Chapter 3: Knowledge-based Computing Education

The philosophical underpinning of the CC2020 Report treats computing as a meta-discipline—a collection of disciplines having a central focus of computing. This chapter explains the concept of knowledge-based learning and how it has encompassed computing education over decades. It reviews the CC2005 report which is primarily a knowledge-based document. Additionally, it addresses how workplace and employment dynamics affect knowledge-based learning and related issues.

3.1: Knowledge-Based Learning

This section addresses some of the underpinnings of knowledge-based learning (KBL). It explores the definitions of learning and knowledge, the attributes of KBL, and the relationship between KBL and computing curricula.

3.1.1: Learning and Knowledge

Before discussing knowledge-based learning, it is useful to first understand the contextual meaning of learning and knowledge. The word *learning* refers to the endeavor of "knowledge or skill acquired by instruction or study" [Mer3], often in an environment conducive to the activity. In turn, the word *knowledge* refers to the "acquaintance with or understanding of a science, art, or technique." [Mer4]

There is an inextricable connection between the two words knowledge and learning. The former refers to content while the latter refers to activity. Thus, people acquire content and skills through the process of learning. Humans acquire (learn) content (knowledge) continuously, almost from the time of birth. For the purposes of this report, content acquisition refers to learning in formal settings or structures such as in classrooms or online environments.

Recently, the term *content knowledge* has come into use, which refers to the body of knowledge and information that teachers teach and that students should learn in a subject or content area. Content knowledge generally refers to the facts, concepts, theories, and principles taught and learned in specific academic courses [Edg1]. This form of knowledge occurs in core courses of study, curriculum, or learning standards.

3.1.2: Learning from Knowledge Contexts

In general, learning occurs by building on the knowledge a person already has. That is, a person, namely a student, scaffolds new knowledge based on the student's existing knowledge. *Knowledge-based learning* (KBL) depicts this form of learning activity. More formally, "knowledge-based learning is learning that revolves around both the knowledge that the student already has, and the understanding that they are going to achieve by doing work." [Tes1]

Students, teachers, and the public have all experienced knowledge-based learning. Basic schooling allows advancement from one grade level to the next based on the verified knowledge acquired in one grade before advancement takes place. Often, verification takes place by evaluating students' knowledge content through tests, oral or written examinations, interviews, and other tools useful in assessing whether a student has achieved the expected knowledge base for a given level. At universities, course prerequisites attempt to ensure that a student has the necessary knowledge needed to advance to the next course level.

Knowledge-based learning has existed for millennia. Whether formally or informally, KBL has used approaches to elevate human knowledge on a global scale. Teachers deliver information to learners and then check their level of attainment. Reflective learners can assess themselves on the acquired new knowledge. Teachers direct learners on what they need to know and check whether they learned it. Using this approach and providing reliable comment, teachers can help students see where they have learned or where they have erred.

Chapter 4: Competency-based Computing Education

While early work in defining model computing curricula was based on knowledge, as discussed in Chapter 3, more recent work has been transitioning toward a competency-based view of computing education. This trend has been an important pivot in defining curricular standards that codify expectations to go beyond simply communicating knowledge. Within the broader context of industry, professions, and society, a curriculum description centered on competency focuses on an individual's capability to perform and to apply their computing education in a practical and professional service to society.

A coherent competency model to define computing curricula should promote and clearly describe the practical benefits of computing programs to its stakeholders: students, benefactors, faculty, administrators, employers, accreditors, lawmakers, and society. Describing computing competence in a practical context shifts the focus of curricula away from describing a body of knowledge in relation to a disciplinary area and channels it toward pragmatic student accomplishment and performance. Descriptions of what graduates can do in practical situations replace descriptions of content learning and memorization. Competency more effectively describes outcome expectations. It challenges educators to develop more proficient computing professionals, and it allows society to recognize the purpose and benefits of a computing education within a competency framework.

4.1: Competency and Competency-Based Learning

Competency is not a novel idea. The concept goes back centuries and even millennia. The construction of the Giza Pyramids or the Roman Colosseum are examples of structures designed and engineered by competent professionals of the time. A general dictionary defines competency as "the quality or state of having sufficient knowledge, judgment, skill, or strength." [Mer1] It is important to note that the use of this word always occurs in a context: being competent in law does not mean being competent in medicine.

4.1.1: Competency and its Meaning

The Harvard University Competency Dictionary [Har2] describes a useful overview of competency through the following definition and explanation.

> *Competencies, in the most general terms, are "things" that an individual must demonstrate to be effective in a job, role, function, task, or duty. These "things" include job-relevant behavior (what a person says or does that results in good or poor performance), motivation (how a person feels about a job, organization, or geographic location), and technical knowledge/skills (what a person knows/demonstrates regarding facts, technologies, a profession, procedures, a job, an organization, etc.). Competencies are identified through the study of jobs and roles.*

Thus, competency identifies closely with job-related behavior and performance. It is a person-centered concept that requires demonstration of human behavior together with technical skills and knowledge.

The CC2020 project embraced competency as an underlying theme of its activities and as a principal component of the CC2020 Report. The members of the Task Force believe that every career path in computing, whether industrial, academic, governmental, or any other career, is founded on competent performance. The Report observes that knowledge is only one component of the idea of competency. While the working definition of computing competency may evolve, adopting the idea of competency as the foundational idea on which to base academic program design permits a stronger alignment between the product of an education and the needs of professional practice in the workplace. Thus, it is appropriate that competency should form the basis for expressing both the target of learning in computing education and the fitness to task in the workplace. This approach ensures that all graduates of computing programs have the preparation to be effective for specific career paths.