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MAPPING IS CURRICULUM RESEARCH AREAS: A SYSTEMATIC LITERATURE REVIEW FROM 2010 TO 2019

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Abstract:

Research on IS curriculum addresses many important aspects related to IS curriculum planning: sharing of good curriculum planning practices, reviewing and recommending contents for IS curriculum, and identifying graduates' competency needs. A bit surprisingly, however, there is no systematic literature review on IS curriculum research, increasing the possibility that knowledge does not accumulate, or reach intended beneficiaries. In this paper, we present results of a systematic literature review of IS curriculum research from 2010 to 2019. In total, 204 articles are downloaded from Scopus, AIS eLibrary, and ACM digital library. In addition to providing an overview of research demographics, we classify the articles first into three broad categories (planning process, curriculum contents, competency requirements), and secondly to more specific classes within each category. For IS curriculum researchers, the results assist in identifying prior research in different areas, thus promoting accumulation of research knowledge. For IS faculty, the paper provides an overview of IS curriculum related studies and a possibility to identify papers based on their immediate curriculum design needs and interests.

Keywords: IS curriculum, systematic literature review, literature review

I. INTRODUCTION

The Association of Information Systems maintains a global database, Eduglopedia (https://eduglopedia.org/), that provides information about 1028 IS programs of 581 institutions around the world. It is reasonable to suggest that actual number of IS programs globally is much higher. Curriculum guidelines such as IS 2010 and MSIS 2016 constitute one means to seek high quality in IS programs. For undergraduate level IS curriculum, IS 2010 pays attention to the architecture of the curriculum and provides recommendations for electives and career tracks [Topi et al., 2010]. For graduate level IS curriculum, MSIS 2016 maps various competencies and professional profiles to build a set of modules to transfer competencies to an implementable curriculum [Topi et al., 2017].

Research addressing various aspects of IS curriculum serves as a means to transfer knowledge related to IS curriculum process, program contents and competency requirements. Prior systematic literature reviews (SLRs) have typically focused on a particular aspect of IS curriculum. For example, Blair et al. [2018] focused on cybersecurity and used one section to review the salient literature for examining the evolution of IS education, providing a way for improving cybersecurity in IS education. Figl [2010] did an SLR in order to build a framework on strategies to improve team competencies in IS education. Babajide et al. [2018] conducted a systematic review to identify the observations and opportunities for four topics of gamification in IS education. While recognizing the value of these specific reviews, we believe that also a broader view on IS curriculum research can be useful.

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This paper uses an SLR method to classify research on IS curriculum [Kitchenham, 2004]. We focus on the IS curriculum research from 2010 to 2019. By searching on three databases of AIS eLibrary, Scopus, and ACM digital library, 204 articles on IS curriculum were collected. The classification of papers was based on careful analysis of problem formulation and study design, with a purpose of identifying papers that share a similar focus on a particular aspect of IS curriculum design. Based on this work, we build a framework of IS curriculum research that identifies three main research areas: curriculum planning process, curriculum contents, and competency requirements. Further classification within the categories led to 10 classes. The resulting framework, grounded to existing research, forms one contribution of this paper, together with observations regarding research demographics and propositions for future research.

II. RESEARCH METHODOLOGY

In Kitchenham's [2004] definition, the SLR is "a means of identifying, evaluating, and interpreting all available research relevant to a particular research question, or topic area, or phenomenon of interest." Compared with the conventional literature review, the SLR contains a clear review protocol, search strategy, inclusion, and exclusion criteria. It is more specific, rigorous, and complete [Kitchenham, 2004]. The strategy is aimed at detecting as much of the relevant literature as possible. The procedure of the SLR are document below.

The main purpose of this research is to find the current research states of IS curriculum during 2010 and 2019, and then give recommendations for IS curriculum development. Research questions are listed below:

RQ1: What is the status of IS curriculum research, in terms demographic data of publications?

RQ2: What are the main research areas of IS curriculum research?

RQ3: What recommendations can be given for future research on IS curriculum?

With respect to RQ1, it is mainly concerned about the demographic information of the IS curriculum research, such as year, journal/conference and country. To address RQ2, based on the research purpose and content, this research classified the existing literature from 2010 to 2019. In RQ3, we provide some propositions for research direction and provide recommendations for IS curriculum development.

Following our research objective, we used keywords "information systems curriculum" or information systems curricula" as search words in Scopus and ACM digital Library. In AIS eLibrary the search was made with "curriculum" or "curricula", as all papers in the database are in the field of information systems. We limited the search year from 2010 to February 2020. All papers found were downloaded and listed in excel. The detailed research strategies are shown in table 1.

Table 1: Searching strategies of three databases

Databases	Searching strategy	Num. of retrieved papers
AIS elibrary	abstract: "curriculum" OR abstract: "curricula" 01.01.2010-02.19.2020	413
Scopus	(TITLE-ABS-KEY ("information systems") AND TITLE-ABS-KEY ("curriculum" OR "curricula")) AND DOCTYPE(ar OR cp) AND PUBYEAR > 2009 AND (LIMIT-TO (LANGUAGE, "English"))	1832
ACM digital Library	[Abstract: "information systems"] AND [[Abstract: "curriculum"] OR [Abstract: "curricula"]] AND [Publication Date: (01/01/2010 TO 29/02/2020)]	645

Before reviewing and classifying articles based on contents, several the inclusion criteria (IC) and exclusion criteria (EC) were used. All papers that (1) were not in English, (2) were not full-text journal or conferences papers with a peer-review process, and (3) were outside the time frame (01/2010 to 02/2020), (4) were not bachelor or master level IS curriculum research were excluded. As we used several databases, duplicates had to be removed from the sample. We used excel formula IF(COUNTIF(range,criteria),value_if_true, value_if_false) to compare article titles. First, we compared AIS eLibrary with Scopus, and there are 59 AIS articles in Scopus results. And then, we compared ACM with AIS and Scopus, and there are 56 ACM articles in AIS and Scopus results. (In table 2, all duplicates appear on row "AIS elibrary").

The screening based on contents is a subjective and difficult part of a literature review [Okoli and Schabram, 2010]. This research conducted two screenings on the basis of title-abstract-keywords and full-text. The basic problem at this stage was, whether IS curriculum is a main topic of the paper is sufficiently related to some aspect of IS curriculum design. Two reviewers (one senior researcher and one junior researcher) conducted this process by using "1" as related, and "0" as unrelated. By uniting their comments, the final decision on each article was made as a mutual judgement. This led to a sample of 177 articles, which were then used as a basis for backward and forward screening. Relevant articles from forward citation chaining and backward citation chaining were added to collect articles as comprehensively as possible. This led to identifying 27 more articles making the final sample size to 204 articles. Table 2 shows the number of related articles in each procedure.

Table 2: Selected procedures

Databases	Search result	Exclude duplicate articles	Title-abstract-keywords review	Full-text review	Citation	Total
AIS library	413	413	109	79	79	204 articles
Scopus	1832	1773	217	95	95	
ACM Library	645	589	5	3	3	
Citation	0	0	0	0	27	

The third step was the classification of articles. Based on authors' experience, initial classification rules were established. Two researchers (authors) independently classified the entire curriculum literatures, and then exchange ideas which resulted to iterations with a slightly revised classification scheme.

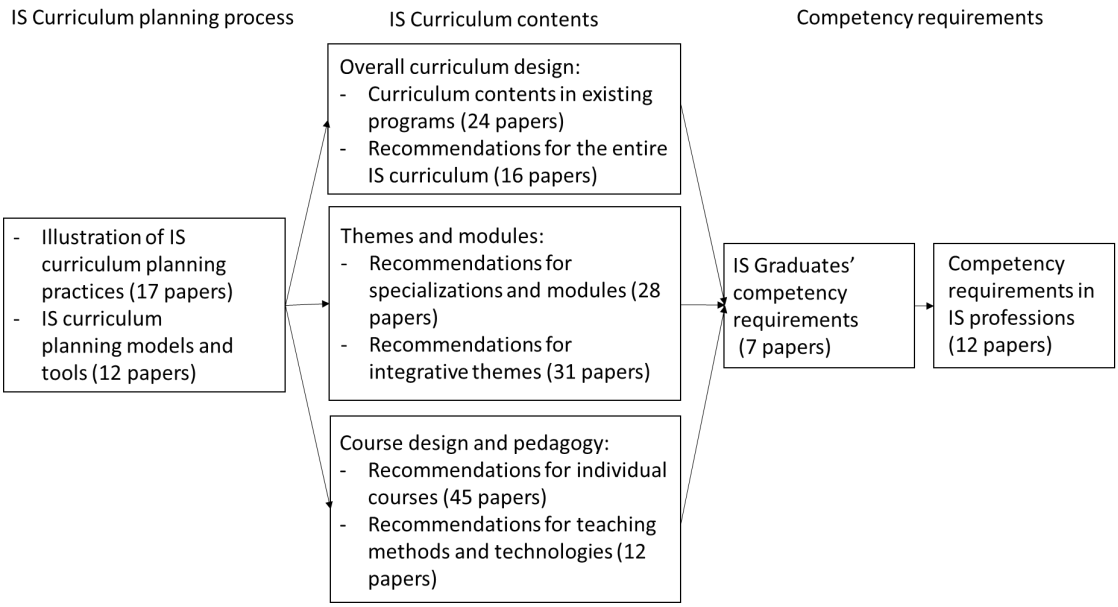

Figure 1. Overview of IS curriculum research areas

With three rounds of iteration, the final classification rules were fixed (Figure 1). Already the first classification scheme had the distinction to three main categories: curriculum planning process; curriculum contents, and competency requirements. Curriculum planning process papers were further classified to papers focusing on (1.1) curriculum planning practices; and (1.2) curriculum planning methods and systems. Curriculum content papers were classified further as (2.1) descriptions of curriculum contents in existing programs, (2.2) recommendations related to entire curriculum; (2.3) a specialization or module; (2.4) an integrative theme; (2.5) a single course; or (2.6) a particular learning method. Finally, papers looking at graduates' competencies were classified to papers (3.1) measuring graduates' competencies, and (3.2) papers that investigate competency requirements in the IS profession.

Classification of papers to one area was naturally not an easy task. Many papers were covering supportive themes from more than one area. We believe, however, that the classification scheme described in Figure 1 is sufficient to identify and classify papers based on similarity and main research goals and objectives, thus forming areas of IS curriculum research.

III. IS CURRICULUM RESEARCH DEMOGRAPHICS

Over the past ten years, there is some fluctuation in the volume of IS curriculum research. The number of publications per year is between 15 and 26. The IS curriculum research reached its peak in 2012 with 26 papers. Figure 2 shows the details of distribution of paper per year. Although the sample is small, it is interesting to note that after the release of curriculum guidelines (IS 2010 and MSIS 2016), a small increase in publishing activity can be seen. This observation is supported by the contents of the papers, as some papers explicitly addressed model curricula, for example by explaining choices made [Lawler et al., 2012a; Leidig et al., 2019; Mills et al., 2012], or investigating the degree to which IS programs were in alignment with the new recommendations [Apigian and Gambill, 2010; Bell et al., 2013; Clark et al., 2017; Larson, 2013; Leidig et al., 2014; Sagheb-Tehrani, 2015; Wibisono and Nisafani, 2013; Yang, 2012].

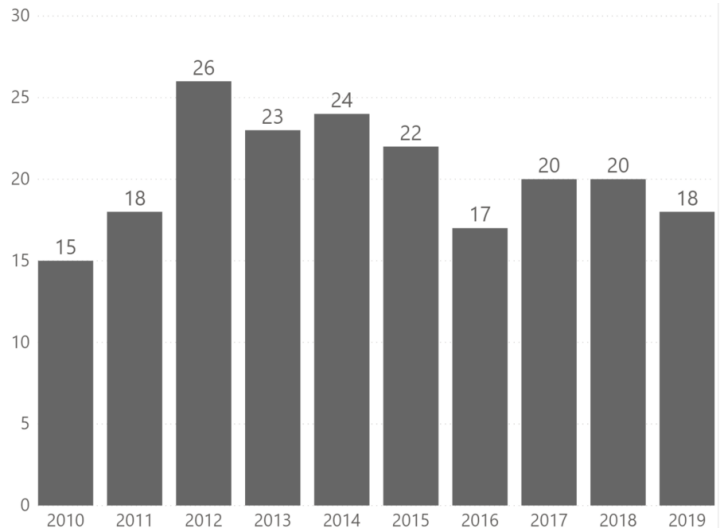

Figure 2: Distribution of paper by year

Table 3 lists the publication journals and conferences with the publication numbers greater than one. The top three journals are *Journal of Information Systems Education*, *Information Systems Education Journal*, and *Communications of the Association for Information Systems*. Papers from these journals account for 29.41% of the total samples. The top three conferences are *Americas Conference on Information Systems (AMCIS)*, *Information Systems Education Conference (ISECON)*, and *Southern Association for Information Systems (SAIS)*, which accounts for 19.61% of the total samples.

Table 3: Distribution of paper by channels

Journal	Num.	Conference	Num.
Journal of Information Systems Education	29	Americas Conference on Information Systems (AMCIS)	21
Information Systems Education Journal	17	Information Systems Education Conference (ISECON)	12
Communications of the Association for Information Systems	14	Southern Association for Information Systems (SAIS)	7
Journal of Education for Business	8	AIS Special Interest Group for Education (SIGED) conference	6
Journal of Computer Information Systems	5	International Conference on Information Systems (ICIS)	5
Issues in Information Systems	4	European Conference on Information Systems (ECIS)	4
International Journal of Information and Communication Technology Education	3	Midwest Association for Information Systems (MWAIS)	3
Journal of Higher Education Theory and Practice	3	International Conference on Information Technology in Medicine and Education (ITME)	2
Journal of Computing Sciences in Colleges	2	Multikonferenz Wirtschaftsinformatik (MKWI)	2
Journal of Information Technology Education: Innovations in Practice	2	Pacific Asia Conference on Information Systems (PACIS)	2
Review of Business Information systems	2		

Further analysis of the demographics demonstrates that research community surrounding IS curriculum is very much U.S. based. According to the first authors' institutions, the country/area distributions are shown Table 4. In 138 papers, occupying 68% of the total sample, the first author is from the U.S. Papers with a first author from e.g. Germany, Australia, UK, and China do exist, but volumes are considerably lower.

Table 4: Country/area distribution of publications

Country/Area	Num.	Country/Area	Num.	Country/Area	Num.
USA	138	Indonesia	2	Malaysia	1
Germany	7	Austria	1	Norway	1
Australia	6	Botswana	1	Portugal	1
UK	6	Canada	1	Romania	1
China	5	Egypt	1	Russia	1
Singapore	4	France	1	Saudi Arabia	1
South Africa	4	Hongkong	1	Southern Africa	1
Turkey	4	India	1	Thailand	1
Denmark	3	Ireland	1	United Arab Emirates	1
Finland	3	Israel	1		
Sweden	3	Kingdom of Saudi Arabia	1		

The most active institutions (based on first author affiliation) are Bentley University with seven papers, followed by James Madison University (6 papers), and Grand Valley State University, Marymount University, Middle Tennessee State University, Quinnipiac University, Singapore

Management University and University of South Alabama (4 papers). Among the list of the top 16 institutes having three or more papers, Singapore Management University is the only institution outside of the U.S.

Table 5 lists the top five most cited papers. The top two papers have been cited more than 500 times. One is IS2010 which is the latest guideline for bachelor curriculum, and the other is a top journal paper which published in *Management Information Systems Quarterly*. The remaining three papers were published between 2010 and 2011, and have over 50 citations. Out of the papers published during years 2010-2014, 3.43% of papers (7 papers) had reached over 50 citations, 9.31% of papers (19 papers) had more than 20 citations, while 34.31% had less than 10 citations (70 papers). For the more recently published papers (2014-2019), no one paper had more than 50 citations, 3 papers had more than 20 citations and 85 papers had less than 10 citations.

Table 5: The top five most cited papers

Reference	Title	Journal	Citation
Topi et al., 2010	IS 2010: Curriculum Guidelines for Undergraduate Degree Programs in Information Systems	Communications of the Association for Information Systems	653
Fichman et al., 2014	Digital Innovation as a Fundamental and Powerful Concept in the Information Systems Curriculum	Management Information Systems Quarterly	532
Veltri et al.,2011	Curriculum Mapping as a Tool for Continuous Improvement of IS Curriculum	Journal of Information Systems Education	67
Winkelmann and Leyh, 2010	Teaching ERP systems: A Multi-Perspective View on the ERP System Market	Journal of Information Systems Education	66
Benamati, Ozdemir and Smith, 2010	Aligning undergraduate IS curricula with industry needs	Communications of the ACM	57

IV. FINDINGS

Research on IS Curriculum planning process

In the IS curriculum process category, the primary research focus is on describing or prescribing the processes that IS faculty carries out in order to define the curriculum. When reviewing the research design of the 29 papers in this category, we further defined them to two research classes: (1) illustration of good practices and routines, and (2) recommendation of methods and tools to support curriculum planning and evaluation. The emphasis in the first class is slightly more descriptive, often based on reflection of process that was carried out, while the second class puts more emphasis on a particular method, thus having a slightly more prescriptive tone.

Illustration of IS curriculum planning practices

There are altogether 17 papers classified to this area. Majority of papers (10) present a single case, often from authors' own university, to investigate the practices used in curriculum planning process. There are, however, also papers that present materials collected from several universities, relying for example few case study (2), survey (2), and interviews (1). The papers provide rich descriptions of practices on:

One part of papers illustrates practices related to ensuring connections with a variety of IS planning stakeholder groups [Gallaugher and Wyner, 2016]. Papers illustrate the diversity of groups that IS program heads may involve, see table 6.

Table 6: Curriculum planning practices related to stakeholder groups

Stakeholder groups	Reference
IS faculty	[Benamati et al., 2010; Kajtazi and Holmberg, 2019; Ramesh and Gerth, 2015; Saulnier and White, 2011]
Employers and advisory boards	[Benamati et al., 2010; Taylor and Calitz, 2019]
Students and alumni	[Gallaugher and Wyner, 2016]
Related disciplines within the university	[Anderson and Shemroske, 2013]

Another set of articles adopt also cases experience or longitudinal perspective to curriculum planning, investigating, for example, ways how planning process incorporates external trends, such as (see table 7):

Table 7: Incorporation of external trends for IS curriculum planning process

External trend	Reference
Historical review	[Brites-Pereira et al., 2017; George and Marett, 2019; Pauli et al., 2011]
Technological changes	[Ayalew et al., 2012; Lending et al., 2019; Shah et al., 2017]
Introduction of new curriculum guidelines or accreditation criteria	[Claybaugh et al., 2020; Saulnier and White, 2011]
Local requirements and guiding principles	[Ramesh and Gerth, 2015]

Overall, the papers paint a rich picture of the efforts of universities in planning and revising their IS curriculum. While the papers are typically based on descriptive materials regarding the planning process, papers do have a slightly prescriptive tone – purpose is to seek and present good practices, that are expected to improve the planning outcomes.

IS curriculum planning models and tools

There are 12 papers classified to planning models and tools. Majority of them (7) propose conceptual models or tools, and then use different empirical materials to illustrate or verify them via case study (3), prototype implementation (2), or successful implementation stories (2). The remaining papers (5) present tools for conducting curriculum related surveys (2), conceptual models (2), or results from SLRs (1). Based on the content, papers in this category can be divided into supporting curriculum design and supporting curriculum evaluation, see table 8.

Table 8: Models and tool supporting IS curriculum design and evaluation

Categories			Reference
IS curriculum design	Information system supporting curriculum design process		[Jacobi et al., 2014; Slack, 2011]
	Models	For supporting curriculum decisions	[Liu and Murphy, 2012]
		For communication with students and faculty	[May and Lending, 2015]
		For solving skill gap between IS and IT workforce	[Liu and Murphy, 2018]
		For promoting program sustainability	[Case and Tabatabaei, 2019]

IS curriculum evaluation	A curriculum mapping matrix	[Veltri et al., 2011]
	A curriculum design IS model	[Ling et al., 2018]
	An evaluation model for IS curriculum planning	[Prifti et al., 2018]

The tone in these papers is more prescriptive - the core contribution of the papers rests on demonstrating a useful model or method for IS curriculum design and/or evaluation.

Research on IS curriculum content

Papers classified to IS curriculum content category focus on describing or prescribing the design of the IS curriculum: overall curriculum, specializations, integrative themes, single courses, or teaching methods. This is the largest research area, with a total of 156 papers in the sample.

Curriculum contents in existing programs

There are 24 papers, where the focus is on reviewing IS curriculum in existing programs. Out of the 24 papers, majority (22) are based on an IS curriculum survey or collected listing of courses from university websites. In three of these papers, survey data was complemented with interviews. The rest of the research conducted research by using case study (1) and interview (1).

In terms of contents and study design, information regarding curricula in existing programs is often collected to compare it with some reference model, but also to demonstrate the academic status as such (see table 9):

Table 9: Reviews of IS curriculum contents

Categories		Reference
Comparison of existing programs to model curricula, such as IS 2010 (15), IS 2003 (1), IS 1996 (1), MSIS 2006 (2), CS 2013 (1), and BISE (1)	Deviations	[Apigian and Gambill, 2014, 2010; Clark et al., 2017; Larson, 2013; Leidig et al., 2014; Lo and Cruz, 2014; Wibisono and Nisafani, 2013]
	Adherence	[Bell et al., 2013; Osatuyi and Garza, 2014; Yang, 2016]
Mapping of the state of academic field of IS		[Kasparian et al., 2017; Karsten et al., 2015; Bandi et al., 2014; Hwang et al., 2014; Larson and Harrington, 2012; Stefanidis and Fitzgerald, 2010; Yang, 2012]
Comparison of countries/universities/institutes		Reis et al., 2018; Sagheb-Tehrani, 2011b, 2011a, 2015, 2016]
Identification of specialization and career tracks offered in programs		[Hwang and Curl, 2014; Stefanidis et al., 2013]

For curriculum design, papers provide valuable insights on curriculum contents. Implicitly, these are sometimes seen as indicating “right” choices, because they reflect widely held views of necessary curriculum contents within the IS discipline.

Recommendations for the entire IS curriculum

Papers in this class provide explicit recommendations or guidelines for topics, courses or capabilities that IS curriculum as a whole should address. This class contains 16 papers, where recommendations are argued on the basis of survey (7), conceptual research (6), data mining (1), prototype implementation (1), or case study (1). In terms of education level, 10 papers focused on the level of undergraduate level, and 5 papers related to graduate level. Research design of these prescriptive papers are as listed in Table 10.

Table 10: Recommendations for entire IS curriculum

Categories			Reference
Closely related to the model curriculums	Papers written as part of curriculum taskforce work		[Topi, 2014; Topi et al., 2014; Topi et al., 2011; Topi et al., 2010]
	Papers that build upon	model curriculum (IS 2002, IS 2010; MSIS 2006) recommendations	[Rosenthal et al., 2013; Doyle and Schuff, 2012; Sidorova and Harden, 2012]
		Comparing IS 2010 and ABET CAC standards	[Burns et al., 2014a]
		Curriculum assessment more broadly	[Alzahrani, 2013]
		Based on IS 2010 revision	[Leidig et al., 2019]
	Papers addressing the relationship between IS research areas and IS curriculum		[Sidorova and Harden, 2012]
Focus on a particular type of IS program	A computer information systems (CIS) curriculum		[Longenecker et al., 2014; Longenecker et al., 2013]
	Management information systems (MIS) design framework		[Thouin et al., 2018; AkçetİN et al., 2017; Erkollar et al., 2016]

The papers in this class have a stronger aim at prescribing what should be taught in IS programs, thus having particular relevance for designing the IS program core, i.e. courses that are compulsory.

Recommendations for specializations and modules

Specializations and modules are important parts in IS curriculum. In this class, researchers provide guidelines and recommendations for designing a particular specialization or module within an IS program. In total, there are 28 papers in this categories, with 12 conceptual research, 8 case study, 7 survey and 1 focus group interview.

Papers related to specializations and modules examine the design of specific IS modules, that are often seen as specialization themes. Majority of specialization modules has technical or security related flavor, see table 11.

Table 11: Recommendations for specialization modules

Categories		Reference
Data science	Data analytics	[Jafar et al., 2017; Mills et al., 2016; Waguespack and Hunsinger, 2015a]
	Business Intelligence and analytics curriculum	[Mitri and Palocsay, 2015; Oliphant, 2013]
Mobile computing or mobile apps development		[Iversen and Eierman, 2012; Lawler et al., 2012c]
Design	Robotics education	[Tsoy et al., 2018]
	Programming	[Babb et al., 2013; Baugh, 2014]
Information technology infrastructure	Service oriented architecture	[Teo et al., 2010]
	Information technology infrastructure library	[Jarman, 2011]
	Cloud computing module	[Chen et al., 2012]

	Software defined networking	[Laverty et al., 2014]
Security	Security or cybersecurity	[Foltz and Renwick, 2011; Raj et al., 2018; Wang and Wang, 2019; Yang and Wen, 2017]
	Security and forensics	[Ferguson, 2012]
	Global IT security	[Sauls and Gudigantala, 2013; White et al., 2013]

In addition to technical specialization, also possibility to offer specialization on the basis of a particular use domain have been discussed, such as healthcare IS curriculum [Foster and Nash, 2016; Khan, 2011], logistics IS [Rutner et al., 2014], and enterprise systems [Saltz et al., 2013]. Along with specializations, research has also addressed modules of IS curriculum, such as research methodology curricula [McArthur and Vithal, 2017], and program prerequisites module [Reynolds et al., 2016].

Recommendations for integrative themes

Papers classified to this area propose integrative themes for the IS curriculum. Rather than being a module or course, a theme affects the entire curriculum. The papers identify a theme, argue its significance, and reasons why it needs to be included as part of the IS curriculum. Empirical research methods comprise case studies (8), surveys for students or educators (4), literature reviews (3), reviews of university website information (3), content analysis (1), and interviews (1). Rest of the studies were conceptual research. Typically, the theme is illustrated as part of curriculum or program redesign, curriculum implementation, or other form of case study. Based on the themes, it can be broadly grouped into four areas, as illustrated in Table 12.

Table 12: Four areas of integrative themes

Categories		Reference
Individual competencies	Soft skills, business communication skills, critical thinking skill, intercultural communication skills, team competencies, computational thinking, service learning, liberal education, behavioral competencies, entrepreneurship, IT entrepreneurial skill, career skills, and workforce readiness	[Matthee and Turpin, 2019; Mitchell and Benyon, 2018; Agerfalk et al., 2017; Jones and Liu, 2017; Kanabar and Kaloyanova, 2017; Liu and Murphy, 2017; Lang and Babb, 2015; Pratt et al., 2014; Cleveland, 2013; Khoo, 2012; Lawler et al., 2012b; Pawlowski and Holtkamp, 2012; Alshare et al., 2011; Hall and Johnson, 2011; Chung et al., 2010; Figl, 2010; Woodward et al., 2010]
IS theory/thinking related themes	Comprising systems approach, IS design pedagogy, and design-focus methods	[Waguespack and Hunsinger, 2015b, Schell and Mathieu, 2015; Babb and Waguespack, 2014]
IS professional skills, originate more from practical tasks	Requirements elicitation, industry practices, business information systems design, business process management certification, and digital transformation	[Ezell et al., 2019; Tan et al., 2018; Morelli, 2016; Woodley and Shackleton, 2012; Hadidi, 2011; Carlsson et al., 2010]
Ethics and social responsibility	Ethics and social responsibility, green values, and social design	[Dell and Venkatesh, 2012; Scott et al., 2012; Harris et al., 2011]

Overall, papers illustrate a wide variety of important themes, that IS curriculum should acknowledge. Rather than being dedicated to a single specific course or module, they are recommended to be addressed as an underlying theme in many courses. Some of the IS related themes, such as systems approach and design related themes, are also suggested as providing a broader philosophy, that could provide theoretical foundation for the entire IS curriculum.

Recommendations for individual courses

The focus of papers in this class is on a particular course, emphasizing their significance as part of curriculum, but also providing recommendations for designing the course. Majority of papers rely on a case study or conceptual research to illustrate details of course syllabus (22). Some of them added a survey for evaluating satisfaction or feedback of the course (17), or used focus groups (2), experiments (2), or interviews (1) to collect data.

In terms of contents, the most widely discussed course is the IS introductory/core course, also referred to as Foundations of IS or MIS course [Chen and Holsapple, 2014; Fichman et al., 2014; Freedman et al., 2012; Ghosh, 2012; Harden et al., 2018; Li, 2011; McCoy et al., 2013; McGuire and Benamati, 2018; Schwieger, 2012; Ward, 2010; Whelan and Firth, 2012; Whitney et al., 2019]. Recommendation for this course comprise, for example, cross-functional content teaching method [Freedman et al., 2012], MIs (Multiple "I"s) teaching approach [Chen & Holsapple, 2014], soft skills development [Whitney et al., 2019], task-driven teaching method [Li, 2011], and adoption of digital innovation as the foundational concept [Fichman et al., 2014].

Another widely discussed course are the IS capstone course [Baird and Riggins, 2009; Gill and Ritzhaupt, 2013], IS development project course or project work course [Makkonen and Vaidya, 2013; Obwegeser et al., 2016; Obwegeser and Papadopoulos, 2016; Tan, et al., 2010] or a real-world project [Nestorov et al., 2019]. Recommendations for this course comprise hybrid project management methodology [Baird and Riggins, 2009], case pedagogy and individual projects teaching methods [Gill and Ritzhaupt, 2013].

With regard of courses focusing on a particular topic, descriptions of courses are provided for a large number of courses in main facets of the IS curriculum, details are listed in table 13:

Table 13: Recommendations for individual courses

Particular topic		Reference
Systems development area	IS analysis and design, software development programming or mobile device programming, pair programming, hybrid agile IS development, use-cases approach, and IT security	[Avery and Oakley, 2019; Reynolds et al., 2017; Xiao, 2017; Dongo et al., 2016; Ndabvonga-Dongo and Reed, 2015; Wang and Wang, 2014; Guidry and Totaro, 2013; Tan et al., 2010].
Data and Analytics area	Database course, big data analytics course, data visualization course.	[Nestorov et al., 2019; Asamoah et al., 2017; Lindoo and Duncan, 2016; Wang and Wang, 2016]
Use domain area	Use domain area: health informatics, ERP, enterprise systems, enterprise architecture, enterprise business solutions course, and enterprise modelling.	[Hunt et al., 2015; Schell, 2014; Petersen and Krogstie, 2013; Shankararaman et al., 2012; Mathieu and Schell, 2011; Tan and Sedera, 2010; Winkelmann and Leyh, 2010]
Management and consulting area	IT service management, IT consulting classes, simulated consulting project, career paths training	[Dillon and Lending, 2014; Proehl et al., 2013; Makkonen and Vaidya, 2013]

While many traditional courses are already widely discussed, some "new" topics in IS curriculum, such cybersecurity, or digital innovation, have not been described yet as a single dedicated course, at least not with a connection to IS curriculum.

Recommendations for teaching methods and technologies

Papers in this class focus on guidelines for using teaching methods within IS education. There are 12 papers in this category. Researchers typically refer to real world cases or empirical research to share the method implementation experience. Seven papers provide a teaching case to illustrate a particular method, two present results of a student survey. The remaining three were based on interview study, literature review, or thought experiment research method.

The papers in this class can be broadly divided to general and IT based methods. General teaching and learning methods comprise application of specific educational methods to IS education contexts. IT enabled teaching and learning papers illustrate technology mediated ways of teaching and learning, details shows below in table 14.

Table 14: Teaching methods

Teaching methods		Reference
General teaching methods	Use of case study methodology in technology-focused IS courses, applying a conceptual framework for task and tool personalization, studio classes, personalized flipped classroom, collective learning extension for rapidly evolving IS courses, mini-case study for a technical course, and the writing across the curriculum techniques	[Shankararaman et al., 2018; Zhao et al., 2018; Agarwal and Ahmed, 2017; Philipp and Mareike, 2017; Doyle et al., 2015; Melzer & Schoop, 2015; Saulnier, 2015; Baumgartner, 2013]
IT based teaching methods	IT innovation teaching with LEGO® MINDSTORMS® NXT, ERPsim (a kind of ERP teaching-learning tool), educational cloud, and gamification research	[Osatuyi et al., 2018; Hwang et al., 2016; Chen et al., 2015; Pedersen et al., 2010]

It is perhaps important to note, that due to the keywords used in SLR, there may well be a much broader base of research focusing on IS teaching methods, or individual course design discussed above. The papers presented here were chosen, because the articles matched with the search words. We chose to present them, as the design of individual courses and the choice of teaching methods do constitute important facets in any IS curriculum design effort.

Competency requirements

Papers in this category focus on graduates' entry level competencies and competency requirements in the IS profession. One motivation for research is, that the knowledge on required competencies is an important input for IS curriculum planning and evaluation.

Descriptions of graduates' competency requirements

The papers in this class focus on the graduate's competencies. The purpose in these papers is to derive, what competencies graduates should have, or do have, upon completion of an IS program. Study design is based on review of industrial competence frameworks such as e-CF (1), job ads review (1), or recruiters or student surveys (3). Table 15 shows the research content.

Table 15: Graduates' competency requirements research content

Research content	Reference
Using the European e-CF 3.0 competence framework and students' evaluation, process improvement, IS governance, innovating, risk management, and information security management were found to be top five important competences. A global competency model for IS graduate degree were built.	[Topi et al., 2017; Topi et al., 2015].
Based on job ads review, Longenecker et al. [2012] expanded skills list from 37 to 69, and emphasized six major areas of skills: software development, web development, database operating systems and telecommunications, strategic organizational development, interpersonal and team skills, and project management.	[Longenecker et al., 2012]
The only study that included an actual measurement of graduates' competencies focused on the impact of programming and system design course to graduates' professional systems design ability, highlighting the need to complement programming skills with other competencies.	[Bin et al., 2016]
One study focused on course-employer gap, and found that security, project management, web development, and enterprise architecture are the gaps between IS curriculum and employer expectation.	[Burns et al., 2014b]
This paper adopted a text-mining approach to map IS curriculum with industry skills in a visual-based method.	Xun et al. [2015]
This paper found Naive Bayes is the best predict algorithm the suitability of IS students' skills for the recruitment.	[Almutairi and Hasanat, 2018]

Defining graduates' competency requirements, or measuring entry-level competences empirically, is not a straightforward task. However, considering how much recent model curriculums (MSIS 2016 and forthcoming CC2020 and IS2020 guidelines) emphasize competencies as a basis for IS curriculum work, we expect more research, and wider diversity of study design, in this area.

Competency requirements in the IS profession

Papers in this class focus directly on the measurement of competencies needed in IS professions, and 12 papers are in this class. The task is slightly easier, as the focus is on actual jobs within the IS profession, and their competency needs. Empirical data to elucidate competency needs were collected from job advertisements (5), employers and managers (4), students and alumni (1), and experts and faculties (1). Studies looking at competency requirements in the IS profession often contrast hard skills and soft skills, see table 16.

Table 16: Competency requirements in the IS profession

Research content	Reference
IS managers appreciate people with soft skills rather than technical skills, and there is a shift from technical to non-technical skills	[Branchet and Sanseau, 2017; Jones et al., 2018; Uğur and Hamit Turan, 2019]
The most critical soft skills in the IS profession: personal attributes, teamwork/communication, project management/leadership/control/governance, and willingness to learn.	[Brooks et al., 2018; Föll et al., 2018; Jones et al., 2018; Branchet and Sanseau, 2017; Omar et al., 2014; Steven et al., 2011]
Hard skills, or domain-related skills: business intelligence/data analytics and mining, networks. In the context of developing software for cars, second level support, java backend development, strategic management, and software development have been	[Brooks et al., 2018; Föll et al., 2018; Omar et al., 2014]

identified.	
The popular or most expected jobs in the labour market: systems analysts, programmers, and application developers.	[Vladoiu et al., 2019; Woolridge and Kim, 2017; Woolridge and Parks, 2016; Omar et al., 2014]

While the results are not directly translated into competency related goals for IS programs, they implicitly provide background knowledge for discussions on IS curriculum design.

V. LIMITATIONS AND FUTURE RESEARCH

One limitation of the SLR reported in this paper is that we essentially used only one keyword, “IS curriculum”. Hence, the 204 papers represent only those articles that explicitly used this word. A large number of papers have been published on e.g. individual IS courses, or IS teaching methods, without explicit use of IS curriculum. Coverage of papers is probably relatively better in sections that focus specifically on IS curriculum process or contents of the entire curriculum. In all categories, important articles may have been omitted.

Even with this single keyword, the sample grew so large that is became difficult to illustrate contents of research within each research theme. The total sample of 204 articles is too large, to allow a normal presentation of each article, e.g. as tables describing methods, data, and conclusions. Because of the large sample, and broad coverage, also the classification decisions were bound to be subjective; as many papers were addressing more than one theme, interpretation and judgement was needed which theme is the most central one. Overall, presentation of results can be better referred to as a curriculum mapping study (Petersen et al. 2008; Kitchenham et al. 2011), than a genuine systematic literature review (Kitchenham, 2004). With current broad coverage and large sample, using Webster and Watson terminology (Webster and Watson, 2002), our classification scheme could be best labelled as ad hoc or taxonomy classification.

Future research should focus on more specific aspects of IS curriculum, and then use additional search words to ensure coverage of all papers in that theme. For example, an SLR focusing only on IS teaching methods could use additional words like 'pedagogy' and 'education' to improve coverage. A more focused approach in future SLR will allow more specific contributions to the body of knowledge within each of the categories identified in our SLR. With a more rigorous and focused approach, a more challenging view on research in each curriculum related theme could emerge. With a more focused theme, and improved coverage of all papers, the analysis of literature could reach higher order conceptual frameworks and theoretical systems (Webster and Watson, 2002).

Nevertheless, we believe that the classification scheme does identify the broad themes that IS curriculum research covers, and can be used as a basis for more focused and elaborate systematic literature reviews. We additionally propose, that there may be a need for such literature reviews, as the citation frequencies that for many papers remained alarmingly low, perhaps implicitly providing also a justification for future SLR papers.

VI. CONCLUSIONS

The value of this paper is in the mapping of the research community and main research themes surrounding IS curriculum. In terms of the research community, one of the main results is that IS curriculum research community is strongly dominated by US based researchers. In 68% of papers, first author was from the U.S., most active publishers were from U.S. universities, and also the most popular conference for submitting papers was AMCIS. Considering the significance of IS curriculum decisions, the data raises the question: why are the contributions from Europe/Africa and Asia/Pacific so limited?

The second goal of this research was to identify the main research areas of IS curriculum research. For this end, we conducted an SLR for IS curriculum extracting 204 papers from three databases, and present herein a framework of IS curriculum research. As demonstrated in Figure 1, we identified three broad research categories, focusing on planning process, curriculum contents, and graduates' competency requirements. Each of these categories were further divided into classes, and papers within each class were briefly introduced in the Findings section.

One observation related to research themes is the central role of the model IS curriculums jointly developed and published by ACM/AIS. Most cited paper is Topi et al. [2010] that is based on the IS 2010 report. Large number of papers investigate the alignment of curricula of existing IS programs, often in close relation with the recommendations in model curricula. In prior research, the primary and natural unit of analysis has been a course, forming also the basis for analyzing the curriculum, its core courses, and specializations. Recent model curriculum MSIS 2016 and drafts for IS2020 and CC2020 are, however, strongly advocating competency based models to form a basis for curriculum design, to complement the traditional that is based on knowledge areas and units, and course structures and learning objectives.

Following the conceptual turn in model curricula, one area clearly requiring further theorizing and empirical work is the graduates' competencies and IS professional competencies. Research focusing on graduates' competencies – and competency gaps - would be critically needed in providing a more fine-grained view of such competencies, also to support curriculum decisions. In addition to the seminal studies on IS graduates' competency needs (Tables 15 and 16), also papers recommending "integrative themes" can provide a useful foundation for future research efforts (Table 12). Competencies related to integrative themes are typically not associated to a single IS course, but acquired via many courses.

Curriculum design of undergraduate and graduate IS programs is an important task for universities offering such programs, and a fundamental question for the IS discipline as a whole. IS curriculum design has intrigued many researchers, and results of their studies provide useful contributions for IS faculty in designing the programs in their own institution. The classification scheme is closely related to IS curriculum practice, and hopefully makes it easier for IS faculty to identify papers related to their immediate curriculum design needs.

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REFERENCES

Agarwal, N. and F. Ahmed (2017). Developing collective learning extension for rapidly evolving information system courses. *Education and Information Technologies*, 22(1), 7–37.

Agerfalk, P. J., J. Sjöström, and T. Tuunanen (2017). Evaluation of IS Curriculum Design: A Pilot Study using the California Critical Thinking Skills Test. *ICIS 2017: Transforming Society with Digital Innovation*.

Akçetİn, E. et al. (2017). Designing Undergraduate Curriculum for Management Information Systems (Mis) Education: a Comparison of the Mis Programs of Turkish Universities With Those of Global Universities. *Journal of Computer and Education Research*, 5(9), 50–60.

Almutairi, M. M. and M. H. A. Hasanat (2018). Predicting the suitability of IS students' skills for the recruitment in Saudi Arabian industry. *21st Saudi Computer Society National Computer Conference*, NCC 2018, 1–6.

Alshare, K. A., P. L. Lane, and D. Miller (2011). Business Communication Skills in Information Systems (IS) Curricula: Perspectives of IS Educators and Students. *Journal of Education for Business*, 86(3), 186–194.

Alzahrani, R. M. (2013). Curricula assessment of undergraduate degree information systems in saudi universities. *Information (Japan)*, 16(5), 3119–3131.

Anderson, S. and K. Shemroske (2013). A design and implementation of a resource-constrained computer science program in a combined CS/CIS department. *Journal of Computing Sciences in Colleges*, 184–190.

Apigian, C. H. and S. Gambill (2014). A Descriptive Study of Graduate Information Systems Curriculums. *Review of Business Information Systems (RBIS)*, 18(2), 47–52.

Apigian, C. H. and S. E. Gambill (2010). Are We Teaching the IS 2009 * Model Curriculum ? *Journal of Information Systems*, 21(4), 411–421.

Asamoah, D. A. et al. (2017). Preparing a Data Scientist: A Pedagogic Experience in Designing a Big Data Analytics Course. *Decision Sciences Journal of Innovative Education*, 15(2), 161–190.

Avery, A. and R. L. Oakley (2019). The business case for IT security as a core course in IS curriculum. *25th Americas Conference on Information Systems*.

Ayalew, Y. et al. (2012). Developing a contextualized information systems curriculum for an emerging economy. *Electronic Journal of Information Systems in Developing Countries*, 54(1), 1–19.

Babb, J. et al. (2013). Confronting the issues of programming in information systems curricula: The goal is success. *ISECON: Information Systems Educators Conference*, 1–31.

Babb, J. S. and L. J. Waguespack (2014). In search of design-focus in IS curricula. *Information Systems Education Journal*, 12(4), 29–39.

Baird, A. and F. J. Riggins (2009). Planning and Sprinting: Use of a Hybrid Project Management Methodology within a CIS Capstone Course. *Journal of Information Systems Education*, 23(2012), 31–37.

Bandi, R. K., R. A., Rao and L. Gunupudi (2014). State of the academic field of IS in India. *Information Technology and Management*, 15(3), 163–175.

Baugh, J. M. (2014). Programing Not Required? Did the Is-Model Curriculum Get It Right? *Issues in Information Systems*, 15(1), 399–408.

Baumgartner, I. (2013). Case study methodology in technology-focused Information Systems courses: Examining the students' perspective. *Proceedings of 2013 IEEE International Conference on Teaching, Assessment and Learning for Engineering, TALE 2013*, 223–226.

Bell, C., R. Mills, and K. Fadel (2013). An analysis of undergraduate information systems curricula: Adoption of the IS 2010 curriculum guidelines. *Communications of the Association for Information Systems*, 32(1), 72–95.

Benamati, J. H., Z. D. Ozdemir and H. J. Smith (2010). Aligning undergraduate IS curricula with industry needs. *Communications of the ACM*, 53(3), 152–156.

Bin, Z. et al. (2016). Research on the Professional Core Courses, Influence on Professional Ability: Taking the Major of Information Management and Information System in Wuhan University of Technology as an Example. *Proceedings - 2015 International Conference on Industrial Informatics - Computing Technology, Intelligent Technology, Industrial Information Integration, ICIICII 2015*, 280–284.

Branchet, B. and P. Y. Sanseau (2017). From technical to non-technical skills among information systems suppliers: An investigation in the skills domain. *Journal of Enterprise Information Management*, 30(2), 320–334.

Brites-Pereira, M., A. J. Osório, and M. J. Almeida (2017). Information systems curriculum in an Australian university: Past developments and future directions. *IFIP World Conference on Computers in Education*.

Brooks, N. G., T. H. Greer, and S. A. Morris (2018). Information systems security job advertisement analysis: Skills review and implications for information systems curriculum. *Journal of Education for Business*, 93(5), 213–221.

Burns, T. et al. (2014a). A study of information systems programs accredited by ABET in relation to IS 2010. *Information Systems Education Journal*, 12(1), 4–16.

Burns, T. et al. (2014b). Information System Curriculum versus Employer Needs: A Gap Analysis. *Information Systems Education Journal*, 12(1), 4–16.

Carlsson, S. A., J. Hedman, and O. Steen (2010). Integrated curriculum for a bachelor of science in business information systems design (BISD 2010). *Communications of the Association for Information Systems*, 26(1), 525–546.

Case, T. and M. Tabatabaei (2019). Built to last? Applying a program sustainability model to is degree programs. *25th Americas Conference on Information Systems, AMCIS 2019*, 1–5.

Chen L. and C. W. Holsapple (2014). Teaching the introductory MIS course: An MIs approach. *20th Americas Conference on Information Systems, AMCIS 2014*, 1–12.

Chen L. et al. (2012). Introducing cloud computing topics in curricula. *Journal of Information Systems Education*, 23(3), 315–324.

Chen L., A. Keys, and D. Gaber (2015). How Does ERPsim Influence Student's Perceived Learning Outcomes in an Information Systems Course? An Empirical Study. *Journal of Information Systems Education*, 26(2), 135–146.

Chung, W. et al. (2010). Integrating computational thinking into information systems and other curricula. *Proceedings of the 2010 International SIGED: IAIM Conference*.

Clark, J. et al. (2017). IS curriculum models, course offerings, and other academic myths/hopes. *Journal of Higher Education Theory and Practice*, Vol. 17.

Claybaugh, C. C. et al. (2020). Anatomy of an information systems program continuous improvement process for AACSB accreditation. *Journal of Education for Business*, 95(3), 159–168.

Cleveland, S. (2013). On-the-job Informal Learning Practices for IS Students. *SAIS 2013*.

Dell, D. A. and M. Venkatesh (2012). Social design's implications for the IS field. *ACM International Conference Proceeding Series*, (315), 346–353.

Dillon, T. W. and D. Lending (2014). Using professional consultants to mentor CIS students on a simulated consulting project. *SIGMIS-CPR 2014 - Proceedings of the 2014 Conference on Computers and People Research*, 171–175.

Dongo, T., A. H. Reed, and M. O'Hara (2016). Exploring pair programming benefits for MIS majors. *Journal of Information Technology Education: Innovations in Practice*, 15, 223–239.

Doyle, M., R. Flanagan, and J. Moustafellos (2015). Learning by doing: Studio classes in MIS education. *2015 Americas Conference on Information Systems, AMCIS 2015*.

Doyle, M. and D. Schuff (2012). IS2010: Looking through the windshield or at the rear-view mirror? *18th Americas Conference on Information Systems 2012, AMCIS 2012*, 1, 585–591.

Erkollar, A., B. Oberer, and Ö. E. Kurt (2016). A Framework for Developing an Internationalised Management Information Systems (MIS) Curriculum At the Bachelor's Degree Level. *The Online Journal of Quality in Higher Education-April*, 3(2), 1–13.

Ezell, J. D. et al. (2019). Developing measurable cross-departmental learning objectives for requirements elicitation in an information systems curriculum. *Journal of Information Systems Education*, 30(1), 27–41.

Ferguson, J. (2012). Blending Information Systems Security and Forensics Curricula. *MWAIS 2012*.

Fichman, R. G., B. L. Dos Santos, and Z. Zheng. (2014). Digital Innovation as a Fundamental and Powerful Concept in the Information Systems Curriculum. *MIS Quartely*, 38(2), 329–354.

Figl, K. (2010). A Systematic Review of Developing Team Competencies in Information Systems Education. *Journal of Information Systems Education*, 21(1), 323–337.

Föll, P., M. Hauser, and F. Thiesse (2018). Identifying the skills expected of IS graduates by industry: A text mining approach. *International Conference on Information Systems 2018*, *ICIS 2018*.

Foltz, C. B. and J. S. Renwick (2011). Information Systems Security and Computer Crime in the IS Curriculum: A Detailed Examination. *Journal of Education for Business*, 86(2), 119–125.

Foster, G. and J. Nash (2016). Introducing health informatics as an elective module in an information systems honours degree: Experiences from Rhodes university. *Communications in Computer and Information Science*, 642, 123–130.

Freedman, J., G. Wyner, and G. M. Wyner (2012). Desperately seeking is curriculum relevance: Teaching information systems in a cross-functional context. *AMCIS 2012*.

Gallaugher, J. and G. Wyner (2016). Case study: Content and connections in the information systems curriculum. *2016 AIS SIGED International Conference on IS Education and Research*.

George, J. F. and K. Marett (2019). Invited Paper: The Times they are a Changin': How Non-Technology Factors have Affected IS Curriculum over Time. *Journal of Information Systems Education*, 30(4), 222–231.

Ghosh, S. (2012). Innovating in the MIS core course - bridging business and technology. *18th Americas Conference on Information Systems 2012, AMCIS 2012*, 6, 4291–4300.

Gill, T. G. and A. D. Ritzhaupt (2013). Systematically evaluating the effectiveness of an information systems capstone course: Implications for practice. *Journal of Information Technology Education: Research*, 12(1), 69–94.

Guidry, B. N. and M. W. Totaro (2013). MIS students and the systems analysis and design course project: A proposed experiential approach. *International Journal of Innovation and Learning*, 13(2), 121–139.

Hadidi, R. (2011). Incorporating the Common Body of Knowledge for Business Process Management Certification in the MSIS Model Curriculum Incorporating the Common Body of Knowledge for. *MWAIS 2011*.

Hall, L. L. and R. D. Johnson (2011). Preparing is students for real-world interaction with end users through service learning: A proposed organizational model. *Journal of Organizational and End User Computing*, 23(3), 67–80.

Harden, G., R. M. Crocker and K. Noe (2018). Introductory information systems course redesign: Better preparing business students. *Journal of Information Technology Education: Innovations in Practice*, 17, 113–126.

Harris, A. et al. (2011). Incorporating Ethics and Social Responsibility in IS Education. *Journal of Information Systems Education*, 22(3), 183–190.

Hunt, C. S., D. Panigrahi, and A. Momenipour (2015). Augmenting the information systems curriculum with a course in health informatics. *International Journal of Business Research and Information Technology*, 2(1), 121–135.

Hwang, D. and S. S. Curl (2014). The market for career tracks in undergraduate IS curricula in the U.S. *Information Systems Education Journal*, 12(3).

Hwang, D., Z. Ma and M. Wang (2014). The information systems core: A study from the perspective of IS core curricula in the U.S. *2014 Proceedings of the Information Systems Educators Conference, ISECON 2014*.

Hwang, D., R. Pike, and D. Manson (2016). The Development of an Educational Cloud for IS Curriculum through a Student-Run Data Center. *Information Systems Education Journal*, 14(1), 62–70.

Iversen, J. H. and M. E. Eierman (2012). Fitting Mobile in the IS Curriculum Fitting Mobile in the IS Curriculum. *Midwest (MWAIS)*.

Jacobi, F. et al. (2014). Towards a design model for interdisciplinary information systems curriculum development, as exemplified by big data analytics education. *ECIS 2014 Proceedings - 22nd European Conference on Information Systems*.

Jafar, M. J., J. Babb, and A. Abdullat (2017). Emergence of Data Analytics in the Information Systems Curriculum. *Information Systems Education Journal*, 15(5).

Jarman, R. (2011). Progress in introducing ITIL into an information Systems curriculum. *17th Americas Conference on Information Systems 2011, AMCIS 2011*, 5, 3548–3554.

Jones, C. G. and D. Liu, (2017). Approaches to incorporating IT entrepreneurship into the information systems curriculum. *Journal of Information Systems Education*, 28(1), 43–58.

Jones, K., L. N. K. Leonard and G. Lang (2018). Desired Skills for Entry Level IS Positions: Identification and Assessment. *Journal of Computer Information Systems*, 58(3), 214–220.

Kajtazi, M. and N. Holmberg (2019). IS Education Revisited: Reflections on a BSc Program in Business Information Systems Design. *5th International Conference on Information Management, ICIM 2019*, 144–149.

Kanabar, V. and K. Kaloyanova (2017). Identifying and embedding behavioral competencies in information systems courses. *Proceedings of the 25th European Conference on Information Systems, ECIS 2017*, 3115–3122.

Karsten, H. et al. (2015). Master's degree programs in information systems: a global view. *SIGED 2015*.

Kasparian, N. A. et al. (2017). EHealth literacy and preferences for eHealth resources in parents of children with complex CHD. *Cardiology in the Young*, 27(4), 722–730.

Khan, S. N. (2011). Strengthening The Curriculum Of Information Systems Program. *Review of Business Information Systems (RBIS)*, 15(3), 23–34.

Khoo, B. (2012). Towards a career skills oriented undergraduate information systems curriculum. *International Journal of Information and Communication Technology Education*, 8(2), 1–19.

Kitchenham, B. (2004). Procedures for Performing Systematic Literature Reviews. In *Keele University. Keele, UK*.

Kitchenham, B. A., D. Budgen, and O. P. Brereton (2011). Using mapping studies as the basis for further research–a participant-observer case study. Information and Software Technology, 53(6), 638-651.

Lang, G. and J. Babb, (2015). Addressing the 21st century paradox: Integrating entrepreneurship in the computer information systems curriculum. *Information Systems Education Journal*, 13(4), 81–91.

Larson, S. (2013). Comparing ABET-Accredited IS undergraduate programs and the ACM 2010IS model curriculum. *19th Americas Conference on Information Systems, AMCIS 2013*.

Larson, S. and M. C. R. Harrington (2012). A survey of ABET accredited information systems undergraduate programs in the USA. *Proceedings of the Information Systems Education Conference, ISECON*.

Laverty, J. P., D. Wood, and J. Turchek (2014). Software defined networking (SDN) network virtualization for the IS curriculum? *2014 Proceedings of the Information Systems Educators Conference, ISECON 2014*.

Lawler, J. P. et al. (2012a). CIS program redesign driven by IS2010 model: A case study. *Information Systems Education Journal*, 10(1).

Lawler, J. P. et al. (2012b). Fusing communication and writing skills in the 21st century's IT/IS curricula. *Information Systems Education Journal*, 10(2), 48–54.

Lawler, J. P. et al. (2012c). The need for mobile application development in IS curricula: An innovation and disruptive technologies perspective. *Information Systems Education Journal*, 10(1), 61–74.

Leidig, J., P. Leidig, and R. Ferguson (2014). University responses to the IS 2010 model curriculum: A pre and post comparison. *2014 Proceedings of the Information Systems Educators Conference, ISECON 2014*, 1–8.

Leidig, P., R. Ferguson, and J. Reynolds (2019). Invited Paper: IS2010: A Retrospective Review and Recommendation. *Journal of Information Systems Education*, 30(4), 9.

Lending, D., M. Mitri, and T. Dillon (2019). Invited Paper: Ingredients of a High-Quality Information Systems Program in a Changing IS Landscape. *Journal of Information Systems Education*, 30(4), 7.

Li, M. (2011). "Task-driven" approach in the Management Information System of teaching. *2011 2nd International Conference on Artificial Intelligence, Management Science and Electronic Commerce, AIMSEC 2011*.

Lindoo, E. and D. Duncan (2016). Introducing Data Visualization Techniques in Computer Information Systems Curriculum. *Journal of Computing Sciences in Colleges*, 32(2), 19–25.

Ling, T. C. et al. (2018). Validation of curriculum design information system model. *Indonesian Journal of Electrical Engineering and Computer Science*, 12(3), 1305–1311.

Liu, X. M. and D. Murphy (2017). Are They Ready ? Integrating Workforce Readiness into a Four-Year College IT / IS Curriculum. *SAIS 2017*.

Liu, X. and D. Murphy (2012). Tackling an IS Educator's Dilemma: A Holistic Model for "When" and "How" to Incorporate New Technology Courses into the IS/IT Curriculum. *Proceedings of the Southern Association for Information Systems Conference*, 126–181.

Liu, X. and D. Murphy (2018). Constructing a Connected Program in It/Is : a Non-R1 University Case. *SAIS 2018 Proceedings*, 22.

Lo, A. and A. P. Cruz (2014). The implementation of the AIS/ACM is 2010 curriculum by top US universities: An analysis of catalogs and college websites. *20th Americas Conference on Information Systems, AMCIS 2014*.

Longenecker, H. E. et al. (2014). Establishing the basis for a CIS (Computer information Systems) undergraduate program: On seeking the body of knowledge. *2014 Proceedings of the Information Systems Educators Conference, ISECON 2014*, 13(5).

Longenecker, H. E., D. Feinstein, and J. D. Clark (2012). Information systems curricula: A fifty year journey. *Proceedings of the Information Systems Education Conference, ISECON*.

Longenecker, H. E., D. L. Feinstein, and J. S. Babb (2013). Is there a need for a computer information systems model curriculum? *2013 Proceedings ISECON: Information Systems Educators Conference and CONISAR 2013*, *Conference on Information Systems Applied Research*, 1–12.

Makkonen, P. and S. Vaidya (2013). Career paths training for the first year students in information systems science-motivational view. *19th Americas Conference on Information Systems, AMCIS 2013 - Hyperconnected World: Anything, Anywhere, Anytime*.

Mathieu, R. G. and G. P. Schell (2011). Enterprise architecture - An analysis of IS 2010's newest core course. *Proceedings of ISECON*, 1–9.

Matthee, M. and M. Turpin (2019). Teaching Critical Thinking, Problem Solving, and Design Thinking: Preparing IS Students for the Future. *Journal of Information Systems Education*, 30(4), 242–252.

May, J. and D. Lending (2015). A conceptual model for communicating an integrated information systems curriculum. *Journal of Computer Information Systems*, 55(4), 20–27.

McArthur, B. and R. Vithal (2017). Information systems research methodology curricula at public South African universities. *Proceedings of the European Conference on Research Methods in Business and Management Studies*.

McCoy, S., A. Everard, and B. M. Jones (2013). Investigating the introduction to is course content: Do faculty, recruiters, and students equally value topical areas? *19th Americas Conference on Information Systems, AMCIS 2013 - Hyperconnected World: Anything, Anywhere, Anytime*.

McGuire, C. and J. Benamati (2018). Driving relevance into the introductory information systems course. *Americas Conference on Information Systems 2018: Digital Disruption, AMCIS 2018*, (25), 1–5.

Melzer, P. and M. Schoop (2015). A conceptual framework for task and tool personalisation in IS education. *2015 International Conference on Information Systems: Exploring the Information Frontier, ICIS 2015*, 1–17.

Mills, R. J., K. M. Chudoba, and D. H. Olsen (2016). Is programs responding to industry demands for data scientists: A comparison between 2011-2016. *Journal of Information Systems Education,* 27(2), 131–140.

Mills, R. J. et al. (2012). Examining is curriculum profiles and the IS 2010 model curriculum guidelines in AACSB-accredited schools. *Journal of Information Systems Education*, 23(4), 417–428.

Mitchell, A. and R. Benyon (2018). Teaching tip adding intercultural communication to an IS curriculum. *Journal of Information Systems Education*, 29(1), 1–10.

Mitri, M. and S. Palocsay, (2015). Toward a model undergraduate curriculum for the emerging business intelligence and analytics discipline. *Communications of the Association for Information Systems*, 37(1), 651–669.

Morelli, F. (2016). Digital Transformation of Information Systems Master'S Curriculum. *International Journal of Business and Management*, 06(01), 523–531.

Ndabvonga-Dongo, T. and A. H. Reed (2015). Enhancing software development in the MIS curriculum using pair programming. *2015 Americas Conference on Information Systems, AMCIS 2015*.

Nestorov, S., N. Jukic, and S. Rossi (2019). Design and Implementation of a Data Visualization Course with a Real-World Project Component in an Undergraduate Information Systems Curriculum. *Journal of Information Systems Education*, 30(June), 202.

Obwegeser, N., P. Papadopoulos, and J. Catalano (2016). The Research-Teaching Nexus in Information Systems Education: A case study. *Tenth Mediterranean Conference on Information Systems*.

Obwegeser, N. and P. M. Papadopoulos (2016). Integrating research and teaching in the IS classroom: Benefits for teachers and students. *Journal of Information Systems Education*, 27(4), 249–258.

Okoli, C. and K. Schabram (2010). A Guide to Conducting a Systematic Literature Review of Information Systems Research. *Sprouts*, 10.

Oliphant, G. (2013). Enriching the Undergraduate Information Systems Experience: Programs in Business Systems Analysis. *Issues in Information Systems*, 14(1), 99–105.

Omar, A., M. Miah, and E. Nkabyo (2014). Aligning academic curricula to industrial needs. *2014 Proceedings of the Information Systems Educators Conference, ISECON 2014*, 1–15.

Osatuyi, B. and M. Garza, (2014). IS 2010 curriculum model adoption in the United States. *20th Americas Conference on Information Systems, AMCIS 2014*, 1–11.

Osatuyi, B., T. Osatuyi, and R. D. La. Rosa (2018). Systematic review of gamification research in is education: A multi-method approach. *Communications of the Association for Information Systems*, 42(1), 95–124.

Pauli, W. E., T. Halverson, and J. McKeown (2011). The 2010 CIS baccalaureate degree compared with IS 2010 guidelines. *Journal of Higher Education Theory and Practice*, 11(2), 102–111.

Pawlowski, J. M. and P. Holtkamp (2012). Towards an internationalization of the information systems curriculum. *Multikonferenz Wirtschaftsinformatik 2012 - Tagungsband Der MKWI 2012*.

Pedersen, R. U., C. Nygaard, and M. Pedersen (2010). Improving students' learning outcomes through innovative teaching practices within information systems education. *Proceedings of the 2010 International SIGED: IAIM Conference*.

Petersen, K. et al. (2008). Systematic mapping studies in software engineering, in: Proceedings of 12th International Conference on Evaluation and Assessment in Software Engineering (EASE).

Petersen, S. A. and J. Krogstie, (2013). Experiences from teaching Enterprise Modelling to students of Information Systems. *CEUR Workshop Proceedings*.

Philipp, M. and S. Mareike (2017). Personalising the IS Classroom- Insights on Course Design and Implementation. *ECIS*.

Pratt, J. A., A. Keys, and T. Wirkus (2014). Preparing information systems graduates for a complex society: Aligning is curricula with liberal education learning outcomes. *Journal of Information Systems Education,* 25(1), 35–44.

Prifti, L. et al. (2018). Developing an evaluation model for information systems curricula. MKWI 2018 - *Multikonferenz Wirtschaftsinformatik*, 783–794.

Proehl, T. et al. (2013). IT service management within the is curriculum: Comparing two german experiences. *19th Americas Conference on Information Systems, AMCIS 2013 - Hyperconnected World: Anything, Anywhere, Anytime*.

Raj, R. K. et al. (2018). Enhancing Cybersecurity Content in Undergraduate Information Systems Programs : A Way Forward. *The 13th Pre-ICIS Workshop on Information Security and Privacy*.

Ramesh, V., and A. B. Gerth (2015). Design of an integrated information systems master's core curriculum: A case study. *Communications of the Association for Information Systems*, 36, 301–316.

Reis, J. et al. (2018). Evaluation of information systems curriculum in Portugal and Russia. *Advances in Intelligent Systems and Computing*, 1(March), 498–507.

Reynolds, J., R. Ferguson, and P. Leidig (2016). A Tale of Two Curricula: The Case for Prerequisites in the Model Curriculum. *Information Systems Education Journal*, 14(5), 17.

Reynolds, J., R. Ferguson, and P. Leidig (2017). Programming in the IS Curriculum: Are Requirements Changing for the Right Reason? *Information Systems Education Journal*, 15(1), 80–85.

Rosenthal, P., K. Dhariwal, and J. Whitehouse (2013). IS'15 - A model curriculum reflecting the emerging IS profession. *2013 Proceedings ISECON: Information Systems Educators Conference and CONISAR 2013, Conference on Information Systems Applied Research*, 1–8.

Rutner, S., M. Avies, and S. Cox (2014). IS Logistics a Viable Minor for Information Systems Majors: How to Create an Opportunity. *SAIS 2014*.

Sagheb-Tehrani, M. (2011a). Information systems curriculum: Some concerns. *International Journal of Education Economics and Development*, 2(4), 347–362.

Sagheb-Tehrani, M. (2011b). Towards a consistent model information systems curriculum. *Proceedings of ISECON*.

Sagheb-Tehrani, M. (2015). Towards a Consistency of Information Systems Curriculum*. Issues in Information Systems*, 16(2), 28–37.

Sagheb-Tehrani, M. (2016). A proposal towards computer information systems curriculum. *International Journal of Business Information Systems*, 22(2), 211–234.

Saltz, J., M. A. Serva, and R. Heckman (2013). The GET immersion experience: A new model for leveraging the synergies between industry and academia. *Journal of Information Systems Education*, 24(2), 121–131.

Saulnier, B. (2015). Using Writing Across the Curriculum (Wac) Techniques To Promote Increased Student Engagement and Learning in the Computer Information Systems Curriculum. *Issues in Information Systems*, 16(Ii), 108–115.

Saulnier, B. and B. White (2011). IS 2010 and ABET Accreditation: An Analysis of ABET-Accredited Information Systems Programs. *Journal of Information Systems Education*, 22(4), 347–354.

Sauls, J. and N. Gudigantala (2013). Preparing information systems (IS) graduates to meet the challenges of global IT security: Some suggestions. *Journal of Information Systems Education*, 24(1), 71–73.

Schell, G. (2014). Early Results – Including an Enterprise Architecture Course in Information Systems Curricula. *Southern Association for Information Systems Conference*.

Schell, G. and R. G. Mathieu (2015). Teaching the Systems Approach in the Information Systems Curriculum. *The Southern Association for Information Systems Conference*.

Schwieger, D. (2012). Developing an introductory level MIS project in accordance with AACSB assurance of learning standard 15. *Information Systems Education Journal*, 10(6), 15–24.

Scott, E., C. McGibbon, and G. Mwalemba (2012). Attempts to embed green values in the Information Systems curriculum: A case study in a South African setting. *ECIS 2012 - Proceedings of the 20th European Conference on Information Systems*.

Shah, V., A. Kumar, and K. Smart (2017). Moving Forward by Looking Backward: Using Backward Design to Develop an Innovative MSIS Program. *AMCIS 2017*.

Shankararaman, V., L. Eng Kit, and S. Dale (2012). Integrating enterprise system's 3rd wave into IS curriculum. *18th Americas Conference on Information Systems 2012, AMCIS 2012*, 3, 1887–1896.

Shankararaman, V., S. Gottipati, and A. Megargel (2018). Mini-Case Study Pedagogy: Experience from a Technical Course in an Information Systems Program. *Frontiers in Education Conference, FIE*, 1–8.

Sidorova, A. and G. Harden (2012). Achieving alignment between IS research and IS curriculum: Toward stronger IS discipline identity. *18th Americas Conference on Information Systems 2012, AMCIS 2012*, 1, 600–608.

Slack, J. M. (2011). A curriculum design system for information systems programs. *Proceedings of ISECON*, 1–15.

Stefanidis, A. and G. Fitzgerald, (2010). Mapping the Information Systems Curricula in UK Universities. *Journal of Information Systems Education*, 21(4), 391–410.

Stefanidis, A., G. Fitzgerald, and S. Counsell (2013). IS curriculum career tracks: a UK study. *Education + Training*, 55(3), 220–233.

Stevens, D., M. Totaro, and Z. Zhu (2011). Assessing it critical skills and revising the MIS curriculum. *Journal of Computer Information Systems*, 51(3), 85–95.

Tan, C. H., W. K. Tan, and H. H. Teo (2010). Designing an information systems development course to incorporate agility, flexibility, and adaptability. *Communications of the Association for Information Systems*, 26(1), 171–194.

Tan, F. T. C. and D. Sedera (2010). Introducing a Small and Medium Enterprises syllabi design: An Enterprise Systems hands-on approach. *ACIS 2010 Proceedings - 21st Australasian Conference on Information Systems*.

Tan, Y. L., K. Nakata, and D. Paul (2018). Aligning IS Master's Programs with Industry. *Information Systems Education*, 29(3).

Taylor, E. and A. P. Calitz (2019). The use of industry advisory boards at higher education institutions in Southern Africa. *Annual Conference of the Southern African Computer Lecturers' Association*, 244–259.

Teo, L. K. Y., D. W. THE, and B. J. Corbitt (2010). Service Oriented Architecture (SOA): Implications for australian university information systems curriculum. *PACIS 2010 - 14th Pacific Asia Conference on Information Systems*, (January), 1286–1296.

Thouin, M. F., W. E. Hefley, and S. Raghunathan (2018). Student attitudes toward information systems graduate program design and delivery. *Journal of Information Systems Education*, 29(1), 25–36.

Topi, H. et al. (2010). IS 2010: Curriculum guidelines for undergraduate degree programs in information systems. *Communications of the Association for Information Systems*, 26(1), 359–428.

Topi, H. et al. (2011). Future of master's level education in Information Systems. *Communications of the Association for Information Systems*, 28(1), 437–452.

Topi, H. (2014). Program directors' perspectives on MSIS outcome expectations and future directions. *SIGED: IAIM Conference*.

Topi, H. et al. (2014). Moving toward the next generation of graduate degree programs in information systems. *Communications of the Association for Information Systems*, 34(1), 693–710.

Topi, H. et al. (2015). Current MSIS students' views on program outcomes. *AIS SIGED: IAIM International Conference*, 1–11.

Topi, H. et al. (2017). MSIS 2016 global competency model for graduate degree programs in information systems. *Communications of the Association for Information Systems*, 40(18).

Tsoy, T., L. Sabirova, and E. Magid (2018). Effective Robotics Education: Surveying Experiences of Master Program Students in Introduction to Robotics Course. *MATEC Web of Conferences*, 220, 4–11.

Uğur, N. G. and A. Hamit Turan (2019). Critical professional skills of MIS graduates: Practitioner vs. Academician perspectives. *Journal of Education for Business*, 94(4), 251–258.

Veltri, N. F. et al. (2011). Curriculum Mapping as a Tool for Continuous Improvement of IS Curriculum. *Journal of Information Systems Education*, 22(1), 31–42.

Vladoiu, M., Z. Constantinescu, and D. Danciulescu (2019). Career Tracks and Job Requirements in Information Systems vs. ACM / AIS IS 2010 Curriculum Guidelines : An Empirical Study. *28th International Conference on Information Systems Development*.

Waguespack, L. J. and S. Hunsinger (2015a). A proposed concentration curriculum design for big data analytics for information systems students. *Information Systems Education Journal*, 13(3).

Waguespack, L. J. and S. Hunsinger (2015b). IS Design Pedagogy: A Special Ontology and Prospects for Curricula. *Information Systems Education Journal*, 13(3), 4–13.

Wang, S. and H. Wang (2014). Redesigning the information systems analysis and design course: Curriculum renewal. *Journal of Computer Information Systems*, 55(1), 30–39.

Wang, S. and H. Wang (2016). Renewal of classics: Database technology for all business majors. *Journal of Computer Information Systems*, 56(3), 211–217.

Wang, S. and H. Wang (2019). Opportunities and challenges of cybersecurity for undergraduate information systems programs. *International Journal of Information and Communication Technology Education*, 15(2), 49–68.

Ward, S. (2010). Internationalizing the curriculum and the instructor - lessons from teaching the information systems core course in Nepal. *16th Americas Conference on Information Systems 2010, AMCIS 2010*, 7, 5218–5227.

Webster, J. and R. T. Watson (2002). Analyzing the past to prepare for the future: Writing a literature review. MIS quarterly, xiii-xxiii.

Whelan, E. and D. Firth (2012). Changing the introductory is course to improve future enrollments: An irish perspective. *Journal of Information Systems Education*, 23(4), 395–406.

White, G. L., B. Hewitt, and S. E. Kruck (2013). Incorporating global information security and assurance in I.S. education. *Journal of Information Systems Education*, 24(1), 11–16.

Whitney, M., P. Guilbaud, and A. Romanova (2019). Introductory information systems course: Driving 21st century skill development with student response systems. *25th Americas Conference on Information Systems, AMCIS 2019*, 1–10.

Wibisono, A. and A. S. Nisafani (2013). Curriculum Structure of the Undergraduate Programs of Information Systems in Indonesia in the Year of 2013. *Information Systems International Conference*.

Winkelmann, A. and C. Leyh, (2010). Teaching ERP Systems: A Multi-Perspective View on the ERP System Market. *Journal of Information Systems Education*, 21(2), 233–240.

Woodley, C. and P. Shackleton (2012). Putting PS into IS: Developing Professional Skills and enhancing employability through curriculum initiatives in Information Systems. *Proceedings - Pacific Asia Conference on Information Systems, PACIS 2012*.

Woodward, B., P. Sendall, and W. Ceccucci (2010). Integrating soft skill competencies through project-based learning across the information systems curriculum. *Information Systems Education Journal*, 8(8).

Woolridge, R. and K. Kim (2017). Identifying Job Focus and Course Priorities in IS Curriculum Development Using Online Job Advertisements. *Journal of Research in Business Information Systems,* 111–129.

Woolridge, R. W. and R. Parks (2016). What's In and What's Out: Defining an Industry-Aligned IS Curriculum Using Job Advertisements. *Journal of Higher Education Theory and Practice*, 16(2), 105–119.

Xiao, Y. (2017). Experimental case design of "mobile device programming" for specialty of information management and information system. *Proceedings - 2016 8th International Conference on Information Technology in Medicine and Education, ITME 2016*.

Xun, L. S., S. Gottipati, and V. Shankararaman (2015). Text-mining approach for verifying alignment of information systems curriculum with industry skills. *2015 International Conference on Information Technology Based Higher Education and Training, ITHET 2015*.

Yang, S. C. (2012). The Master's Program in Information Systems (IS): A Survey of Core Curriculums of U.S. Institutions. *Journal of Education for Business*, 87(4), 206–213.

Yang, S. C. (2016). The core curricula of information systems undergraduate programs: A survey of AACSB-accredited colleges in the United States. *Journal of Education for Business*, 91(5), 258–266.

Yang, S. C. and B. Wen (2017). Toward a cybersecurity curriculum model for undergraduate business schools: A survey of AACSB-accredited institutions in the United States. *Journal of Education for Busines*s, 92(1), 1–8.

Zhao, M. et al. (2018). The Practice of the Flipped Classroom Mode in the Information System Security Curriculum. *Proceedings - 9th International Conference on Information Technology in Medicine and Education, ITME 2018*, 669–672.