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The ACM/AIS IS2020 Competency Model for Undergraduate Programs in Information Systems: A Joint ACM/AIS Task Force Report

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The ACM/AIS IS2020 Competency Model for Undergraduate Programs in Information Systems: A Joint ACM/AIS Task Force Report

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Abstract:

The Association of Computing Machinery (ACM) and the Association of Information Systems (AIS) along with the ISCAP EDSIG, recently released a joint taskforce report *IS2020: A Competency Model for Undergraduate Programs in Information Systems*. In this paper, the co-chairs of IS2020, the latest Information Systems curriculum guidelines, provide their insight on the problems presented with existing guidelines, illustrate the issue, and share their opinions that led to the release of these latest guidelines.

Keywords: Information Systems, Curriculum, Competency Model.

1 Introduction

The IS2020 report (Leidig et al., 2021) is the latest iteration of model curriculum work for the Information Systems (IS) discipline that dates to the early 1970s. The previous IS model curriculum report, IS2010 (Topi et al., 2010), was a major effort that expanded IS curricula guidelines from a primarily business school context to other domains. The IS2010 report articulated guidelines as IS capabilities, knowledge, and skill requirements, and characterized the core of the IS curriculum, electives, and career tracks (Topi et al., 2010). The model curriculum report prior to IS2010, was IS2002 (Gorgone et al., 2003), which was a relatively minor update of IS'97 (Davis et al., 1997). Both the IS2002 and IS'97 projects were a joint effort between the ACM, AIS, and DPMA/AITP (Data Processing Management Association/Association of Information Technology Professionals). The IS'97 project was preceded by DPMA'90 (Longenecker and Feinstein, 1991), the 1983 ACM Curriculum Recommendations (ACM, 1983), and 1973 ACM Curriculum Recommendations (Couger, 1973).

This debate article serves as an introduction to the full IS2020 curriculum guideline report (Leidig et al., 2021), but it is also written as a debate paper, reflecting and arguing for the choices that we made. Despite a long and successful tradition in preparing curriculum guidelines, the ideal of universal curriculum guidelines is also challenged by many contemporary trends. IS programs are provided globally, in very different educational systems. In addition to computing and business schools, IS programs can now be found in information management schools, engineering schools, design schools and schools of medicine or social sciences. Job placement of IS graduates is becoming more diverse and new jobs are emerging. The exceptionally fast pace of technological change is also raising a valid question regarding the value of somewhat permanent guidelines.

When we organized panels for preparing the IS2020 guidelines, problems related to the identity of IS programs were widely discussed. In business schools, IS programs are often labelled as digital marketing, or fintech, or business analytics, to illustrate the profiling of the program, raising the question of whether these are also IS programs. In computing schools, questions often relate to the relationship between the IS program, and other programs of the school, such as those in computer science, cybersecurity, or data science. Hence, we received questions about how an IS program is different from other digital-based programs, or computer science programs, or data analytics? And what exactly is an "IS program"?

Given this inherent and increasing diversity in IS programs, and the many related IS professions, do we need a single set of guidelines? Is it possible to create a one-size-fits-all model that any and all institutions can use to make curricular decisions? Our opinion is that a uniform, singular set of guidelines intended for all IS programs is both possible and needed, perhaps more than ever. These guidelines should not be prescriptive, rather provide a guide for institutions designing their IS program. Even with built in flexibility, guideline reports increase program comparability, which in turn should better assist students, parents, employers, and other stakeholders, in comprehending the expected benefits and outcomes of a program.

In this paper we explain, how we ended up changing some parts of the tradition, to better address the wide diversity in global influences, new IS jobs, and academic structural constraints. In particular, we explain the arguments behind moving towards competency models, for recommending a common core for IS programs (while acknowledging a possibility to profiling), and for conceptualizing a shift towards more continuous work in updating the guidelines. Experiences and solutions from the entire taskforce report provide illustrations using specific IS2020 guidelines. By doing so, the paper intends for its own part, to participate in and contribute to the debate around IS curriculum.

2 What should guidelines be about – courses or something else?

A defining characteristic of IS education is that IS programs co-exist in a wide variety of faculties and institutions. While business schools and computing schools provide the typical academic context for many IS programs particularly in the U.S. and Europe, globally, information (management) schools and engineering schools are also important contexts. Lately, following the expansion of information systems use into new domains, IS programs have been established in medical schools, design schools, and schools within the faculties of humanities and social sciences.

Each of these institutional homes often are structured differently with different views of what to emphasize or include in an IS degree. A larger challenge from the perspective of offering guidelines is that the number of courses available or allowed for a major differs considerably. Undergraduate IS programs in many

business schools offer a limited number of courses, while programs housed in other units without the broad coverage required of other disciplines are able to offer many more courses in information systems. A problem that the IS2020 taskforce faced was related to the diversity of programs in educational contexts, should we define a list of core and elective courses? Is it even possible to identify a set of courses that would be appropriate for the variety of programs that adequately matches the mission of each institution?

The solution that we chose was to move away from defining a model curriculum with courses, to defining a competency model. The model defines what graduates should attain upon completion of a program instead of what specific courses are offered. These models are more flexible, and can be adapted to fit individual institutions. In this regard, IS2020 is both architecturally and philosophically different from its predecessor, IS 2010. The IS 2010 report was structured around describing courses using a knowledge area (KA), knowledge unit (KU), and learning outcome (LO) hierarchy (or, KA-KU-LO model).

In doing so, IS2020 continues and builds upon the philosophical shift evident in the MSIS2016, IT2017, and CC2020 curriculum projects in the utilization of a competency model for curriculum specification. An important input to this report is the MSIS2016 report, that provided a global competency model for graduate degree programs in IS (Topi et al., 2017). The work of CC2020 task force had a major influence on the way we conceptualized the competencies: the elements that define a competency include knowledge, skills, and dispositions.

Our definition of a competency, as it relates to undergraduate curricula in IS, is consistent with that of MSIS2016 and CC2020: *A competency is the graduate's ability to apply knowledge, skills, and dispositions to effectively complete tasks*. The knowledge component includes core concepts of the discipline of study. Elaborations on knowledge – Knowledge Areas, Knowledge Units, Knowledge Elements – have been the mainstay of most curricular models. Skills are the verbs in competency-task statements that suggest the approach to the application of knowledge. For this purpose, the IS2020 follows the CC2020 approach of adopting a modified Bloom's taxonomy of learning objectives. The disposition component has to do with attitude, behavior, social skill, and emotional capabilities. It imbues sensitivity to task context that is value-laden and requires an ability to divine the intention behind the application of knowledge-skill pairs. For more detailed discussion on the competency model, see section 3.2. starting on page 35 of the full report and Figure 3.1. on page 36 for a visual illustration of competency components.

The IS2020 distinguishes two options for defining tasks, one drawn from education and the other from profession. In an *education context*, a task relates to assignments that students do as part of a course. In curricular competency, a student is able to apply his/her knowledge to complete a given task and demonstrate this competency in exams or tests. In a *professional context*, competency refers to tasks that are completed as part of routine work related to a job profile, leading to successful performance. Competency frameworks such as SFIA and eCF describe competencies using levels such as awareness, novice, supporting, and independent.

The dialogue between curricular competencies, professional competencies, and tasks is an important one. Such dialogue could usefully conceptualize, for example, the role of co-curricular activities, such as internships and non-course training programs (Code Academy, Coursera, EDX and the like), as a bridge between the two types of competencies. IS education often goes beyond the formal coursework. While acknowledging the significance of this issue, we considered explicit integration of competencies between educational and professional contexts to remain outside the scope and resources of the task force. Instead, we chose a slightly conservative approach – our focus is on entry-level competencies of graduates, acquired mainly through completing assignments as part of their studies.

The competency model allows institutions to map competencies to courses independent of a one-to-one relationship. This relationship is illustrated in the N to N relationships in the overall architecture model of the IS2020. (Figure 1) The architecture acknowledges that universities will continue to define program level learning outcomes, courses, and course learning objectives. The definition of competencies does not, however, need to fix assumptions regarding the number of courses that a program should offer. In addition, a single competency area can be taught in many courses. This conceptual choice allows for greater flexibility in defining the guidelines, so that they address genuine needs for example in IS profession, rather than a compromise regarding the number of courses in a "typical" IS program.

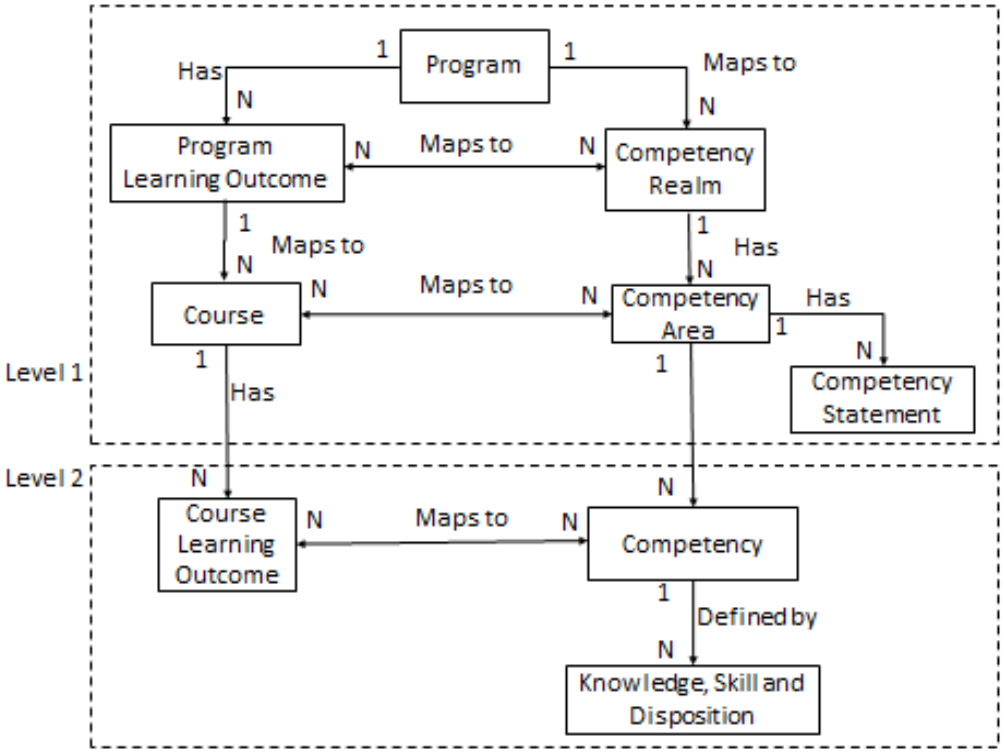

Figure 1: Architecture in the IS2020 report

The competency-based philosophy aims at placing the impetus and onus on curriculum design where it should lie – with the principles and faculty designing a given program. The desired outcome is not only a pro forma presentation of required courses in the major, it also provides a philosophy, structure, and basic guidelines to design a curriculum that more specifically outlines the aims and intents of that program. Topi et al. (2019) list the following benefits of a competency-based approach.

- Competencies focus on what the students need to learn, not what educators need to teach.
- Competencies effectively communicate expectations of graduates to external stakeholders.
- Competencies encourage reflection on student learning.
- Competencies can be used globally in diverse contexts.
- Competencies fit well with most accrediting agencies that use an outcome-focused approach.

The downside of moving from curriculum models to a competency model is, that the guideline report also becomes an advocate of a new curriculum design philosophy that is somewhat new for many educators. Adoption of competency thinking raises many questions, that is outside the scope of curriculum guideline work and that a single guideline report cannot easily answer, for example regarding the role of dispositions in defining learning objectives, or methods for measuring students' competencies. Also, the number of competencies becomes very high, leading to large number of details. In many ways, the traditional curriculum model, with a fixed set of core and elective courses, was easier to adopt. The tension between flexibility to adapt guidelines to different contexts, and ease of adoption in one specific context, will probably continue, and is closely related to our call for a more continuous and community-based effort in updating the guidelines.

3 Should guidelines define a core for all IS programs?

In the latest Job Index report in the U.S., typical job titles for IS graduates are IT Consultant, Data Analyst, Computer Systems Analyst, IT Auditor, Software Applications Developer, and Information Security Analyst (Mandviwalla et al., 2019). The list of IS jobs can be extended with the list of IS Job profiles in the European eCompetency framework, listing jobs such as Project Manager, Enterprise Architect or Business Analyst, that were mentioned already in the IS 2010 report. This diversity in jobs is reflected in IS programs, as IS programs often profile themselves to the needs of their local job market. Section 1.2 of the full IS2020 report

(p. 18) provides a brief introduction to typical IS job profiles, while Appendix 1 (p. 78) links competency areas to typical program level career tracks.

Given this diversity of IS jobs, it is a fair question to ask, if a universal core needs to be defined. Even the exploratory taskforce, that preceded the IS2020 taskforce, left this question open in the guiding principles: "It should be determined whether the model curriculum must have a core of content that is common to all IS programs globally" (de Vreede et al. 2019, p. 11). The fundamental question is, do IS jobs rely on a common body of knowledge, or a common set of competency areas, that is useful regardless the specific IS profession. Graduates of IS programs end up in different professions, so why not let programs or even individual students specialize to local demand?

While acknowledging the need for programs to specialize, IS2020 taskforce determined a common core is needed and useful. We believe that IS profession does expect a minimal common core set of competencies that all IS graduates should have. An important strength of IS programs is the applied and end-to-end view on developing information systems, both as a technical systems development task, and as a task in social systems in the use domain. Although the IS graduates will most likely adopt a specific role in developing information systems, their education also provides them with a broader understanding of the roles, related to data, security, infrastructure, application development, together with adoption and value of these systems in different use domains. In particular, undergraduate programs should lay a broad foundation and understanding of all these perspectives.

With the high demand for graduates of IS programs leading to significant geographic mobility, employers expect a somewhat universal set of competencies from degrees of similar names. The taskforce considered differences in program names, such as information systems, management information systems, computer information systems, business information systems, etc. Such names are important as they convey the specialization of the program, but they also have a common core that they often viewed from a similar perspective. Therefore, regardless of the program name, or profile of the program, constituents of these programs also do expect a common coverage and experience.

Figure 2 provides an overall view of competencies that identifies the core as required competency areas, while also identifying possibilities to profile a program by adding electives. At the highest level, we identify six competency realms. By grouping competency areas to broader realms, it is intended to promote program-level discussions on profile, specializations, and electives. In particular, the four competency realms in the middle (Data, Technology, Development, Organizational Domain) aim at providing depth by allowing sequencing, thus also providing a possibility to profile the program with a specialization. For each realm, however, at least one competency area is identified as required, thus ensuring the breadth of coverage that characterizes the IS degree. The ability to integrate knowledge across four realms is further strengthened in the Foundations and Integration realms, thus preparing a more holistic understanding of the discipline, improving the ability of students to first identify required competencies (in Foundations), and the ability to combine and deploy acquired knowledge and skills as needed (Integration). For a more detailed description of competency realms and areas, see section 4.2 of the full report, starting on page 50, and Appendix 2 (p. 82-94) and Appendix 3 (p. 95-182) for more detailed mapping of individual competency areas.

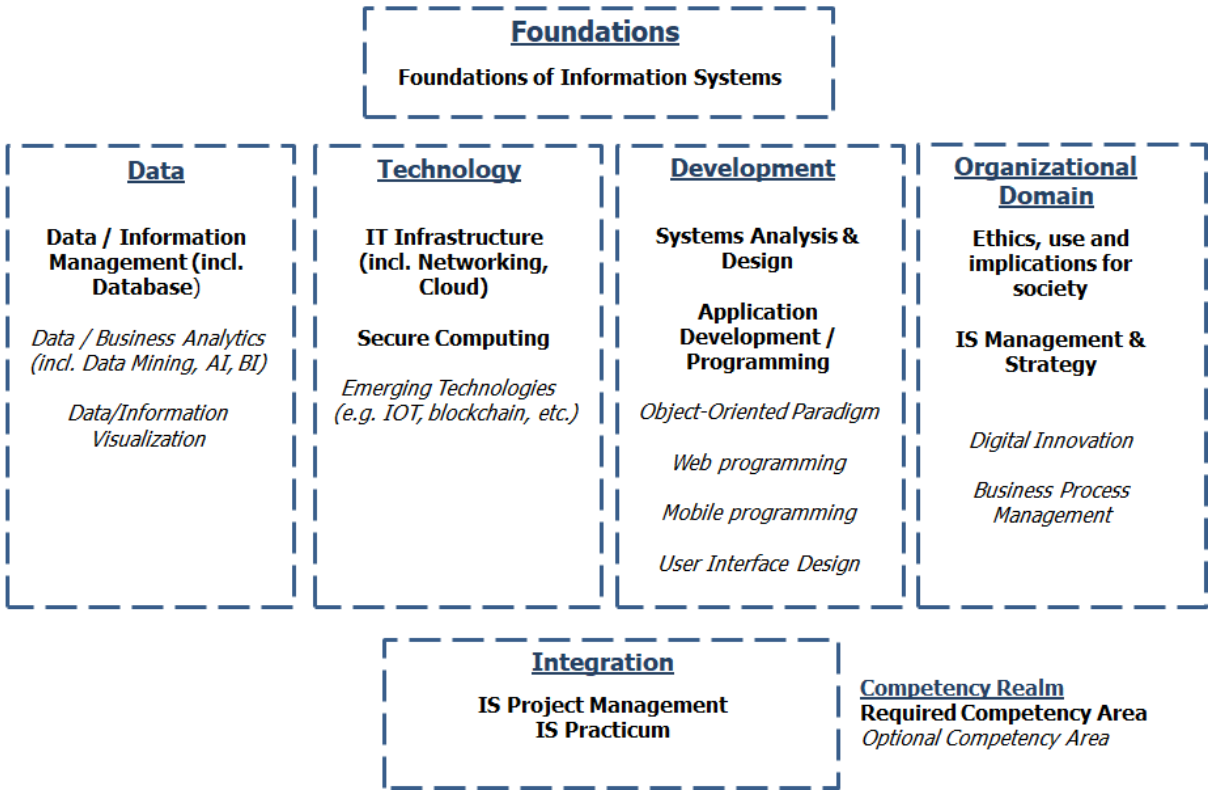

Figure 2 Competency based IS curriculum guidelines

In many ways, the identification of the core follows the traditions of IS education, as described in prior guideline reports. Six out of 10 required competency areas were identified already in the IS2010 guidelines, as core courses (Foundations, Data Management, IT infrastructure, Systems Analysis and Design, IS Management and Strategy, and IS Project Management). This, of course, does not mean that the competencies, and associated knowledge areas, would have remained the same. New trends such as cloud computing, agile development, or digital transformation (to mention only few), need to be addressed, but we believe this is best done by refining the competency areas, their tasks and competencies, and associated courses and learning objectives.

The four new required areas can be seen as expanding the core to technical design, by returning application development as a required competency area, but also by adding computing security and IS practicum as required areas. Organizations are again developing applications (in addition to using packaged software) to support their internal operations, or to develop a digital component for their value offering. This, among other things, has led to increasing calls from industry that IS graduates need more technical skills. The ethics, use and implications for society is related to the ubiquitous nature of information systems, and increasing influence of these systems in society at large.

Identification of a core for IS programs is like equally difficult and controversial, as identification of core for the entire IS discipline (See for example Grey, 2003; McBride, 2018). The IS2020 follows the traditional idea, that true to its namesake, the IS discipline has held the information system as the central unit of analysis. Broadly speaking, “information systems” are often defined as the synthesis, reconciliation, and harmonization of both the technical system (comprising data and computer programs) and the social system (users who form the basis of input data and output information). The flexibility offered by the competency model enables us to incorporate a few more perspectives to the core, that were deemed as most important, also based on feedback in numerous panels. However, we understand that many other competency areas could be equally well considered. The choice of core competencies for IS programs should be a target for continuous discussion and debate.

4 Can we wait for another 10 years, to make the next update?

A characteristic feature in the IS discipline is that education and research are both driven by new waves of technological innovations, new types of applications, and changes in the way individuals, organizations, and society deploy them. During the past 10 years, major developments in the technological environment include the proliferation of smart mobile devices, sensors, cyber-physical systems, the Internet of Things (IoT), and smart networks (Prifti et al., 2017). These technologies, among others, have a profound impact on possibilities to collect, store, and utilize data, resulting to high-volume data sets that enable the use of Artificial Intelligence (AI). AI robots, Virtual Reality (VR), Augmented Reality (AR), AI-enabled Decision Support Systems, Robotic Business Process Automation and ambient computing have all emerged as commercially viable technologies.

In a short period of time, organizations have started to implement technologies to complement their traditional value offering, product or service, with data driven services, or digital products. The revolution has perhaps been even more fundamental for individuals, whose daily life and social communication is increasingly dependent on digital applications. It is evident that IS are becoming increasingly ingrained in our everyday business, professional and personal lives (Bélanger, Van Slyke and Crossler, 2019). Therefore, IS has become more society-centric, not simply organization-centric.

Some implications and consequences resulting from this revolution will be controversial and even negative, threatening the basic rights of citizens, and creating hazards for societies.

The fast pace of change can also be seen as challenging the historical practice for updating curriculum guidelines. We agree with the view that the provision of permanent guidelines that continue to be relevant to an industry in perpetual flux is challenging, if not impossible. When discussing this in IS2020 panels, one competence that was mentioned in relation to this was that graduates should learn how to learn, as the knowledge provided during studies will be outdated soon after graduation. Because of this pace of change, trying to predict, how technologies will mature and be deployed, for example by mid 2020s, and what the competence requirements in IS jobs will be, is indeed a difficult, if not impossible task. The need for a more ongoing discussion surrounding curriculum recommendations, and the use of online platforms to facilitate such discussion, has been recognized in prior guidelines (IS2010 and MSIS2016) and was one of the recommendations of the exploratory task force for IS2020.

We do not fully agree, however, with a view that permanent guideline reports would have become irrelevant. Most model curriculum guidelines have a very long tradition of serving as a static document for a significant timeframe, often lasting a decade or more. For the many different ACM guidelines, the process is the same as in other computing disciplines. There are strong incentives not to change the process and expectation. For many stakeholder groups, knowing and expecting a fixed set of recommendations provides the stability to follow a model. Also, our opinion, based on the IS2020 work, is that tradition is good and useful, as long as the purpose is to look at high level principles and guidelines. Our high level recommendations to include the six IS competence realms, and also many IS competence areas, have remained essentially the same, despite major changes in the technology and applications since 1960s. Although the contents within each competency area have changed completely or at least significantly, the competency areas have sustained their relevancy. For example, essential competencies inside “infrastructure” have been completely renewed for each decade, but as a competency area, it has remained relevant.

It is also important to note, that publishing of guideline reports is part of a continuous and ongoing discussion on IS curriculum-related matters, taking place in IS education-related journals and conferences. Journals such as Journal of Information Systems Education; Information Systems Education Journal, and Communications of AIS rank high in terms of IS curriculum-related publications. Popular conferences for presenting IS curriculum-related papers include Americas Conference on Information Systems (AMCIS), Information Systems Education Conference (ISECON/EDSIGCON) and Southern Association for Information Systems (SAIS) and AIS SIGED conference. The publishing of a new curriculum guideline report often intrigues researchers to write papers that compare model curriculum to existing programs, but many papers address curriculum related matters also without a reference to any particular guideline report.

At present, the impact of IS curriculum-related research articles on curriculum guidelines is inevitably somewhat indirect and slow. The integration of results and views from articles will have to wait until the next revision round, and although the research results are essential, they are still only one input. Hence, we may need something more current and applicable to update also the more detailed and lower-level recommendations: identify new or altered tasks inside a competency area, refine associated competences,

their knowledge areas, skill levels, and dispositions. As competencies are translated to courses, details need constant updating. The IS community should be engaged in an ongoing discussion and application. We believe, that such engagement and discussion could also alleviate the problems resulting from the shift towards a competency model. Smaller groups, representing a particular educational context and program profile, could easily translate competency model recommendations into a curriculum recommendation, that could be usefully applied by similar programs in other universities.

The IS2020 taskforce proposed a solution for a continuous IS curriculum effort. Such an effort would focus on and support both individuals and institutions who wish to browse, develop, or discuss computing curricula from a competency perspective. This living document community should aspire to advance a state of the art in curriculum development, through an open-source model. Through this platform, the community could promote the use of a competency-based computing curricula tool among the world-wide computing education community. Continued community engagement can be further supported by sponsoring panels, workshops, research, conference sessions, social media, and community events. Hence, our preliminary ideas have been conceptualized, but there is a need for new initiatives, to get the AIS, ACM, ISCAP EDSIG, and other organizations involved in designing and delivering information systems programs, to authorize and implement a living document community. For more information on the proposed solution, see section 5.2 starting on page 70 of the full report.

5 Conclusions

This article provides an opportunity to rethink both the process and contents of IS curricular guidelines. Our opinion is that a uniform, singular set of guidelines intended for all IS programs is both possible and needed, perhaps more than ever. While these guidelines are not meant to be prescriptive, we feel they provide a guide for institutions designing IS programs within a wide diversity in global influences and academic structures. In particular, we propose the value of moving towards a competency model. The solution that we chose was to move away from defining a model curriculum with courses, to defining a competency model. The model defines what graduates should attain upon completion of a program instead of what specific courses should be offered. These models are more flexible, and can be adapted to fit individual institutions. The competency model allows institutions to map competencies to courses independent of a one-to-one relationship.

The IS2020 taskforce also determined a common core is needed and useful. We believe that the IS profession expects a minimal common core set of entry-level competencies that an undergraduate IS program should offer, regardless of its institutional preference or profile. We provide an overall view of competencies that identifies a common core of required competency areas, while also providing possibilities for specialization by adding electives. At the highest level, we identify six competency realms. For each realm, at least one competency area is identified as required, ensuring the breadth of coverage that characterizes the IS degree. The ability to integrate knowledge across the four realms is further strengthened in the Foundations and Integration realms which are required to prepare a holistic understanding of the discipline, and the ability to combine and deploy acquired knowledge and skills as needed.

We believe that the choices we made are well argued. But we also acknowledge that our choices were made in time, and sustaining relevancy and value of guidelines will call for continuous debate and future research. The choice of core competencies for IS programs should be a target for ongoing discussion. In addition, pedagogical questions related to the contents that discipline level guidelines can usefully address, and the process for updating those guidelines, should be target for open discussion. For this end, the IS2020 taskforce proposes a solution for a continuous IS curriculum effort in the form of a living document. This living document could be in the form of a community to curriculum development through an open-source model that strives to keep competencies current and relevant to the IS education discipline. Making changes to existing tradition is, however, in itself a delicate effort and cannot succeed without open discussion within the community that it is intended to serve.

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Appendix A

Full Taskforce Report

The joint ACM/AIS task force was launched in January 2019 and submitted the final version of the competency model recommendation for approval in February 2021. The IS2020 was developed by a global task force, with representatives from all three AIS regions (Table I). Following the example of the IS 2010 taskforce, the IS2020 taskforce made efforts toward an open and transparent process to the IS community.

Table 1. IS2020 Task Force

Name	Org.	Affiliation	Country
Paul Leidig (co-chair)	ACM	Grand Valley State University	USA
Mark Thouin	ACM	University of Texas at Dallas	USA
Raja Sooriamurthi	ACM	Carnegie Mellon University	USA
Brenda Scholtz	ACM	Nelson Mandela University	South Africa
Jay F. Nunamaker Jr	ACM	University of Arizona	USA
Hannu Salmela (co-chair)	AIS	University of Turku	Finland
Carina de Villiers	AIS	University of Pretoria	South Africa
Venky Shankararaman	AIS	Singapore Management University	Singapore
Greg Anderson	AIS	Brigham Young University	USA
Lesley Gardner	AIS	University of Auckland	New Zealand
Jeffry Babb	EDSIG	West Texas A&M University	USA

Reference for the full IS2020 guideline report:

Leidig, P., Salmela, H., Anderson, G., Babb, J., de Villiers, C., Gardner L., Nunamaker, J.F., Scholtz, B., Shankararaman, V., Sooriamurthi, R. and Thouin, M., (2021) IS2020 A Competency Model for Undergraduate Programs in Information Systems, Association for Computing Machinery and Association of Information Systems. DOI: 10.1145/3460863.

Link for downloading: https://www.acm.org/education/curricula-recommendations

About the Authors

Paul Leidig. Dr. Paul Leidig is a Professor and Director of the School of Computing at Grand Valley State University. Leidig holds several positions within the computing education community including the

Computing Sciences Accreditation Board (CSAB), the ABET Board of Delegates, and the Association of Computing Machinery (ACM) Education Board. Leidig serves as chair of the CSAB Criteria Committee, co-chair of the Information Systems IS2020 Curriculum Taskforce, co-chair of the ACM Data Science Taskforce, and the Computing Curricula 2020 taskforce. He is a past-president of the Association of Information Technology Professionals (AITP) Education Special Interest Group (EDSIG), and was named an AITP-EDSIG Fellow and a Fellow of CSAB. Leidig served as co-chair of the Information Systems IS2020 Taskforce.

Hannu Salmela. Dr. Hannu Salmela is a Professor of information systems at Turku School of Economics. He held research and teaching positions at the University of Kentucky, University of Vaasa, West Georgia State University, and University of Twente. He served as Head of Department of Management and Vice Dean of Turku School of Economics. He was involved in developing international master's programs with Tilburg University, Aix-Marseille University, University of Passau and Central China Normal University. Salmela served as co-chair of the Information Systems IS2020 Taskforce.