2016

Communication and leadership skills in the Computer Science and Information Systems curricula: A case study comparison of US and Bulgarian programs

CSECS 2016, pp. 000 - 000

The 12th Annual International Conference on
Computer Science and Education in Computer Science

July 01-02 2016, Fulda, Germany

COMMUNICATION AND LEADERSHIP SKILLS IN THE COMPUTER SCIENCE AND INFORMATION SYSTEMS CURRICULA: A CASE STUDY COMPARISON OF US AND BULGARIAN PROGRAMS

Vijay Kanabar, Boston University

Kalinka Kaloyanova, Sofia University

***Abstract**:* In this paper we present results from our curriculum research on the behavioral educational topics being in the computer science (CS) and information systems (IS) academic programs in two countries USA and Bulgaria. Specifically, we address learning outcomes as they pertain to IT Project Management. Our research reveals that the two countries approach undergraduate education from different vantage points. The US universities provide a flexible general education curriculum in many academic areas and students have the opportunity to strengthen their soft skills before they enter the workforce. Bulgarian universities provide specialized education in main CS subject areas and the students are technically strong upon graduation. Is there a way to balance out this divergent educational experience so that students get the best of both worlds? Our paper explores this aspect and provides possible solutions.

***Keywords**: Project Management Education, PMI Curriculum, Project Based Teaching.*

***ACM Classification Keywords**: K.3.2 Computer and Information Science Education, Curriculum, Information Systems education, K.6.1 Project and People Management, Management techniques.*

INTRODUCTION

Today modern educational systems make great efforts to give the students not only solid theoretical background but also to provide them a set of appropriate practical skills. Such competencies are needed in the workforce and Human Resources (HR) hiring managers rank skills such as leadership, communications and working well in teams very highly [Lowden et al, 2011] and [Kanabar et al, 2015]. The two curriculum guidelines of interest to IS/CS students one sponsored by ACM/AIS and another sponsored by PMI address this aspect as well.

The main goal of this research is to understand and explore our research, initially presented in "Assessing Mastery of Project Management Core Competency in an IT Project Management Course ", [Kaloyanova and Kanabar, 2015] where we arrived at several main conclusions:

- The students appeared to be competent learning and leveraging technical skills rather than non-technical skills.
- While the students from both USA and Bulgarian universities in the study demonstrated similar competence for technical project management knowledge areas, the students from USA showed better results in non-technical areas.

In this paper we continue to investigate the reasons for the second conclusion above by reviewing the CS/IS curricula at the two universities and to determine the primary reasons for the above variance. We also investigate in reasonable depth the nature of CS/IT curricula and the differences between the educational standards for Europe vs. USA as well as recommend approaches to balance the divergent educational experiences so that students get the best education regardless of the country where they may be pursuing CS/IS education.

KNOWLEDGE AND SKILLS IN CS & IS AREA

In this section we underscore the recommendations from two leading curriculum guidelines that are used by faculty teaching CS/IS and PM courses.

The IS 2010 report is the latest output from model curriculum work for Information Systems (IS) that began in the early 1970s with the sponsorship of ACM [Topi et al, 2011]. Both the undergraduate and graduate curricula are comparable in their recommendation of the following seven core areas for the IS major:

1. Foundations of Information Systems
2. Data and Information Management
3. Enterprise Architecture
4. IT Infrastructure
5. IS Project Management
6. Systems Analysis and Design
7. IS Strategy, Management, and Acquisition

As you can see PM appears prominently as a distinct area of focus for students. Below we paraphrase in detail the skills and capabilities that are very important for Information Systems programs because it is impossible for IS graduates to exhibit the required high-level IS capabilities without these foundational knowledge and skills [Topi et al, 2011]:

1. Leadership and collaboration
2. Communication
3. Negotiation
4. Analytical and critical thinking, including creativity and ethical analysis.

Since IS project management is recommended as a core foundational competency we describe the knowledge and skills in the PM area next.

KNOWLEDGE AND SKILLS IN PM AREA

In late 2012 the Project Management Institute (PMI) responded to the expressed need of educators interested by designing a series of workshops to collect more systematic information from faculty on current teaching in project management and input on how to respond to increasing demand for curriculum support [IEEE Guide--Adoption, 2011]. During next three years the guidelines were also reviewed by hiring managers at assorted project-oriented organizations [Kanabar and Messikomer, 2015].

Teaching project management skills is a challenge at undergraduate level. At this level most students are inexperienced, so first they need to obtain the basic skills and competence in the technical software project management areas and only after that we can address the soft skills. Examples of technical knowledge include: estimate project cost, prepare project schedule, and create quality plan. Additional technical PM skills include how to plan, monitor and control projects, evaluate progress, and report a troubled project. Students must know how to create a charter, scope statement, WBS, and understand complex concepts such as Earned Value Management [PMBOK, 2012].

In contrast behavioral competencies are not complex to understand – identify stakeholders, communicate with stakeholders, work in teams, lead and motivate teams, or manage conflicts, however, developing these skills and teaching them is a very complex task.

The ISO/PMI standards address these "soft skills" under knowledge areas titled [PMBOK, 2012]:

- Project Human Resource Management

- Project Communications Management
- Project Procurement Management
- Project Stakeholder Management

The "Curriculum Guidelines Summary Report of PM Topics Selected" [Task Force on PM Curricula, 2015] groups this under three domains:

- Technical Competencies
- Behavioral Competencies
- Strategic Awareness

In the next section we investigate the curricula at universities in USA and Bulgaria.

BEHAVIORAL SKILLS EDUCATION IN CS AND IS AREAS IN USA

Boston University is a large university with over 32,500 undergraduate and graduate students and nearly 10,000 faculty and staff, 17 schools and colleges, and 250 fields of study. As such one should not be surprised that the university has two computer science degrees and two IS degrees at the graduate and undergraduate level.

There are two computer science programs at Boston University. Their profile is presented below.

- The BA and MA in Computer Science is targeted towards students pursuing a research oriented career or a career in an industry where theoretical programming is a key component of the student’s career. The BSand MS in Computer Science is targeted to students who are already employed and are taking computer science classes for additional knowledge. They are primarily practitioners and their educational costs are paid by employers.
- There are two information systems programs

- The BS and MS in CIS and MIS. The CIS education is targeted towards practitioners who are interested a technical career and the MIS is targeted towards students interested in a managerial IS career. The Management Information Systems track is hosted in the school of management while the CIS is hosted in the Metropolitan College.

An analysis of the programs at BU reveals the following--a dedicated course in project management is available to students in the Metropolitan College studying computer information systems at both the undergraduate and graduate level. For students in the computer science program, however, the project management course can only be taken as an elective. Likewise, the MIS program offers a project management course both the undergraduate and graduate level to students.

Since the focus of our paper is on soft skills, such as leadership, teambuilding, stakeholder analysis and engagement, ethics and professionalism, we describe other courses that provide such competencies in the figure below.

As the Figure 1 illustrates, undergraduates are required to have at least two semesters of instruction in academic reading writing and research and up to eight courses which fulfill the writing requirement. All such courses are relevant to communications when one manages projects or works in teams. It is common knowledge that more than 90% of what a project manager does in large projects is oral and written communication.

Goal	Requirement
Foundational Skills 1. English writing and related communication skills 2. Foreign language competence for communication in a global world 3. Basic competence in mathematics	1. Two semesters of instruction in academic reading, writing, and research 2. Study of a foreign language through the intermediate (fourth-semester) level, or equivalent proficiency 3. Completion of a mathematics course numbered CAS MA 109 or higher
General Education Acquisition of a breadth of knowledge and ways of knowing across the: ▪ humanities (HU) ▪ mathematical and computational sciences (MCS) ▪ natural sciences (NS) ▪ social sciences (SS)	**Core Curriculum** Completion of the integrated Core program (eight courses, which also fulfill the writing requirement) *-OR-* **Divisional Studies** Two courses in each of the three divisions outside the division (HU, MCS, NS, or SS) of the student's major
Major In-depth study leading to significant skills and understanding in an area of the student's choice	Completion of an existing 9-16-course Major *-OR-* Independent Major CS

Figure 1: Boston University Undergraduate Education

As indicated in the Figure 1 nine to sixteen courses in the major are available to students for the IS/CS core courses. The nature of such courses varies from one college to another and depends on whether they are studying CS, MIS or CIS. In the first two years, a few mandatory computing courses exist, others provide theoretical knowledge, includes, math, programming and foreign languages are required. A discussion of the specialization courses is out of scope for this paper – but it is sufficient to say they include coverage of topics such as software engineering, programming, databases and data communications.

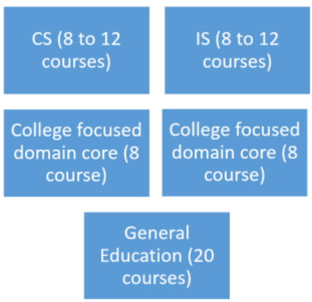

Figure 2: General education, domain core and IS/CS Specialization Courses distribution in USA Schools

BEHAVIORAL SKILLS EDUCATION IN CS AND IS AREAS IN BULGARIA

Sofia University is the oldest higher institution in Bulgaria, founded in 1888. Today the university offers a wide range of degrees in 16 faculties with more than twenty thousand students.

It is common practice European universities to start with core courses in the area since the first year of the education. Faculty of Mathematics and Informatics (FMI) at Sofia University also follows this tradition in all provided undergraduate programs in IT area: Informatics, Computer Science (CS), Information Systems (IS), Software Engineering (SE) and their corresponding master programs - Information Systems, Software Engineering, IT Services and Projects.

Following the recommendations of the curricula the CS program at FMI is focused on strong theoretical knowledge in the area. It consists mainly of math, programming, algorithms, operating systems courses in the first two years. The program continues with courses on database systems, artificial intelligence, software architectures. More than 100 elective courses are provided every semester but they usually are technically oriented.

The Table 1 describes the education during the first two years and the last two years. There is no Project Management course or other mandatory courses on these topics. The only course where the issues are discussed is the course "Social and legal aspects of IT", provided during the 6th semester.

The undergraduate program on IS at FMI is based on the recommendations of the curriculum, developed by ACM and Association of Information Systems (AIS). In this curriculum the Project Management course is a mandatory one, and it is a part of the FMI IS program since the program was established in 2006.

Table 1 CS education at FMI - Sofia University

First two years	Second two years
• Mandatory courses • Strong theoretical knowledge • Math, programming • Foreign languages	• Elective courses • Advanced programming, Database Management • Courses in Software Engineering and Project Management areas

Considering the need for good communication skills of IS specialists a new course "Communication skills and Team working" was provided to the students - first as elective, than as mandatory from 2015-2016 academic year.

Taking into account the crucial role of the documentation during the process of software development, a new elective course "Writing technical documentation" is announced for both CS and IS program for the next 2016-2017 academic year.

Besides this specialized courses non-technical skills can be learned in some general courses. For example, during the course "Analysis and design of IS" the students prepare team projects [Kaloyanova, 2014]. They learn how to work in a team, how to share responsibilities, how to interact with real stakeholders. The students also make several presentations, prepare documentation, etc.

THE RESULTS

At the undergraduate level only nine to sixteen courses are available to teach the core technical areas of CS/IS in USA schools. The general education that spans two years provides students a lot of flexibility to develop interests in other disciplines and most certainly to develop their written and oral communications and leadership skills.

Table 2 Boston University - Sofia University Comparison

	Boston University Programs	**Sofia University Programs**
Overall focus	Strong general education for the first two years.	Strong theoretical knowledge starting from first year of education.
Specialized courses	Few courses focus on specialization and students are encouraged to explore all disciplines outside the major.	Only a few courses that directly focus on non-technical skills.

When compared with Sofia university – which is representation of other EU countries, one notices educational differences vividly. Students in Bulgaria take more than twenty programming/technical courses. This provides them a richer knowledge in the specialization areas upon graduation.

While it is inevitable that the educational systems in the two countries will not change in the near future – we provide the following recommendations.

- Identify courses and opportunities that provides students the opportunity to build leadership, teams, and communication abilities.
- A few senior level programming courses should be adapted so that students work in teams so that they develop

communication skills, soft behavior skills, including stakeholder engagement skills.

- Such projects should involve external companies so that students develop strong stakeholder engagement skills.

CONCLUSION

Following the above discussion we provide some main recommendation that the professors could follow.

a) To address workforce expectations, instructors must focus on the learning outcomes that develop soft skills, while the IS curricula seems to do so, there is opportunity to introduce software project management as a required course even in the CS curricula

b) If this is not possible, optimize any opportunity to educate students in the areas of project management in other courses – example in a database course or a programming course by introducing team projects and involving external industry participants as sponsors.

Within this context, we also recommend future research in the areas of pedagogy. It is important to develop course activities and assignments that can teach non-technical skills across the board in the CS/IT curriculum. If so instructors will find it easy to embed non-technical learning outcomes in technical courses and develop competent students that the workforce wants.

ACKNOWLEDGMENTS

Kaloyanova: This paper is partially supported by Sofia University "St Kl. Ohridski" SRF under the contract 68/2016. *Kanabar:* PMI has provided funds to support curriculum research and supported the global curriculum design effort in PM.

BIBLIOGRAPHY

[IEEE Guide--Adoption, 2011]. IEEE Guide--Adoption of the Project Management Institute (PMI(R)) Standard A Guide to the Project Management Body of Knowledge (PMBOK(R) Guide)--Fourth Edition, 2011.

[Lowden et al., 2011]Lowden, K., St. Hall, D. Elliot and J. Lewin, Employers' perceptions of the employability skills of new graduates, Edge/SCRE Centre, 2011.

[Kaloyanova, 2014] Kaloyanova K., Information Systems Analysis and Design Course with Projects Based on Real Customers Requirements, Proceedings of the 8th Mediterranean Conference on Information Systems, MCIS 2014, 3-5 September, 2014, Verona, Italy; CD-ROM. ISBN: 978-88-6787-273-2, MCIS 2014 Proceedings. Paper 31; http://aisel.aisnet.org/mcis2014/31

[Kaloyanova and Kanabar, 2015] Kaloyanova K., V. Kanabar, Assessing Mastery of Project Management Core Competency in an IT Project Management Course, Proceedings of the 11th International Conference Computer Science and Education in Computer Science (CSECS), 4-7 June, 2015, Boston, USA, pp. 19-25.

[Kanabar and Messikomer, 2015] Kanabar, V.,C. Messikomer, Design and Implementation of an Adaptive Curriculum Framework for Project Management Education, Proceedings of IRNOP 2015, International Research Network on Organizing by Projects, London, UK, 2015.

[Kanabar et al, 2015] Kanabar, V; Klein, G; Messikomer, C;Niederman, F, "Addressing the Discrepancy between Workforce Skills Expectations and Undergraduate Information Systems Education" (2015).2015 Proceedings. Paper 5. http://aisel.aisnet.org/siged2015/5

[Kanabar, 2014] Kanabar V., Developing a Curriculum framework for Project Management:Architecture, Competencies, and Educational Approaches, Proceedings of the 10th Annual International Conference on Computer Science and Education in Computer Science (CSECS 2014), 4-7 July, 2014, Albena, Bulgaria, pp. 135-144.

[PMBOK, 2012] A guide to the project management body of knowledge (PMBOK guide). Newtown Square, Pa: Project Management Institute. 5th Edition, 2012.

[Task Force on PM Curricula, 2015]. PM Curriculum and Resources. Newtown Square, Pa: Project Management Institute, 2015.

[Topi et al, 2011] Topi H, J. Valasich, R.Wright, K.Kaiser, J.F. Nunamaker Jr, J. Sipior, G.J. de Vreede, IS 2010 Curriculum Guidelines for Undergraduate Degree Programs in Information Systems, http://www.acm.org/education/curricula/IS%202010%20ACM%20final.pdf

Authors' Information

Vijay KANABAR, PhD, PMP, Boston University, Metropolitan College, Associate Professor. Email: kanabar@bu.edu

Major Fields of Scientific Research: *IT Project Management, Curriculum Design and Development, Online education. Web application Development. Web Analytics.*

Kalinka KALOYANOVA, Professor, PhD, University of Sofia, Faculty of Mathematics and Informatics and BAS – Institute of Mathematics and Informatics, kkaloyanova@fmi.uni-sofia.bg.

Major Fields of Scientific Research: *Database Systems, Information Systems, Software Engineering, Project Management, Service Management*