events are evident in this chapter?

In general, there has been a shift in emphasis in formal learning situations to include more *showing* and *doing* and somewhat less *telling* as a result of the powerful technologies now available. While it seems like the best of times in terms of what can be done to use technologies to effectively and efficiently support learning, performance, and instruction, it may seem like the worst of times for those who are charged with designing, maintaining, and sustaining the technologies used to support learning. Instructional designers have many more options in choosing resources and support mechanisms than ever before. Establishing what works best with whom and in various situations is more difficult than ever before. Cost models are dynamic, in part because technologies are now rapidly replaced by newer technologies. Training teachers to make effective technologies that change so rapidly is an ongoing challenge.

For the learner: Recall the activity to describe making a calculation with the abacus and the same calculation with the slide rule. What difference did you note? Someone might argue that to make an effective use of the slide rule, one first needed to have an expectation about the range for a reasonable solution since it is very easy to misalign the cursor line on the slide rule and make a big mistake as a result. The act of reflecting in advance on the problem and a reasonable answer might be considered a learning activity or a form of asking oneself. Make an entry in your educational technology journal on the learning value of reflecting and instructional value of asking as a means to encourage reflection. Provide an example based on your own experience.

Edsger Dijkstra in 1972 argued that computers had yet to solve a single problem; they had only introduced the new problem of learning to use them effectively. That claim seems especially applicable to educational technology in light of the history and the recent explosion of new technologies. The reason for including a brief history of educational technology is not to highlight how far the discipline has come. Rather, it is to remind those entering the discipline and contributing to its continued growth and success that:

- It is seldom the case that there is one right solution or approach to a learning problem or situation involving educational technology, especially given the rich variety of situations and technologies.
- What worked for Plato in his academy may not work well in a twenty-first-century school; it is clear that what people call the Socratic method and then praise did not work out that well for Socrates (Plato's teacher) given how the citizens of ancient Athens reacted (for those not familiar with Socrates, he was jailed and executed due to his peripatetic teaching; the city leaders accused Socrates of corrupting the youth).
- Planning for the effective and efficient use of educational technologies involves planning for the future replacement of a particular technology and the resources, processes, and pedagogical approaches associated with that technology.
- Planning for the future is especially challenging given the rate of change in available technologies; however, educational technologists should plan for the future and subsequent chapters in this volume will suggest new technologies that are emerging and what their impact might be (spoiler alert—smart learning environments and personalized learning may be coming soon to a theater near you).

For the instructor: Direct the class to the UNESCO Web site on education for the twenty-first century (see http://en.unesco.org/themes/education-21st-century) and discuss the ways, means, and implications of what UNESCO is recommending.

1.2 The Scope of Educational Technology

The scope of educational technology is quite large as it involves the application and practice of using technologies (in the form of tools, techniques, resources, processes, etc.) to support, facilitate, and enhance learning, performance, and instruction. While educational technology has emerged as a recognized discipline and profession in the last 50 years, it is a dynamic, complex, and interdisciplinary enterprise. It is dynamic in part due to the rapid changes occurring in technology. It is complex due to the many interacting factors, components, and people involved in an education system or learning environment; moreover, many of the relationships among those factors, components, and people are nonlinear and change over time. Educational technology is inherently an interdisciplinary enterprise involving, among others, content experts, technical specialists, teachers, and administrators, who have different backgrounds and formal training. For an elaboration of a curriculum for advanced learning technology, see Hartley et al. (2010).

For the instructor: Before discussing education systems, consider a class discussion on the notion of a person as a system—that is to say, a collection of related and interacting components with different kinds of relationships among those components. Consider identifying subsystems and discussing one or more of those in some detail. If possible, identify delayed effects within the human system as well as nonlinear relationships among some of the components.

One way to elaborate the scope of educational technology is to consider the life cycle of a representative education system or learning environment. First, consider that you have vacation time coming and you and your family are discussing where to go and what to do on the vacation. How might that discussion proceed? You might begin with wishes and desires, or you could begin with constraints (time, money, distance, etc.). Either way, the discussion has to start somewhere and both kinds of considerations are relevant—desires and constraints. In a sense, both of those considerations are likely to narrow the choices. At some point, the discussion might involve specific activities or sites or experiences that could become the basis for some consensus. Each person involved is voicing a point of view and expressing an opinion. In such a situation, it is quite natural to include those involved in the discussion to ensure that the vacation will be as successful as possible. Compromises are likely to occur as the discussion evolves. When a decision is reached, it might then be desirable to distribute the various tasks associated with implementing the decision (e.g., making reservations, collecting and packing appropriate clothes, notifying friends). Keep vacation planning in mind as a model as the much more complex enterprise of educational technology planning is elaborated.

For the sake of this discussion, let us suppose that a new course has been mandated for all high school students—namely formal and informal logic. There is no requirement to have any knowledge about the subject of logic to follow this discussion. Indeed, an educational technologist recruited to support the effort might well have no subject matter knowledge at all. How might the process evolve? The sections that follow indicate some of the concerns, questions, activities, and processes that might be part and parcel of the life-cycle planning and support of this course from the perspective of educational technology. It is worth noting [and probably worth discussing/challenging in class] that some form of technology is involved in nearly every course, so this discussion naturally involves educational technology. The perspective represented below is not necessarily what is typical when a new course is being planned. In many cases, the content expert or teacher is the primary person leading the way. However, the more that technology is critical for the effort and the larger the scale of the effort, the more important it is that educational technologists and instructional designers play leading roles.

1.2.1 Needs Assessment

How to begin planning support for a new course in formal and informal logic for high school students? Let us suppose that you, the educational technologist in the role of instructional designer, are at the initial planning meeting for this effort, along with a logic teacher, a school administrator, and a system specialist. The administrator begins by stating the mandate—namely, create a new course on formal and informal logic and implement it using the school's learning management system, since the course will be conducted entirely online anytime in the student's last two years, at the students' pace, and required for graduation.

The logic teacher is excited that the subject is receiving such special treatment. You are concerned, however, about the rationale and motivation for the course. You ask, "Who decided that this should be done? How was the need determined? What problem are we trying to solve?" The administrator is prepared and offers the results of a study of graduates and their successes and failures over a five-year period. The administrator called this an exploratory effort to find out how well graduates were doing. As it happened, the study showed that of the 73% of graduates who went directly to college, 57% of them dropped out during the first two years. Surveys suggested that most of those who dropped out felt unprepared for the rigors of college. Follow-up interviews suggested that the lack of preparation involved the challenges of thinking critically and logically required in many of the college courses. You respond by saying that it was wise to conduct that study, which is one kind of needs assessment. The study in effect identifies a gap in high school education. Those in the room readily agree that this gap exists and that it should be addressed.

This example shows a progression from a symptom (high school students entering college drop out at a high rate) to a problem (a gap in preparing high school students to think critically and logically) to a need (address that gap with a new course aimed at developing general reasoning skills). A needs assessment is a way to identify symptoms and likely underlying causes resulting in a clear and coherent statement of the problem to be addressed. It is important to spend time and effort in determining the problem and associated need to avoid unnecessary rework or solving the wrong problem. The remaining life-cycle aspects will be addressed in turn, as this discussion is intended to be introductory and notional. Special emphasis has been placed on needs assessment as that is a critical first step.

1.2.2 Requirements and Feasibility Analysis

Once the problem and need have been identified, the goal or goals of the effort can be identified. These goals also form the basis for determining the degree to which the effort is succeeding once a solution is developed and deployed. It is now possible to begin considering solution approaches and a solution. This can and should be done with the desired goals in mind, as that is how the solution will be evaluated and success determined. A requirement analysis creates a framework for a solution approach.

In this case, it was determined that there was no room in the daily schedule of courses conducted in the school setting for a new course. The school happened to have an online learning management system, and the system administrator indicated that it could be used to host a new course. The logic teacher indicated that the content could be delivered online, including practice with feedback, although the formal tests should take place in a monitored situation at the school. Two tests were proposed, one for the first half of the course on formal logic and a second one for the second half of the course on informal logic. Both tests had to be passed in order to pass the course. Passing would involve a grade of 80% or better on each test, with possibilities for remediation and retesting.

It seems that many decisions had already been made prior to bringing the educational technologist on board. This is not so unusual and has led one of the authors to specify the Universal Underlying Principal of all Systems (including education systems; UUPS—pronounced "oops"): Something has already gone wrong. When a project begins and the educational technologist joins the effort, it is not uncommon for the educational technologist to believe that a bad decision has already been made. Sometimes, it is due to the lack of a needs assessment (not so in this case). In other cases, it is due to a particular solution or solution approach being mandated that is not necessarily an optimal way to address the problem. Perhaps having a self-paced online course with automated feedback on progress and little or no collaboration is not what you believe best in this case, so you raise the question —why that particular approach while recognizing the need to offer the course online and outside the normal day-to-day schedule? The administrator then responds that doing it as a self-paced online course with automated feedback will allow it to be offered to other students not at this school who sign up at a cost. Doing it that way can generate revenue for the school.

You then note that this was not part of the identified need or problem being addressed. In a way, this is what planners and implementers call *mission creep*—expanding the scope of the effort as it evolves. The first corollary to UUPS is that mistakes and oversights rarely occur alone; one often leads to another. You point this out to the administrator and say that there then needs to be added a second need—generating revenue—along with a second goal and outcome measure.

When asked if you can design and develop such a course in collaboration with the content expert, you say you believe so, but you will need to learn more from the content expert and the system administrator. That follow-on deliberation can be considered an early feasibility review of the requirements now in place. Once a simple prototype is constructed early in the design process (Rossett, 2009), a more robust feasibility study can be conducted to confirm that what has been planned can indeed be accomplished.

For the learner: Three corollaries to UUPS have been identified: (1) Mistakes rarely occur in isolation; one tends to lead to another; (2) resources are nearly always inadequate to do what you believe should be done; (3) others generally have good ideas. Were any of these corollaries evident in the example of creating a new online logic course? If so, describe how. If not, indicate how they might have been brought into that discussion.

1.2.3 Design/Redesign

Designing and planning learning activities, selecting and sequencing resources, creating units of instruction, and determining formative and summative assessments are typical tasks to be accomplished as a course is being designed. The big three issues for those planning and implementing courses are: (a) What to teach (content to be learned), (b) how to teach (strategies and activities to promote understanding and mastery), and (c) how to identify things to do differently (evaluation of the course with the potential to improve subsequent versions).

To guide these activities, it is useful to have an overall approach in mind along with associated instructional strategies. At this stage, very close collaboration with the context expert is required. While the content expert is likely to understand what is to be learned very well, it is not as likely that a content expert will understand how best to promote the desired learning. Determining the assumptions being made by the content expert is important as some of those assumptions might require confirmation or turn out be without foundation. Moreover, a content expert will often have a desire to do much more than can be realistically accomplished and may well have a different goal in mind than the one established at the beginning. For example, a content expert may unwittingly want students to become dedicated scholars in that subject area, which was not the original goal. Keeping focused on the goal and desired outcomes is an ongoing challenge. A creative educational technologist can elicit from content expert ideas about innovative activities and learning experiences tightly connected with the specific goals of the effort.

Content experts have a tendency to include the full breadth and depth of their knowledge, while an educational technologist or instructional designer is generally trained to stay close to activities, content, and resources directly aligned with desired learning outcomes. Awareness of these different perspectives is important. The attitude of a content expert might be expressed in this way: “I want my students to love this subject area just like I do.” On the other hand, the attitude of the educational technologist might be expressed as follows: “I want students to succeed in attaining the targeted learning outcomes.”

There are many approaches that can be used in a course. In the logic course case, the overall approach has been partially predetermined—namely a self-paced online approach with primary interactions taking place between an individual learner and the learning system. Within that general approach, there are opportunities for a variety of instructional strategies, ranging from a didactic and expository strategy (present content, provide practice cases with feedback, quiz, etc.) to a problem-based strategy (start with problems and have the learner explored the resources to find a solution). There are also variations of how much learner control to include and when it is desirable to include learner control of such things as problems, topics, resources, and so on. Finding an approach that best fits a situation is a typical challenge for an educational technologist.

Many important decisions occur during the planning or design phase, and it is desirable to see what others think about those decisions. Another corollary to UUPS is this: Others frequently have good ideas. In this case, a second content expert might be invited to offer a perspective and students who have had a similar course could be invited to offer a student perspective. Since the course is being designed to help high school graduates succeed in their first few years at college, it might also be good to involve college instructors who have lots of students dropping out due to poor reasoning capability. Because part of the design process involves selecting resources and activities, prior to fully developing those resources and activities it might also be wise to have input with regard to the meaningfulness and appropriateness of those things. Finally, part of the design process involves specifying how the user interface will work, so having input on the interface in terms of usability and learnability prior to committing resources to development is also a good idea.

During the design phase of an effort, or sometimes earlier, it is generally a good idea to create an implementation plan to guide development and deployment and an evaluation plan that includes both formative and summative evaluations. Many funded efforts require that such plans are submitted with a project proposal.

1.2.4 Development

Once a design has been specified, it is possible to begin developing and implementing the course. The implementation plan can guide this process. This development process is likely to involve the content expert and a number of specialists (e.g., a media specialist, a programmer, and a system specialist). By this point in the development of the course, a number of constraints probably had to be addressed and compromises made, which should be documented. Another UUPS corollary is that resources are seldom adequate to do what you and team believe should be done. Compromises are often necessary. However, what should rarely be compromised is the intended goal of the effort.

Since a number of highly trained people are involved, it is again wise to proceed in steps, beginning with a working prototype that includes parts of all major components including the interface. Once such a working prototype has been developed, it can be tested internally, just as the design was tested one or more times before being passed on to development. This iterative process of design and development is sometimes referred to as design research (Reeves, 2006). This iterative process of refinement can continue into the deployment phase as data on use by students become available.

A point worth emphasizing is that each of these activities is seldom a one-time-and-done kind of thing. It may happen in the evolution of the logic course that the automated feedback mechanisms are not working as they should, or perhaps the system is losing track of learner progress through the various modules. Any number of problems with the implementation can be discovered and addressed during development. A variety of educational technologists are likely to be involved during development (see the roles of educational technologists below). Coordinating their various efforts is a challenging task and one that best resides with the lead educational technologist or instructional designer (not the content expert nor the system administrator).

1.2.5 Deployment

Prior to full-scale deployment on a school-wide or larger basis, it is generally wise to try out the course with a small but representative group of students, including both high-performing students and those who are not doing as well. It is likely that such a trial field test will result in a need to make changes in the design and/or the development of the course. Again, this is a step in a design research approach and it should be well documented, as should each step in this evolving process.

Finally, the course goes live. Is the work of educational technology now done in this case? If you said yes, do not pass, go, or leave the room—there is much more work yet to be done.

For the learner: What else do you think needs to be done for the newly created logic course to be considered a success?

1.2.6 Management

It is likely that the emphasis will shift from the educational technologist to the system administrator and the content expert who will monitor progress and report problems back to the educational technology team should they occur. Plans should be made to (a) monitor student progress, (b) gather and report student performance outcomes, perceptions, and reaction, and (c) track students subsequent to graduation. In some cases, it is required to have a management plan in place; for large-scale efforts, such a plan is advisable even if it is not required.

1.2.7 Evaluation

Once the course is deployed, the natural question to address is whether or not it is achieving its intended goals. To what extent are goals being met? That question is what drives a summative evaluation of the effort—or periodic summative evaluations of the effort. It was mentioned earlier that documenting the effort as it was being designed, developed, and deployed was important. That documentation and associated observations and interviews with key persons as the effort evolves constitute what can be considered a formative evaluation of the effort, again consistent with a design research approach. It is often difficult to interpret the findings of an impact study or summative evaluation without the results of a formative evaluation. An evaluation plan typically includes a formative evaluation plan (e.g., a fidelity of implementation study that typically documents progress and includes interviews and observations) and a summative evaluation plan (e.g., an impact study). As mentioned previously, an evaluation plan is often developed early in the effort. In this case with the online logic course aimed at improving reasoning skills to help high school graduates succeed in college, the impact study needs to involve graduates several years after they have completed the new course.

1.2.8 Support

Support for an educational technology effort runs throughout the process. Determining support requirements and needs occurs early in the process. Identifying key personnel and training them begin early and continue throughout design, development, and deployment. Educational technologists as well as system specialists, programmers, and various staff are likely to be involved in providing support for the online logic course. Students need to know whom to call when they encounter problems. In this case, if the problem involves logic and solving problems, then a tutor might need to be identified and trained.

1.2.9 Training

As previously suggested, identifying training needs and then helping prepare and implement training materials and sessions are important in ensuring the success of an innovative educational technology project. Tutors and staff support personnel obviously need to be trained in order to properly support the new course. Moreover, training students in the first week or so of the course might be required in order to ensure that students know what is expected and can perform all of the necessary actions and activities required in the course. Many innovative educational technology projects fail due to poor communication and inadequate preparation and training of key personnel (Rogers, 2003).

1.3 Dimensions of Educational Technology

Not only is educational technology a multi-disciplinary enterprise but is also multifaceted, having a number of dimensions to take into consideration in light of the processes discussed above and the roles to be discussed below. One of the things that makes educational technology such an interesting profession is the diversity of people, problems, needs, technologies, and solutions that are involved. If one thrives on challenges and complexity, then educational technology is well worth pursuing.

Hartley and colleagues (2010) conducted a three-year study aimed at developing a curriculum for advanced learning technology. Among the dimensions of practice and scholarship relevant to the field, they cited the following:

- Computer and software architecture and engineering
- Design research
- Human–computer interaction
- Learning psychology
- Program evaluation
- Project management
- Social interactions
- System thinking.

Another way of conceptualizing the dimensions of this complex and multi-disciplinary discipline is in terms of the activities, processes, and things with which educational technologists are commonly involved, as in the following brief overview.

1.3.1 Communication/Coordination

When conducting the research to establish competencies for professionals involved in various aspects of educational technology, the International Board of Standards for Training, Performance and Instruction (ibstpi) found that the most critical skill area was communication (see the various standards located at http://ibstpi.org/). Communication competency includes oral, written, and aural skills as well as the ability to make an effective use of various communication modalities and representation forms. Along with effective communication skills are associated coordination skills (e.g., collaborating, compromising, managing, leading). Unfortunately, very little effort is placed on developing communication and coordination skills in many academic programs where the emphasis tends to be on mastering the subject matter. We consider it a myth that people are born with a golden tongue or gift of gab or leadership skills. Those skills can be trained and developed and are among the competences recommended by Hartley et al. (2010) for those being trained as advanced learning technologists.

1.3.2 Content/Resources

With the advent of the Internet, the resources that educational technologists and content experts can access for inclusion in a learning environment are enormous. One way to capture the complexity of this dimension is in terms of a hierarchy that begins with information resources at the base of a pyramid (see Fig. 1.3). Information that has been determined to be reliable and accurate can be considered knowledge and a candidate for inclusion among learning resources. When that

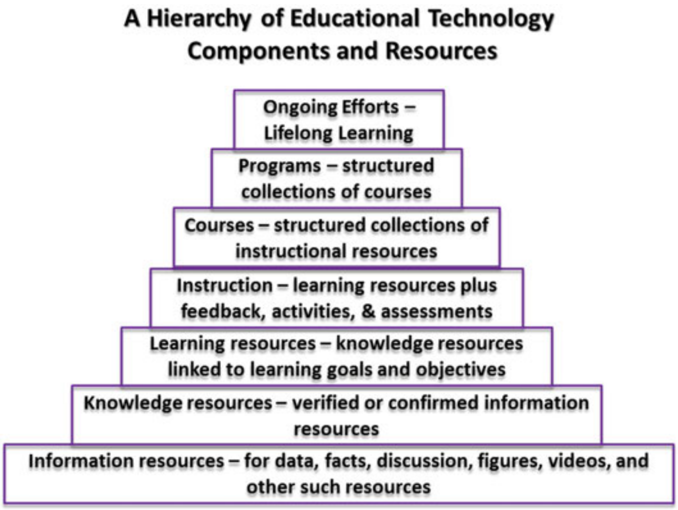

Fig. 1.3 A hierarchy of resources. Adapted from Spector (2015)

knowledge is linked to a learning goal or objective, it can be considered a learning resource. When activities, feedback, and assessment are included with a learning resource, it becomes an instructional object or resource.

1.3.3 Hardware Devices and Software

In addition to having to deal with so many learning resources, educational technologists have to be familiar with, understand, and/or manage a wide variety of devices and associated software. If one focuses only on a computer to be used as the primary delivery or support device, then there are still many things to take into account, including a variety of workstations, personal computers, tablet computers, handheld computers, and so on with various operating systems, software, network configurations, cloud-based systems, and more. One might say that the price of competence as an educational technologist is nearly constant professional development. Openness to new possibilities created by the affordances of new and emerging technologies is required for an educational technologist to maintain currency and relevance as a professional practitioner.

1.3.4 Implementation

Educational technologists not only need to know about and understand how people learn and the resources and devices that can support learning, they need to know how to do a variety of things to make support for learning real and effective (Hartley et al., 2010). In some cases, this may take the form of transferring a reliable text-based resource into a visual form. In other cases, it may require the inclusion of support for discussion forums and chat rooms. In still other cases, support may require the collection and analysis of learner actions and inputs. In a general way, educational technologists need to understand what teachers, students, and support personnel do in order to provide appropriate tools and technologies to help make them more effective and productive in their various activities. An interesting in-class or online activity or discussion could involve a response to these questions: (a) What kinds of learning experiences exist? (b) Who are involved in supporting learning? (c) What kinds of things can be done using technology to support all those involved in learning, performance, and instructional activities?

1.3.5 Media and Representation Formats

Along with the explosion of resources available on the Internet have come a wide variety of representation formats. As the educational technology timeline suggests, text, pictures, audio, and video occurred were dominant in the nineteenth century and first half of the twentieth century. Within each of those media categories, there were a variety of types, such as black and white photographs, graphs along with text, and so on. With the advent of computing and the Internet, the ways and means of representing knowledge resources grew dramatically. Perhaps, a dramatic way to represent the rich variety of representation formats is with the painted scroll from the Song dynasty called "Along the River During the Qingming Festival" attributed to Zhang Zeduan circa 1100 CE (see The China Online Museum located at http://www.comuseum.com/painting/famous-chinese-paintings/along-the-river-during-the-qingming-festival/). The Web site shows a progression of replicas of the original scroll that was more than 5 m in length, culminating with an electronic animated 3D version that is more than 150 m in length and put on display in 2010 at the Shanghai Expo.

1.4 Educational Technology Perspectives

As previously referenced, the work by Hartley and colleagues (2010) on developing a curriculum for the broad domain of advanced learning technologies resulted in important foundation work pertaining to understanding the knowledge, skills, and competencies required of educational technologies. Their work involved numerous surveys of professionals and academics, a detailed review of the research and practice literature, interviews, and focus group discussions over a three-year period. Because the goal was to create a curriculum framework, it was deemed appropriate to adopt a competency framework. As results were compiled, five clusters of related competencies emerged:

1. Knowledge competence domain—as should be obvious at this point in the discussion, an educational technologist has to have well-developed knowledge in a number of areas, including learning psychology, human–computer interaction, social psychology, instructional design, software engineering, technology integration, and so on.
2. Process competence domain—understanding what is possible with regard to a variety of devices and software is critical for an educational technologist; maintaining an up-to-date understanding of what can and cannot be done and at what cost and with which expertise is expected of an educational technology professional.
3. Application competence domain—educational technologists are often responsible for *making things happen*, such as taking the specification for a learning environment or course and translating that specification into a reality; that ability requires competence in a number of application areas, including the creation of media resources and assessment mechanisms.
4. Personal and social competence domain—the work of educational technologists offers within the context of a team involving persons with different backgrounds and expertise; as previously indicated, effective communication, collaboration, and coordination skills are critical for success as a professional practitioner.
5. Innovation and creativity competence domain—new technologies and approaches to learning create a need for professionals to be flexible and creative in making use of appropriate resources and technologies to achieve desired outcomes; this often involves significant changes in learning activities, teaching methods, and instructional designs.

1.5 Emerging Technologies and Changing Contexts

One of the basic beliefs guiding this volume involves change. Learning is characterized by stable and persisting changes in what a person or group of people know and can do. Monitoring changes and progress of learning is among the things that educational technologists need to understand, as do teachers and learners. Technologies change, as indicated in the earlier discussion of the history of educational technology. Changes in technologies are occurring at an increasing rate, as noted previously. In addition, there are changes in how formal learning is conceptualized and organized. The world of the educational technologist is dominated by change, and the various things that change have an effect on each other. A new technology can introduce a new approach to teaching. Subsequent chapters in this volume will revisit the impact of these changes on learning, performance, and instruction. An excellent source for information about emerging technologies and their likely impact on learning and instruction is the New Media Consortium (see http://www.nmc.org/) and their annual *Horizon Reports* in a variety of locations and contexts. As an advance organizer for subsequent chapters, a few remarks on emerging technologies and changing contexts follow.

1.5.1 Emerging Technologies

What are some of the emerging technologies? In the category of devices and hardware, 3D printers and wearable computing devices come to mind. Three-dimensional printers are already having an impact associated with a movement called makerspace (see, e.g., http://library-maker-culture.weebly.com/what-are-they.html), in which learners engage in using a 3D printer to create and test an object or artifact in the context of learning by doing and design-based learning. Wearable devices such as smartwatches and Internet-enabled head-mounted displays exist and will surely find their way into a variety of learning and instructional situations.

In the category of processes and applications of advanced technologies, learning analytics, adaptive instructional systems, and personalized learning are being tested in small-scale situations as extensions of earlier intelligent tutoring systems that can take into account a robust and dynamic representation of the learner in terms of prior knowledge and performance, interests, motivation, preferences, and even moods. Game-based learning, gamification, and augmented and virtual realities are among the emerging technologies that are gradually finding their way into learning and instructional situations. It is nearly impossible to envision all of the possible technologies likely to emerge in the next 10 years. What is certain is that there will be many and the challenge of being a competent educational technologist will increase, along with the need for increasing refined areas of specialization and expertise.

1.5.2 Changing Contexts

What is the likely impact of new and emerging technologies on learning and instructional contexts? Some envision a world in which everyone has access to the collected knowledge and wisdom of humanity along with automated learning and instructional devices and mechanisms; some even predict the disappearance of schools and teachers in such a world. We do not share that particular vision of the future, although we clearly acknowledge that formal learning environments are changing along with increased informal learning resources and environments. An obvious change in formal contexts involves the rapid growth of online learning. Hybrid learning environments that integrated online resources and activities with face-to-face contexts are now the norm in many higher educational institutions as well as in some K-12 schools. Because there are so many Internet resources available to so many people, often at no cost, many teachers are now adopting the practice of flipping the classroom. This involves assigning readings and associated discussions outside of class, sometimes within an Internet-based environment, and using class time to have students practice applying knowledge learned outside class on problems, sometimes working in small groups. This allows the teacher to shift the role from primary presenter of information to that of providing constructive and meaningful feedback to develop learner competence and enhance the application and transfer of knowledge to solving meaningful problems.

Other changes are occurring as well. Whereas literacy used to focus on reading, writing, and basic arithmetic, the concept of literacy has expanded considerably to include digital literacy, which includes multiple literacies (e.g., information literacy, technology literacy, visualization literacy). This means that the notion of basic skills typically taught in primary and secondary school settings has been enlarged, and supporting the development of digital literacy skills using technology is one obvious approach.

Pedagogical approaches are also changing. Since the introduction of interactive simulations in the last part of the previous century, there has been a growing emphasis on learning by doing, sometimes also referred to as authentic or situated learning. Augmented and virtual realities and immersive environments have significantly enhanced the power of interactive simulations. As a result, such applications are expected to continue to change and influence how knowledge and expertise are developed.

1.6 Roles of Educational Technologists

Those trained in the area of educational technology end up in various professional positions with a variety of responsibilities. What follows is a brief review of the job titles, roles, and responsibilities associated with educational technology professionals; it is not intended to be a complete or comprehensive of the various roles in which educational technologists are placed.

- Instructional designer—responsible for planning, analyzing, designing, developing, modifying, implementing, evaluating, and/or managing a variety of courses, instructional systems, and learning environments
- Instructional project manager—responsible for leading instructional development projects, directing educational programs, and/or managing the creation of learning environment efforts
- Media specialist—responsible for creating, finding, modifying, and/or using a variety of media artifacts in various formats
- Technology coordinator—responsible for helping teachers and instructors find, modify, use, and/or integrate a variety of educational technology resources
- System administrator—responsible for managing and supporting an education system, content management system, learning management system, and/or a network environment used to support learning and instruction
- Developer/programmer—responsible for coding instructionally related software and/or developing mediated objects and resources to be used in support of learning and instruction

- Evaluator—responsible for the formative and summative evaluation of lessons, courses, programs, instructional systems, and/or learning environments
- Instructor—responsible leading units of instruction, tutoring students, and/or providing learning guidance and feedback in the context of formal learning contexts.

Another way to represent the complexity of educational technology is in terms of Robert Tennyson's (1995) Fourth-Generation Instructional Systems Development (ISD) model (see Fig. 1.4). Note that in this context, the notion of "development" covers the entire life cycle of planning, implementing, managing, and evaluating an educational effort. Some practitioners refer to this notion of development as big D, and some also use design in the same big D sense to cover the entire life cycle. In this volume, we generally use design and development to refer to specific tasks rather than the entire process.

Terminology is often an important component of gaining competence in a particular domain. For that reason, we have included definitions of key terms in each chapter in an effort to use those terms as would most educational technologists. Nonetheless, different uses do occur in various situations. That is particularly true with regard to terms "assessment" and "evaluation" which are treated later in this volume. In general, and by way of an advance organizer, "assessment" is most often

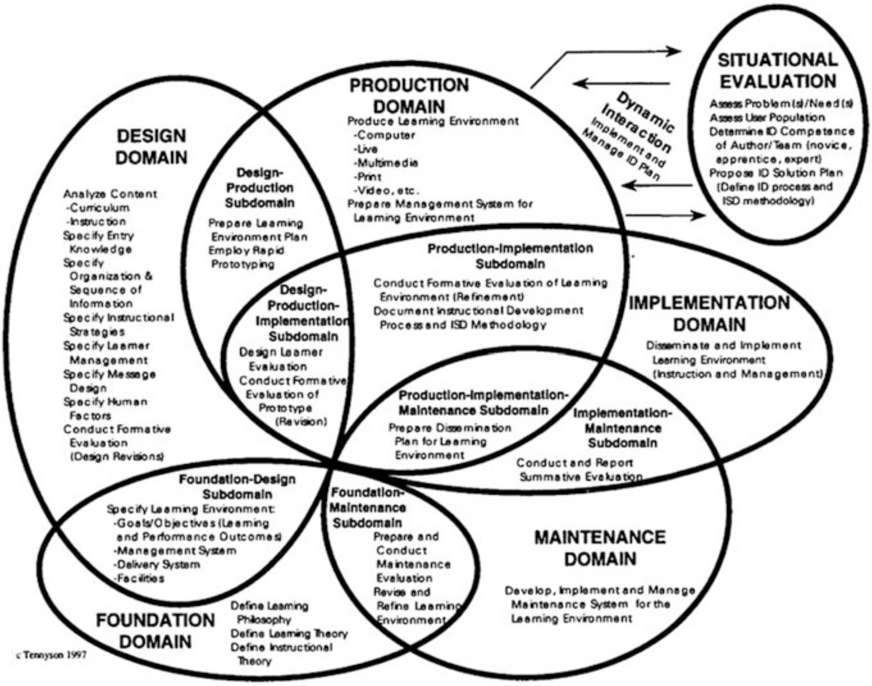

Fig. 1.4 Tennyson's Fourth-Generation ISD model (used with permission)

used to refer to individuals—learners or workers. “Evaluation” on the other hand is most often used to refer to courses, projects, programs, products, policies, processes, or practices. There are two things especially noteworthy in Tennyson’s ISD model. First, a situational evaluation applies regardless of where in that model one happens to be working. Second, the model is elaborate primarily in terms of what people do. As a consequence, that model can serve as a point of departure for elaborating in more detail the roles of an instructional designer, which are differently defined than those of an educational technologist.

Key Points in This Chapter

(1) AECT definition of educational technology is the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources.
(2) The scope of educational technology includes needs assessment, requirements and feasibility analysis, design/redesign, development, deployment, management, evaluation, support, training.
(3) The dimensions of educational technology include communication/coordination, content/resources, hardware devices and software, implementation, media, and representation formats.
(4) Roles of educational technologist include instructional designer, instructional project manager, media specialist, technology coordinator, system administrator, developer/programmer, evaluator, and instructor.

Learning Resources

- The AECT Open Content Portal—open access resources for educational technologists; see https://sites.google.com/site/aectopencontent/
- Emerging perspectives on learning, teaching, and technology—a variety of contributions from leading scholars edited by Michael Orey; see http://epltt.coe.uga.edu/index.php?title=Main_Page
- Instructional Design Central—a privately run Web site for instructional design professionals; see http://www.instructionaldesigncentral.com
- International Board of Standards for Training, Performance and Instruction (ibstpi)—identifies standards and sets standards for instructors, instructional designers, evaluators, online learners, and training managers; see http://ibstpi.org/
- The Makerspace Movement—a community who uses 3D printers to create objects and artifacts which can be used to support learning and instruction; see http://library-maker-culture.weebly.com/what-are-they.html

- The New Media Consortium (NMC)—an organization that tracks and documents promising and emerging technologies likely to impact learning and instruction in the form of annual *Horizon Reports* in a number of contexts; see http://www.nmc.org/
- Open educational resource (OER): Resource Roundup from Edutopia; see http://www.edutopia.org/open-educational-resources-guide
- Open educational resources—a UNESCO guidebook and resource; see http://www.unesco.org/new/en/communication-and-information/access-to-knowledge/open-educational-resources//
- Smithsonian Institute, Resources for Educators; see http://www.si.edu/Educators
- Theory Into Practice Database/Instructional.org—Greg Kearsley's original database created in 1992 which has been revised several times since then; see http://instructionaldesign.org/
- UNESCO: Education for the twenty-first century—see http://en.unesco.org/themes/education-21st-century.

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