The CC2020 Project - Computing Curricula Guidelines for the 2020s

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Abstract—This paper provides an overview of a worldwide project to chart the future of computing education on a global scale. The Computing Curricular 2020 (CC2020) initiative engages a task force of thirty-six professionals from sixteen countries and six continents in the task of producing resources that map the computing and educational advances that have occurred since the publication of its predecessor, CC2005. The results of the initiative will be futuristic in the sense that it will be a durable portfolio of resources useful to educational institutions, governments, industry, students, and the public on a global scale. This paper summarizes the status and approaches developed by the CC2020 taskforce, a digest of the content anticipated in the resources delivered as well as suggestions for their use.

Keywords—Computing curricula; CC2020; global computing education; curricular guidelines; CC2005

I. BACKGROUND

The Association for Computing Machinery (ACM) has initiated a range of efforts over more than five decades to produce a series of curricular documents [1] dating back to the early 1960s. These efforts are ongoing and new recommendations are currently in development [2,3]. In 2005 the ACM and other professional organizations such as the IEEE Computer Society and the British Computer Society produced an "Overview Report" tagged as CC2005 [4], which combined the insights of other curricular guidelines, producing a disciplinary overview that included computer engineering, computer science, information systems, information technology, and software engineering.

Since that effort, many new technologies have emerged that affect all areas of the computing field. In the light of these considerable developments in computing and related fields, the ACM determined it was time to revise the CC2005 document. In 2016 it formed the nucleus of a task force charged with developing innovative recommendations for all baccalaureate computing programs at on a global scale. ACM invited many computing organizations to play a role in managing this pioneering activity and to help sponsor the project. In 2017, the ACM and the IEEE Computer Society became principal co-sponsors of the "Computing Curricula 2020" project and they tagged the project as CC2020.

The CC2005 report has received wide international recognition since its inception. The document, particularly its diagrams and contrasting profiles of computing fields, have become a benchmark in many worldwide curricular development activities. Based on this prior success, the task-force surveyed the computing educational community to gauge the impact and applications of the CC2005 report in the international computing community. From the results of this survey it became apparent that the community desired a new, more comprehensive, innovative, and forward-looking set of resources for benchmarking, comparing, assessing and creating high-quality computing programs worldwide. Many respondents conceived of this as a complement to the CC2005 report. Specifically, the primary goal for this project is to produce a set of resources and online tools to support development and assessment of international computing curricula by the end of 2020.

II. THE CC2020 TASK FORCE

The CC2020 project task force constituted itself during a ten-person, two-day, strategic planning meeting in San Francisco in 2016. The participants decided to replace the CC2005 document totally with a set of new documents and resources rather than just updating it. The meeting also established a framework for a broad-based task force that was both diverse and inclusive. That is, the new resources and documents must reflect many perspectives on computing education and must allow representatives from worldwide organizations to play an active role in the project. The meeting also established the framework for a steering committee.

The responsibility of the task force is to develop visionary new curricular guidelines. The task force coordinates a larger pool of disciplinary experts responsible for providing detailed input to the final products and it serves as curator and reviewer for tasks generated by the steering committee or other entities. The steering committee provides the overall visioning and planning for the project. The task force currently consists of thirty-six professionals representing academia, government, and industry. Its scope encompasses six continents (Asia, Africa, North and South America, Europe, and Australia). Currently, representatives from sixteen countries comprise the task force. The steering committee currently has thirteen members and represents eight countries.

In August of 2017, the steering committee had its first face-to-face meeting in Boston, Massachusetts, USA. Initially, it assembled three sub-groups to work on three major deliverables: a report outline, a web-based curricula comparison and mapping tool, and specifications of disciplinary focused graduate competencies intended to guide curricula development.

Task force meetings take place using online conferencing tools approximately six times per year for three years; steering committee meetings take place face-to-face two times per year for three years. September of 2017 was the inaugural online task force meeting. Among the topics discussed was the acceptance of the word "computing" as the umbrella word to represent all facets of the field. The meeting also adopted the principle that the project should promote competency-based computing to

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IT Competencies = (Knowledge + Skills + Dispositions) in Professional Context

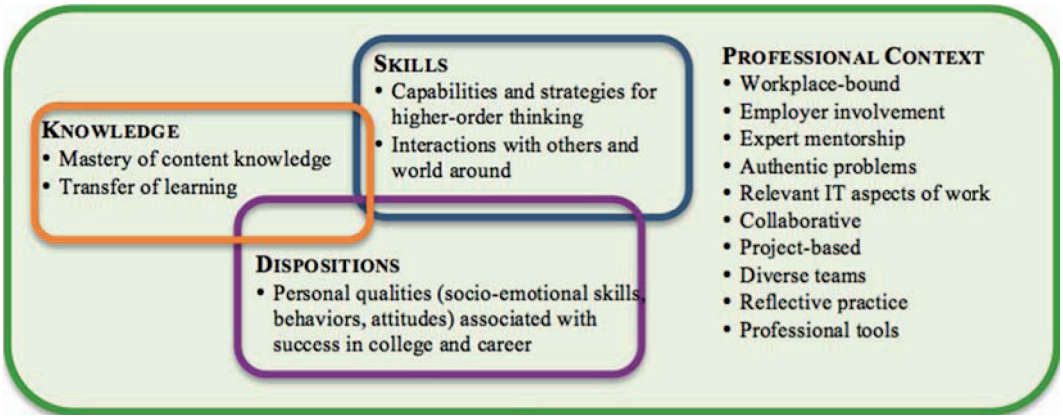

Fig. 1 IT Competency Model

support a broader range of educational contexts and environments.

III. The Role of Competency

The definition of competency adopted for the development of the CC2020 resources draws heavily on the work of the IT2017 report [5]. Higher education legislation and accreditation has converged over the last two decades, reaching a common understanding of learning outcomes, namely, that of which students are expected to be capable after completing some achievement such as a project or after receiving a passing grade in a course of graduating from a program of study. However, there is an element of ambiguity surrounding the definition and use of competency or being competent. The following discussion, based on the IT2017 report, attempts to clarify the meaning of the term for our purposes.

A. Competency and its Meaning

Competence or competency generally refers to expected performance specifications associated with a profession or membership to a licensing organization. For example, society would expect some level of performance from a doctor, a lawyer, or even a barber or hairdresser. In computing, the public expectation is that a practicing professional should have the capability of being more than knowledgeable about computing and the use of computers.

The IT2017 report uses a working definition of competency that connects knowledge with performance. In essence:

Competency = Knowledge + Skill + Disposition

This definition of competency in the IT2017 report avoids the use of knowledge alone in establishing curriculum guidelines only on a body of knowledge, as was the practice of most previously developed curricular guidelines. One can view the elements of knowledge, skill, and disposition as three interrelated dimensions, each having specific measurable meanings.

B. Components of Competency

The three-dimensional definition of competency deserves some clarification. The *knowledge element* refers to the knowing of core concepts, ideas, and content of a discipline. Traditionally, students receive knowledge from their teachers and by reading textbooks, notes, and other references. In most academic settings, this element of learning receives the most attention because courses and their testing mechanisms have traditionally had a focus upon what students know. The *skill* dimension refers to capabilities that develop and become refined over time through practice and perseverance, usually manifested through "hands-on" activity. The dimension of *disposition* generally includes social skills, emotional abilities, behaviors, and attitudes as well as the skill to use those abilities effectively in the pursuance of ones' profession. Figure 1 illustrates competency in the context of information technology.

IV. Guiding Principles

The CC2020 steering committee adopted several guiding principles designed to help the CC2020 project to be successful. The first is flexibility; that is, the project outcome should be flexible enough so it has global acceptance and endurance as well as be adaptable within multiple educational contexts. Additionally, written components must use language that is internationally neutral (not specific to an educational system or context) to complement documents such as the Bologna Declaration [6].

The adoption of the word "computing" to identify the broad field involving computers reflects the reality that this word has become ubiquitous on the world stage. The task force is aware that some regions of the world use different terminologies such as informatics or information and communication technology (ICT) to have a similar meaning as computing to represent the field. This adaptation raises further questions as to the meaning of other terminology such as information technology or computer science in global contexts.

The steering committee also adopted the principle that it is important to contrast different types of computing programs, which was a salient feature of the CC2005 report, and one identified by our survey as highly regarded in the community. This principle is important for CC2020 consumers (students and prospective students) so they are aware how one discipline (e.g., computer engineering) differs from another computing discipline (e.g., information technology). This principle is also important for developers of educational programs who will use the pending resources to guide the development and enhancement of robust degree programs. The task force also seeks to establish a universal understanding of the terminology used to describe anticipated competencies of computing graduates in different areas of specialization.

Another guiding principle for the project is the ability of the task force to capture future trends and visions from industry, from research, and from "grass-roots" developments. This principle has many facets to it and the project must remain responsive to general education needs, changes in technology, teaching methods, as well as existing technologies. We hope

that the reader of this paper will contribute to this effort, and encourage readers to contact the authors with contributions.

V. Content of the Pending CC2020 Resources

The steering committee supports the belief that the CC2020 resources must be responsive to the needs of the global educational community. To achieve this goal, it has proposed the inclusion of six areas in the written report accompanying the other deliverables, as highlighted in the following discussion.

A. Background

This section provides an overview of the entire project, addressing its purpose, its contents, and the various ways of using the project outcomes. It also provides a landscape of computing education from an historical perspective, its current state, and its possible future. It identifies the audience and stakeholders who use the document for quality improvement in existing programs and it provides a benchmark for future computing programs.

B. Methodology

The steering committee envisions a methodology that focuses on organization, procedures, and practice. Among the areas to consider are the conceptual framework for explaining computing education, and its importance for quality and innovation. Through the framework the task-force intends to describe some of the relationships between competencies, bodies of knowledge, professional profiles, educational contexts, and degree programs. Ultimately, future computing degree programs must meet the growing demands of a changing technological world.

C. Competency Models

A discussion on competency already exists in Section III. Competency models focus on the meaning and use of competencies in an educational framework. It defines high-level competencies to show how they differ from knowledge and it indicates ways to formulate competencies and illustrate their structure. The report intends to produce illustrations of competence concentrations for different variations of a computing program, for instance computer communication and networking in the context of studies in information technology.

D. Comparison Tool

The CC2020 project intends to develop an open access, online comparison tool whose description will be part of the report. The community will have open access to this tool to assist in understanding the computing field and to make decisions concerning computing programs. Envisioned users of this tool are computing educators, educational authorities, current and future computing students, industry employers, and recruiters wishing to complement their business models.

E. Program Taxonomies

The CC2020 report includes a structured taxonomy of computing programs. The structure involves classification and nomenclature for diverse knowledge concentration areas. It does this through visual and textual characterizations of each discipline as a composite. CC2005 succeeded in doing some of these taxonomic characteristics through two-dimensional illustrations and comparison tables. The illustrations shown in Appendix A provide an indication of what these representations can look like.

F. Stakeholder Viewpoints

The CC2020 report must also address stakeholder considerations. At a minimum, the stakeholders for this project include educational institutions, employers, industry, government agencies, policymakers, accrediting agencies, professional societies, and most importantly, future students. The project engages with these stakeholders through a program of activities at conferences, industry round tables, and policy summits.

VI. Global Considerations

The CC2020 project and its subsequent products consider all aspects of computing education. The task force is responsive to regional practice, language considerations, cultural differences, and different ways of learning. The report will promote global awareness since it recognizes that its content reflects a part of a worldwide community of computing educators and professionals. The task force will accommodate global differences in vocabulary and interpretations that pervade the professional environments of teachers and researchers. Lack of cultural knowledge can hinder understanding the meaning of terms, thereby inhibiting communication among colleagues and professionals.

VII. Conclusion

This paper attempts to scaffold a monumental work that involves sixteen countries from six continents. There are high aspirations that the work of a task force involving three dozen professionals will produce a futuristic document that can benefit not only computing educational communities, but all humanity. The authors of this paper are members of the CC2020 task force and its steering committee. They are very optimistic on the project's outcome and its benefits to a global community of computing educators and professionals and they encourage your participation.

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References

[1] ACM Computing Curricula Recommendations website; 2001-present. http://www.acm.org/education/curricula-recommendations/. Accessed 2018 Jan 31.

[2] J. Impagliazzo, "Curriculum design for computer engineering and information technology," In Proceedings of the Global Engineering Education Conference (EDUCON), 2015.

[3] H. Alrumaih, "ACM/IEEE-CS information technology curriculum 2017: status report," In Proceedings of the 1st National Computing Colleges Conference (NC3 2016). Saudi Arabia, 2016.

[4] ACM, et al., Computing Curricula 2005: The Overview Report" (CC2005); https://www.acm.org/binaries/content/assets/education/curricula-recommendations/cc2005-march06final.pdf. Accessed 2018 Jan 31.

[5] ACM, et al., Information Technology 2017: Curriculum Guidelines for Undergraduate Degree Programs in Information Technology (IT2017); https://www.acm.org/binaries/content/assets/education/curricula-recommendations/it2017.pdf. Accessed 2018 Jan 31.

[6] Bologna Declaration of 19 June 1999: European Ministers of Education https://www.eurashe.eu/library/bologna_1999_bologna-declaration-pdf/. Accessed 2018 Jan 31.

Appendix A

CC2005 Curricular Illustrations