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Original Scientific Paper

Prestige and Collaboration Among Researchers in the Field of Education and Career Development of ICT Graduates: Is There a Cross-Fertilization of Research and Knowledge?

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Abstract

This paper analyzes state of the art of the research regarding the education and career development of information and communications technology (ICT) graduates based on a comprehensive literature review. Analysis presented in this paper includes 155 papers in two research areas – one related to the education of ICT graduates (101 papers) and the other to their career development (54 papers). The most prestigious papers, most influential journals and groupings of authors in the abovementioned fields are identified by using the citation analysis and Social Network Analysis (SNA). Results show that the most influential papers related to ICT career are research papers dealing with ICT job skills requirements, and related to ICT education are ICT association's related reports and recommendations on curriculum development. In general, results show that there is a lack of cross-fertilization of knowledge in both areas which means that the mixing of ideas that can lead to better research results is missing.

Keywords: career development, ICT education, citation analysis, Social Network Analysis (SNA)

1. Introduction

Nowadays, Information and Communications Technology (ICT) and related industries make an increasingly important contribution to the economic growth and development of a society in general. The statistics from 2014 shows that in 2010 the ICT services sector in Europe was the only segment that has recorded structural increase since the crisis started in 2008 [1]. According to OECD's statistics, levels of

labour productivity within information industries are more than 60% higher than in the total business sector and higher than average across all OECD economies [2].

ICT sector shows high importance in the total economy, with the tendency of further growth. Such trends imply a need for more skilled workers that will contribute to further growth. Current data shows that, in comparison with other sectors, ICT sector represented 2,7 % of EU total employment in 2010 and the share of ICT employment in total employment remain stable in almost all European countries [1]. Newest data for 2014 shows nearly 8 million persons employed in 2014 as ICT specialists, representing 3,7 % of total employment [3]. While on the one hand there is a high demand for ICT specialists and employment of the ICT specialists across the economy as a share of total employment is high (i.e. 4,75% in UK, 4,66% in Canada, 4,07% in USA) [4], on the other hand many countries are facing difficulties when trying to fill vacancies for jobs requiring ICT specialist skills. Almost 40% enterprises with at least 10 employers experienced hard-to-fill vacancies for ICT specialists in 2014 [3].

Predictions for future growth in demand for ICT specialists are also positive. According to the European Centre for the Development of Vocational Training (CEDEFOP), Europe is challenged with 700.000 uncovered vacancies including ICT skills by 2015, and it is expected that 90% of jobs will require some sort of ICT skills in future [5]. Moreover, current predictions of future trends in ICT professional jobs and demand in Europe from 2012 to 2020 present three different scenarios [6], and in all three cases, the demand potential exceeds the predictions about the number of ICT graduates.

Presented data show the societal importance of the topic related to the education and future career development of graduates in the field of ICT. Accordingly, that topic should also be relevant in the context of scientific work, in order to provide scientifically researched and argumented solutions for the evident societal issue. Therefore, the overall goal of this paper is to provide short overview of topics covered within the scientific literature related to the education and career development of future ICT professionals and the specific goal is to detect the most influential papers in the field and to define any groupings of authors that streamline the research in the field.

2. Overview of ICT Professionals' Education Research

From the early beginnings of computer science and related disciplines and educational programmes, there was a problem of determining the body of knowledge and the set of skills that graduates with degrees in computer science should demonstrate from education's and employers' point of view [7], [8], [9]. Consequently, there is an evident mismatch between the industrial needs and the skills that computer science graduates possess [10]. As a solution to the evident mismatch in the skills expected from employers and the ones that graduates possess, the authors propose more intensive collaboration between the academia and industry in the form of internships and cooperative programs [10], [11] as well as the development of teaching

methodologies for solving real-world problems [10]. Suggestions for the improvements of curriculum design and its delivery have been the topic of many research papers [12], [13], [14], [15].

During the 1970s, a pattern of predictions about future trends in computer science developments and labour market needs for computer science professionals can be observed. For the 1980s, upcoming trends raised the question of the following issues in computer science education: theory versus practice in computer science curriculums, practical exposure of students to real-world problems through laboratory courses and the societal and moral issues included in the educational processes [16]. Predictions about future trends also indicated the continued growth of computer jobs in the 1980s [16], as well as growth in the number of different educational programmes in computer science [17]. In the 1990s, together with computer science, the usage of the term 'information system' became more prevalent in the literature, and emphasis was put on the necessary skills of future information systems professionals. There were several comprehensive studies related to knowledge and skills that future information systems professionals should possess to successfully perform their jobs [18], [19], [20] as well the evolution of information systems job skills during the 20-year period (from 1970 to 1990) [21].

The new trends in the emerging field of computer science discipline affected changes in computer science education, including new emerging topics into curriculum. The year 2000 is associated with the Institute of Electrical and Electronic Engineering (IEEE) Computer Society and Association for Computing Machinery (ACM) Joint Task Force on CC-2001 Computing Curricula project [22]. In a broader view on the changes in education, this year is also associated with Lisbon convention [23] and the Bologna process inception, which resulted in the establishment of The European Higher Education Area (EHEA) in a decade. Those initiatives put also a certain focus on teaching pedagogy, which had not been changed in a significant manner before that time [24]. With the new century approaching, much more attention was paid to this aspect of the education, resulting in more work and improvements in teaching methods: project-based learning [25], peer learning [26], active learning [27], [28], team learning [29], studio-based teaching and learning [30], [31], etc.

Around this period, much effort was also invested on the employability of future ICT professionals. The term 'employability' is defined as a person-centred construct, considering 'the quality of character of being employable' [32] and described with three component dimensions – career identity, personal adaptability, and social and human capital [33]. In line with the understanding of employability as a person-centred construct, the major responsibility for career development is put on individuals and not their employers. However, higher education institutions have tended to take responsibility for enhancing students' employability through their educational provision and learning activities, since the first employment after graduation is used as one of the main indicators of higher education quality [34]. In that process, the potential of graduates as perceived from employers became an important topic. The literature focused on ICT graduates refers to this topic in the context of investigating skills perceived as important by employers, [35], [36], [37], [38], with special emphasis on the importance of both hard skills and soft skills, [39],

[40], [41], gaps in curriculum as viewed by the business sector, [42], [43], [44], and general issues in graduates' employability and trends on the IS/IT job market [45]. The growing gap between supply and demand of skilled information technology professionals is stressed [46].

Additionally, the importance and actuality of the abovementioned topics is supported by recent research findings within relevant research and development projects related to graduates employability and by the implications coming from policy documents. The research within the project The Employability of Higher Education Graduates: The Employers' Perspective [47], conducted among more than 900 employers, indicates the need for both professional and interpersonal skills and the integration of new teaching methods into curriculum that would enhance the development of both professional and generic skills. Main findings from HEGESCO project [48] stress the importance of active learning modes as one of the key factors for generating students competences, but also the curriculum development, the cooperation with employers, the acquisition of relevant work experience during higher education etc. In addition, the results of DEHEMS project [49], based on more than 360 interviews performed in six different countries, stress the need to foster the cooperation between academia and industry on more formal basis i.e. to include the industry representatives in the curriculum development processes, to address the development of both hard and soft skills through the curriculum, to provide students with more actual work experience during their studies etc.

The above short review of the history and trends in ICT education leads to the conclusion that the literature, with slight variations over the period of time, mainly refers to the following aspects: changes in curriculum design and delivery, changes in teaching methods, issues regarding the employability of ICT professionals, importance of both hard (technical) and soft (non-technical) skills for future employment, perceived gaps as seen by employers and the need for closer cooperation between academia and industry.

3. Terminology Related to ICT Professionals' Education

As stated in IS 2002 report [50] and further discussed by Woratschek and Lenox [51], [52], the field of ICT has an excessive bundle of different names, including Information Technology, Information Systems, Information Technology Systems, Computer Information Systems, Management Information Systems, Business Information Systems, Information Management, Informatics, Information Science, Information and Quantitative Science, Computing, etc. Generally, computing can be divided into five main areas, namely Computer Science, Computer Engineering, Information Systems, Information Technology, and Software Engineering [53]. For further analysis within this research paper, it is important to understand and to elaborate the differences between different terms related to ICT discipline and to focus the research.

The Computer Science discipline emerged in the early 1960s [54] and one of the first scientific papers on that topic dates back to 1967, referring to the educational

programme in computer science [55]. Although not all academics agreed with the name 'computer science', the name was accepted by two associations very active within the development process of this profession from its very beginning – ACM and IEEE [54]. The Curriculum 68 represented the culmination of major developments in the computer science curriculum in 1960s [54]. In the 1970s, there was very active work on the development of computer science programmes, parallel with the development of the computer science discipline in general [56]. After Curriculum 68, there were several computer science curriculum updates (Curriculum 78, CC91, CC2001, CC2005, CC2013). The detailed examination of the series of ACM/IEEE curriculum updates provides an understanding of the differences between computer science-related education, as described in the following paragraph.

The discipline of Information Systems (IS) focuses on integrating information technology solutions and business processes to meet business objectives in an effective and efficient way. It emphasizes information and views technology as an instrument for generating, processing, and distributing information. From an academic perspective, undergraduate degree programmes in Information Technology (IT) prepare students to meet computer technology needs of business and other kinds of organizations [53]. The information technology discipline evolves rapidly, affecting both content as well as pedagogy. One of the examples is computer networking, which today is an inevitable aspect of information technology but back in the 1990s was not seen as a major topic [57]. Computer Engineering (CE), as one of the parts of computing, embodies the study of hardware, software, communications, and its mutual interaction, while its curriculum focuses on theories, principles, and practices of traditional electrical engineering and mathematics and their applicability to designing computers and computer-based devices. Software Engineering (SE), as a part of computing, born from computer science, is the discipline of developing and maintaining software systems adjusted according to the customers' requirements [53].

Regarding the abovementioned similarities and differences between the disciplines associated with ICT, we can elaborate the further focus of our research primary to the Information Technology and Information Systems, since these two integrate information technology and business systems. Computer Engineering and Software Engineering are narrower and focused on technology, without strong relation with business, while Computer Science is more comprehensive. Therefore, the focus on information systems and information technology will be broadened with the computer science discipline, as it also covers both technical and business skills. To simplify the communication of this study, we will use the abbreviation ICT when referring to the discipline as the focus of our research. For the purpose of clarity of ICT related terms used in this paper, it is also necessary to distinguish the *ICT graduates* from the *ICT professionals*. The term *ICT professionals* refers to the professionals employed in the ICT industry after finishing their education, while the term *ICT graduates* is used when referring to future *ICT professionals* that are still within the system of education.

4. Methods

In order to get a better insight into the scientific work on the education and career development of future professionals in the field of ICT, a comprehensive literature review was conducted by the authors of this paper, with a main goal to give insight into the current research on the education and career development of graduates in the field of ICT, to observe trends during time, to indicate research gaps and to provide guidelines for further research [58]. This review followed the general systematic literature review (SLR) steps proposed by Kitchenham [59] and guidelines from Webster & Watson [60]. Kitchenham stress several reasons for undertaking a systematic review, out of which the most common are [59]: (1) to summarize the existing evidence concerning the treatment or technology, (2) to identify gaps in current research in order to suggest areas for further investigation, and (3) to provide a framework/background in order to appropriately position new research activities. The idea of conducting a systematic literature review on the education and career development of future ICT professionals lies in the fact that the topic appears to be important for a longer period and there is no systematic work found in the existing literature. In this paper, the authors present results based on the papers used in systematic literature review, referring to the following research questions:

1. Which are the most influential papers in the fields?
2. Are there any groupings of authors in the field that streamline the research in the field?

4.1. Literature Search Procedure

The database search was conducted for the purpose of literature review, using several terms which can be divided in three groups. Variations of terms related to ICT, as explained in Chapter *Terminology related to ICT professionals' education*, are terms from the first group: "IT", "ICT", "IS", "Information system", "Computer science" and "Information Technology". In the second group are terms related to education and related contexts such as "Education*", "Graduate*", "Student*", "Curricul*" and "Program*", while the third group contains terms more related to the future careers, employment of students and competences required for their future jobs, i.e. terms "Job", "Career", "Profession*", "Employ*", "Skill*" and "Competenc*" [58]. According to the set terms, database search procedure resulted with two datasets for the analysis – one related to *ICT Education* and the other related to *ICT Career*.

As explained in more detail in [58], the database query was conducted within five databases. Two databases are from the largest professional associations in the research field of ICT: ACM Digital Library and IEEE Xplore Digital Library, and three databases that are considered today to contain the most relevant research papers in spectrum of scientific fields: SCOPUS, ScienceDirect, and Web of Science (WoS). Those databases contain publications from different disciplines, but our research query was limited only to those relevant to the research field according to the predefined categories in each database. Additionally, only the first 500 results

according to the relevance from Scopus and WoS were included in the analysis, without limitation to the year of publishing. In all databases, the search query was limited to the journal papers and conference publications. An initial search was made in the period 24–30 July 2014. From the initial database query, 7179 papers were acquired and read by title. According to the title, 900 papers were selected for the second review phase. After exclusion of the identical papers, 761 papers were obtained to be read by summary. For further analysis of the primary studies selected, inclusion and exclusion criteria were defined for each phase. Inclusion criteria for the third review phase resulted in 155 full papers that were included in the final analysis, 101 within *ICT Education* (Appendix A) and 54 within *ICT Career* (Appendix B).

4.2. Data Analysis Methods

For the analysis of research results, several approaches to the analysis of literature were used, including both qualitative and quantitative methods.

In this paper, the authors first present results of the bibliometric method of citation analysis, which refers to counting the references within the bibliography. According to Baker, citation analysis within its short version considers a count of cited journals, papers, or authors and in the advanced version, it can include the investigation between them to discover certain patterns (in [61]). For the purpose of this paper, the simple document citation analysis was used for counting the papers most cited by all the 101 papers within *ICT Education* and 54 papers within *ICT Career* dataset included in final analysis. There are several reasons that only the simple citation analysis is adequate for analysis of the whole set of references of analysed paper: (1) papers from different databases are included in the analysis, using different citation styles and (2) some papers are older and not adequate for optical character recognition. This brings us to the fact that around 2700 references should be manually prepared for the analysis, which increases the possibility of errors. For more advanced examination of co-citation between the papers included in analysis, social network analysis (SNA) was applied in order to determine the density of research networks, interconnection between different authors and the most influential author in the field.

5. Research Results

This chapter brings detailed results of citation analysis and the social network analysis on the *ICT Education* and *ICT Career* set of papers.

5.1. Most Cited Papers

Tables "Most cited papers in *ICT Education"* in Appendix C and "Most cited papers in *ICT Career"* in Appendix D present papers cited at least in two papers from the observed datasets. Interestingly, four out of five of the most highly cited and co-cited papers in *ICT Career* were published in the middle of 1990-ties, opposite to the most co-cited papers in *ICT Education* that were published ten years later. The most

influential journal for *ICT Career* is *MIS Quarterly*. On the other hand, the most frequently cited papers in *ICT Education* were those published by the ICT associations (ACM and IEEE) and are related to curriculum development recommendations. Although there are more papers analysed related to *ICT Education* (101) in comparison to *ICT Career* (54), the *ICT Career* dataset contains more papers that are found to be highly cited in the Scopus database – 17 compared to only 1 for papers within *ICT Education.* It can be concluded that the most influential papers in *ICT Career* are research papers dealing with ICT job skills requirements, and the most influential papers in *ICT Education* are ICT association's related reports and recommendations on curriculum development. Results of the citation analysis provides one part of the answer to the research question "Which are the most influential papers in the fields?", which will be also amended with the results of social network analysis.

5.2. Cross Fertilization within *ICT Education* and *ICT Career*

For further analysis, the Social Network Analysis (SNA) approach and measures were used to estimate cross fertilization of research ideas and results in each area and between areas [62]. The definitions and formulas used in this paper can be found in [63]. First, a directed graph that contained nodes (vertices) representing papers (points in Figure 1 and Figure 2) and oriented lines (arc) representing co-citations was built (lines in Figure 1 and Figure 2).

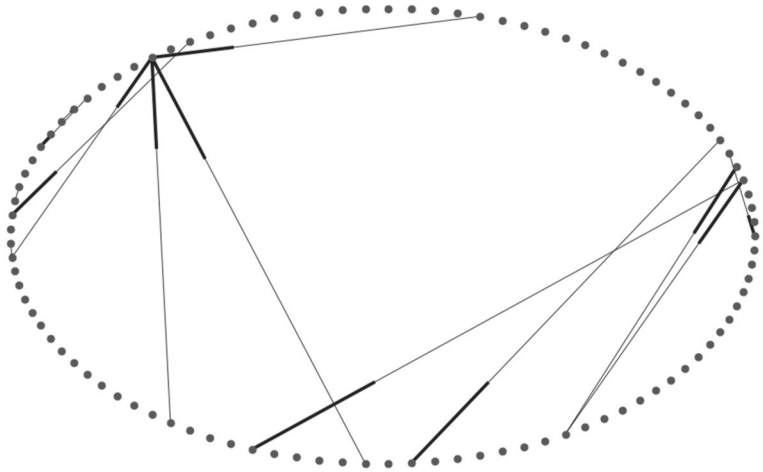

Figure 1. *ICT Education* co-citation network

The origin of an arc is a paper that cited the paper in the head of the arc. Taking into consideration only co-citation within networks, the *ICT Career* network is more interconnected (Figure 1 and Figure 2). This is evident from the network density

measure[1], which shows that the density of the *ICT Career* network is 0,0234 and of the *ICT Education* network is 0,001386. In both networks, there are many independent studies that are not based on similar research backgrounds, but the papers in *ICT Career* share more common references.

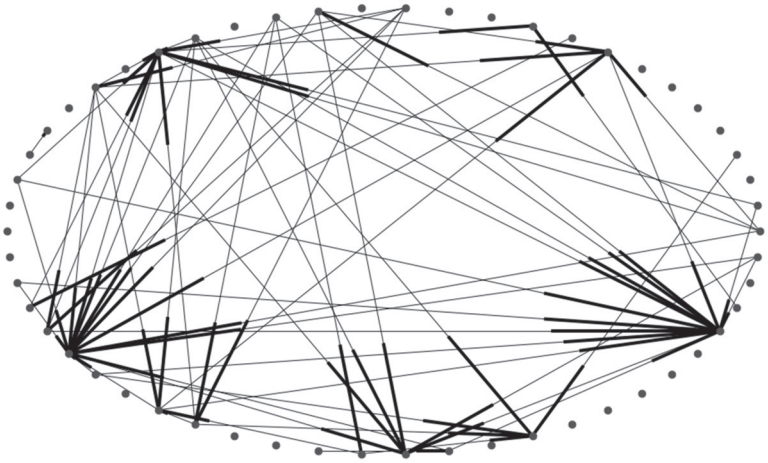

Figure 2. *ICT Career* co-citation network

It is useful to identify the papers that represent the set of common references. For that purpose, the centrality measures in SNA were used. Degree centrality is a measure based on numbers of ties that one node has with others. In directed graphs, as those observed here, it is important to distinguish the centrality based on indegree and the centrality based on outdegree. High indegree centrality indicates the importance or the prominence of a certain node (in this case paper), also called a prestige. A prestigious paper enjoys high popularity, which is in this case shown by being referenced in many other papers. In absolute and standardized (divided with 54) measures, the highest prestige degree within *ICT Career* co-citation network is obtained for the following papers: Lee et al. (1995) [64], cited in 14 papers from the network (0,259), Todd et al. (1995) [21], cited in 13 papers (0,241) and Gallivan (2004) [37] cited in nine other papers (0.1667). Other papers are much less prestigious and cited only six times or fewer. Within the *ICT Education* co-citation network, in absolute and standardized (divided by 101) measures, the highest prestige degree is observed for the paper Hagan (2004) [43], cited in four other papers (0,0396). There are 10 more papers cited only once (0,0099). On the other hand, papers with the high outdegree centrality can be described as very familiar with the research area, since they are citing other papers from the network. Within *ICT Career*, there are two papers: Gallagher et al. (2011) [65] and Goles et al. (2008) [66], that are referencing six other papers from the network, and Donohue & Power (2012) [67] referencing five other papers, and have

[1] The density (D) of the ratio of the number of lines present (M) to the maximum possible e.g. D=M/N(N-1), where N is the number of nodes (vertices). The density is always between 0 and 1.

the highest outdegree. Three other papers are referencing four different papers from the network, six papers are referencing three other papers and 14 more papers are referencing only one or two. As with the other measures, the *ICT Education* network shows lower connectivity, with only one paper referencing two others (Sobiesk et al. 2006) [68] and 12 papers referencing only one paper from the network. Based on the indegree and outdegree measure, several types of papers can be recognized. Both *ICT Career* and *ICT Education* networks contain mostly *isolate* papers (24 in *ICT Career*, 79 in *ICT Education*), without any connections with other papers (Table 1). It can be concluded that there are several papers enjoying prestige in the analysed set of papers but without any papers that take into account the previous research. This analysis contributes to answer the research question "Which are the most influential papers in the fields?".

	INDEGREES	
OUTDEGREES	>0	0
>0	Carrier (ordinary) 12 ICT Career 2 ICT Education	Transmitter 14 ICT Career 11 ICT Education
0	Receiver 4 ICT Career 9 ICT Education	Isolate 24 ICT Career 79 ICT Education

Table 1. Types of papers in *ICT Education* and *ICT Career* network

Figure 3 provides a detailed overview of the structure of *ICT Education* co-citation network (extracted arcs from Figure 1), which consists of eight components of connectivity. This graph does not contain any cutpoints (nodes whose removal increases the number of components of connectivity) or bridges (lines that are critical to the connectedness of the graph). There are no cliques (groups of researchers) identified, but from the analysis of all the authors (and not only the first author as shown in Figure 3 and Figure 4), it can be seen that six isolated components are the result of authors' self-citations.

From Figure 4, it can be seen that the *ICT Career* co-citation network (extracted arcs from Figure 2) has a different structure, with only two components of connectivity, where one of them contains the majority of analysed papers and the other represents a case of self-citation.

The earliest papers dates from Cheney in 1990 [18] and Nelson in 1991 [19], followed by two papers with highest indegree centrality of the network in 1995: Lee et al. [64] and Todd et al. [21] The latest three papers have been by all measures very influential in the area of *ICT Career*. The detailed examination of all the authors shows the existence of one research group with four co-cited papers (Nelson et al. 2007 [38];

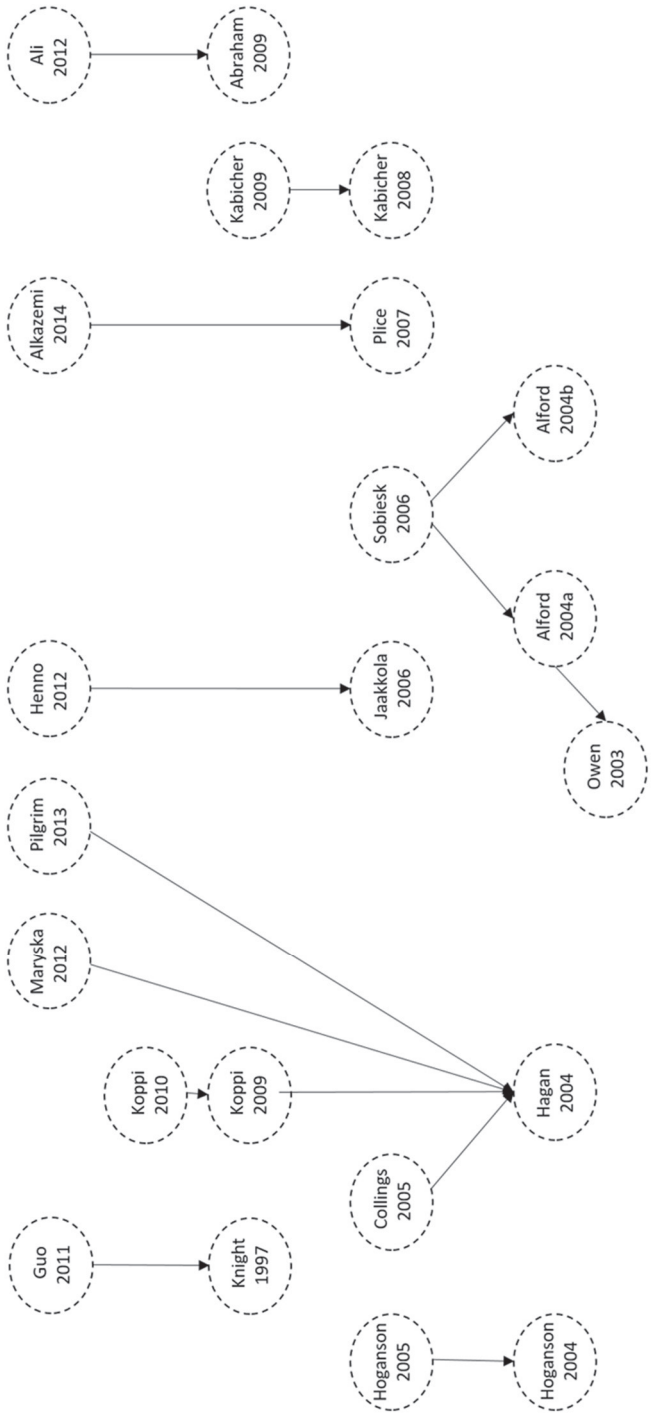

Figure 3. Directed graph of co-citations between papers within *ICT Education*

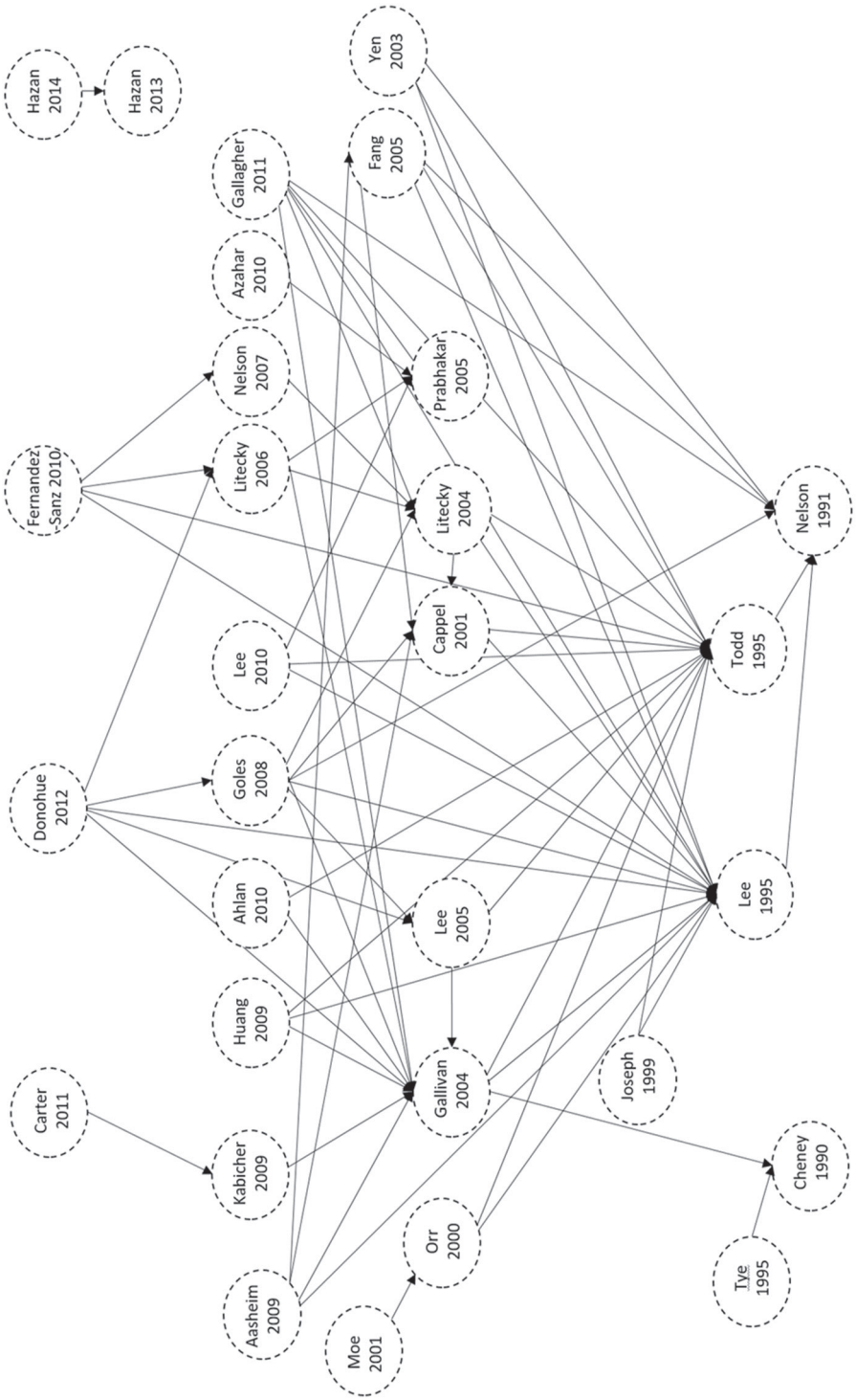

Figure 4. Directed graph of co-citations between papers within *ICT Career*

Litecky et al. 2004 [39]; Litecky et al. 2006 [45]; Prabhakar et al. 2005 [69]). Figure 4 also shows (in form of quazi-Hasse diagram) crucial papers for certain time spans (period) for the *ICT Career.* Presentation of co-citation networks provides answer to the research question: "Are there any groupings of authors in the field that streamline the research in the field?"

6. Discussion and Conclusion

Presented research resulted in several outputs relevant for the research area of the education and career development of future professionals in the field of ICT, as will be discussed and summarized in this chapter. This paper provides the analysis 155 papers in two research areas called *ICT Education* (101 papers) and *ICT Career* (54 papers). The number of relevant papers identified and analysed within *ICT Education* is almost double than within *ICT Career*.

Considering the first research question: "Which are the most influential papers in the fields?" it can be concluded that the most influential papers in *ICT Career* are research papers dealing with ICT job skills requirements and the most influential papers in *ICT Education* are professional associations' related reports and recommendations on curriculum development. In both topics, there are many independent studies that are not based on similar research backgrounds, but the papers in *ICT Career* share more common backgrounds. In general, there is a lack of cross-fertilization of knowledge in both areas which means that the mixing of ideas that can lead to better research results is missing.

The SNA approach that represents references in forms of directed graphs reveals the historical development of two research areas and identifies the most prestigious papers that influence development of the areas but also give us information about influential journals and reports. On the one hand, it is found that ASM/IEEE reports and reconditioning of ICT-related curricula have a considerable impact on research in *ICT Education*. On the other hand, *MIS Quarterly Journal* is far from the most influential journal in the *ICT Career* field. Some of the reasons for this are that the fundamental papers in 1990-ties were published there and that those papers have the highest citation rate in general but also a high co-citation (citation obtained by analysed papers in this study) rate. These papers inaugurated the topic of skills for jobs in the ICT-related industry.

Citation analysis extracted only a few papers that were more cited while they provided more fundamental results based on more comprehensive research. This indicates that future research should tackle more successful case studies with evaluation of results and analysis of transferability into new contexts.

The answer to the second research question "Are there any groupings of authors in the field that streamline the research in the field?" was obtained from the co-citation analysis. The analysis of citation graphs demonstrates that the density of both networks is rather low, implying that there is a lack of sharing of research findings, and therefore, it is not feasible to achieve some important theoretical framework or breakthrough. It is especially important for the *ICT Education* area. Therefore, it

would be important to invest in multi-partner projects dealing with the topics of ICT education and graduates' early career development and establish specialized journal(s) and communities of practice in the mentioned research areas.

Acknowledgements

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Appendix A: List of Papers within *ICT Education*

1. Abraham, Aju Thomas, and Jayasankar Prasad. 2009. "Industry Institute Interaction for Capability Building in Engineering Education in India a Study on the Indian Information Technology Companies." In 2009 ITI 7th International Conference on Communications and Information Technology (ICICT), pp. 17–22.
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Appendix B: List of Papers within *ICT Career*

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Appendix C: Most Cited Papers in *ICT Education*

No.	Paper	Co-citation frequency (from papers in SLR_r3)	Co-citation frequency in Scopus (10th August 2015)
1.	ACM/IEEE Computer Society (2005). Computing Curricula 2005. The Overview Report. ACM/IEEE Comp. Society	6	0
2.	Engel, G. and Roberts, E. (Eds) (2001). *Computing Curricula 2001 – Computer Science*. IEEE Computer Society and Association for Computing Machinery	6	0
3.	Gorgone, J.T.; Davis, G.B.; Valacich, J.S.; Topi, H; Feinstein, D.L. and Longenecker, H.E. (2003). IS 2002: Model Curriculum and Guidelines for undergraduate degree program in Information Systems. Communications of the Associations for Information Systems	6	33
4.	Hagan, D. (2004). Employer satisfaction with ICT graduates, Sixffi Australasian Computing Education Conference (ACE2004), Conferences in Research and Practice in Information Technology, vol 6, Australian Computer Society	4	-
5.	Nunamaker, J.F., Couger, J.D., and Davis, G.B. (1992). 'Information Systems Curriculum Recommendations for the 80s: Undergraduate and Graduate Programs,' Communications of the ACM (25:11), pp. 781-805.	4	-
6.	Tucker, A. (1991). 'Computing Curricula 1991' *Communications of the ACM*, (34: 6), pp. 68-84, June 1991.	4	-
7.	ACM/IEEE Computer Society Joint Interim Review Task Force (2008). Computer Science Curriculum 195 2008: An Interim Revision of CS 2001, Report from the Interim Review Task Force	3	-
8.	Career Space Consortium (2002). Curriculum Development Guidelines. New ICT Curricula for the 21st Century: Designing Tomorrow's Education.	3	-
9.	Davis, G.B., Gorgone, J.T., Couger, J.D., Feinstein, D.L., Longenecker, H.E., Jr. (Eds.) (1997). 'IS'97 Model Curriculum and Guidelines for Undergraduate Degree Programs in Information Systems,' *DATABASE*, Volume 28, Number 1, pp. Bi-B94.	3	-
10.	Ekstrom, Joseph J. and Barry Lunt (2003). Education at the Seams: Preparing students to stitch systems together; Curriculum and Issues for 4-Year IT Programs *CITC4'03*, October 16–18, 2003, Lafayette, Indiana	3	-
11.	Fishbein, M., & Ajzen, I. (1975). Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research. Reading, MA: Addison-Wesley.	3	-

12.	Longnecker, H.E., Jr., Feinstein, D.L., Cougar, J.D., Davis, G.G., and Gorgone, J.T., (1994-1995). 'Information Systems '95: A Summary of the Collaborative IS Curriculum Specifications of the Joint DPMA, ACM, AIS Task Force,' *Journal of Information Systems Education,* Volume 6, Number 4, Winter, pp. 174-186	3	-

Appendix D: Most Cited Papers in *ICT Career*

No.	Paper	Co-citation frequency (from papers in SLR_r3)	Co-citation frequency in Scopus (10th August 2015)
1.	Lee, D., Trauth, E., and Farwell, D. (1995). 'Critical Skills and Knowledge Requirements of IS Professionals: A Joint Academic/Industry Investigation.' *MIS Quarterly*, 19(3), 313-340.	14	400
2.	Todd, P., McKeen J., and Gallupe R. B. (1995). „The Evolution of IS Job Skills: A Content Analysis of IS Job Advertisements from 1970 to 1990,' MIS Quaterly, 19:1, March 1995, pp. 1-27.	13	168
3.	Leitheiser, R. (1992). 'MIS Skills for the 1990s: A Survey of MIS Managers' Perceptions.' *Journal of Management Information Systems*, 9(1), 69-91.	10	95
4.	Gallivan, M., Truex M, D., and Kvasny, L. (2004). 'Changing Patterns in IT Skill Sets 1988-2003: A Content Analysis of Classified Advertising.' *Database for Advances in Information Systems*, 35(3), 64-87.	9	39
5.	Trauth, E., Farwell, D., and Lee, D. (1993). 'The IS Expectation Gap: Industry Experience Versus Academic Preparation.' *MIS Quarterly*, 17(3), 293-307.	9	182
6.	Nelson, R.R. (1991). 'Educational Needs as Perceived by IS and End-user Personnel: A Survey of Knowledge and Skill Requirements,' MIS Quarterly, 15:4, December 1991, pp, 503-525	6	133
7.	Arnett, K. and Litecky, C. (1994). 'Career Path Development for the Most Wanted Skills in the MIS Job Market,' Journal of Systems Management, Vol. 45, No. 2, pp. 6-10.	5	-
8.	Cheney, and Lyons N.R. (1980). 'Information Systems Skill Requirements: A Survey', *MIS Quarterly, 4:* 1 (March 1980) 35-43.	5	-
9.	Nunamaker, J.F., Cougar, J.D. and Davis, G.B. (eds.) (1982). 'Information Systems Curriculum Recommendations for the 80s: Undergraduate and Graduate Programs – A Report of the ACM Curriculum Committee on Information Systems', Communications of the ACM, 25: 11 (November 1982) 781-805.	5	-
10.	Prabhakar, B., Litecky, C. R., & Arnett, K. (2005). *IT Skills in a Tough Job Market*, Communications of The ACM, p91-94.	5	-

11.	Cappel, J. (2001/2002). 'Entry-Level IS Job Skills: A Survey of Employers.' *Journal of Computer Information Systems*, 42(2), 76-82.	4	54
12.	Freeman, P. & Aspray, W. (1999). The Supply of Information Technology Workers in the United States, Computer Research Association, Washington, 25-41.	4	-
13.	Green, G. I. (1989). Perceived Importance of Systems Analysts' Job Skills, Roles, and Non-Salary Incentives. MIS Quarterly, 13(2), 115-133.	4	91
14.	Koh, S., Lee, S., Yen, D.C. and Havelka, D. (2001). 'Evolution of IS Professionals' Competency: An Exploratory Study,' Journal of Computer Information Systems, Summer 28, pp, 21-30	4	-
15.	Litecky, C.R., Prabhakar, B.K., and Arnett, K.P. (1996). MIS job market: Shaken, but not stirred. Journal of Systems Management, July/August, 50-54.	4	-
16.	Litecky, C. R., Arnett, K. P., and Prabhakar, B. (2004). The Paradox of Soft Skills versus Technical Skills in IS Hiring, Journal of Computer Information Systems, 45(1), 69-76.	4	41
17.	Niederman, F., Brancheau, J. and Wetherbe, J. (1991). 'Information Systems Management Issues for the 1990s,' MIS Quarterly, Vol. 15, No. 4, pp. 474-500.	4	289
18.	Sukhoo, A., Barnard, A., Eloff, M., & Van der Poll, J.A. (2005). Accommodating Soft Skills in Software Project Management. The Journal of Issues in Informing Science and Information Technology, 2,691-703.	4	-
19.	Watson, H.J., Young, D., Miranda, S., Robichaux, B. and Seerley, R. (1990). 'Requisite Skills for New MIS Hires,' Data Base, Vol. 21, No. 1, pp. 20-29.	4	-
20.	Abraham, T., Beath, C., Bullen, C., Gallagher, K., Goles, T., Kaiser, K., and Simon, J. (2006). 'IT Workforce Trends: Implications for IS Programs.' *Communications of the Association for Information Systems*, 17, 1147-1170.	3	-
21.	Ashenhurst (ed.) (1972). 'Curriculum Recommendations for Graduate Professional Programs in Information Systems: A Report of the ACM Curriculum Committee on Computer Education for Management', *Communications* of *the ACM,* 15: 5 (May, 1972) 363-398.	3	32
22.	Bailey, J.L., & Stefaniak, G. (2000). Preparing the Information Technology Workforce For the New Millennium. ACM SIGCPR Computer Personnel, 20(4), 4-15.	3	3
23.	Cash, E. et al. (2004). *The Impact of E-commerce on the Role of IS Professionals*. ACM SIGMIS Database, 35(3), 50-63.	3	22
24.	Couger, J.D.,, Davis, G.B., Dologite, D.G., Feinstein D.L., Gorgone, J.T., Jenkins, A.M., Kasper, G.M., Little, J.C., Longenecker, H.E., Jr, and Valacich, J.S. (1995). 'IS'95: Guideline for Undergraduate IS	3	68

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25.	Gorgone, J., Davis, G., Valacich, J., Topi, H., Feinstein, D., Longenecker, H. (2002). Model Curriculum and Guidelines for Undergraduate Degree Programs in Information Systems, Association for Computing Machinery. New York	3	33
26.	Igbaria, M., Greenhaus, J.H., Parasuraman, S. (1991). Career Orientations of MIS Employees: An Empirical Analysis, MIS Quarterly, 15(2), 151-169.	3	145
27.	Koh, S., Lee, S. and Tang, H.L. (2000/2001). 'Educational Gaps as Perceived by IS Educators: A Survey of Knowledge and Skill Requirements,' Journal of Computer Information Systems, 41:2, Winter 2000/2001, pp, 76-84	3	-
28.	Roark, M. L. (1976). Information Systems Education: What Industry Thinks, Data Management, 14(6), 24-28.	3	-
29.	Wade M.R. and Parent, M. (2002). Relationships Between Job Skills and Performance: A Study of Webmasters, Journal of Management Information Systems, 18 (3) p. 71-96.	3	53
30.	Young, D. and Lee S. (1996). „The Relative Importance of Technical and Interpersonal Skills for New Information Systems Personnel,', Journal of Computer Information Systems, Summer 1996, pp. 66-71.	3	-

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