Business Intelligence and Big Data in Higher Education: Status of a Multi-Year Model Curriculum Development Effort for Business School Undergraduates, MS Graduates, and MBAs

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Abstract:

Business intelligence (BI), "big data", and analytics solutions are being deployed in an increasing number of organizations, yet recent predictions point to severe shortages in the number of graduates prepared to work in the area. New model curriculum is needed that can properly introduce BI and analytics topics into existing curriculum. That curriculum needs to incorporate current big data developments even as new dedicated analytics programs are becoming more prominent throughout the world. This paper contributes to the BI field by providing the first BI model curriculum guidelines. It focuses on adding appropriate elective courses to existing curriculum in order to foster the development of BI skills, knowledge, and experience for undergraduate majors, master of science in business information systems degree students, and MBAs. New curricula must achieve a delicate balance between a topic's level of coverage that is appropriate to students' level of expertise and background, and it must reflect industry workforce needs. Our approach to model curriculum development for business intelligence courses follows the structure of Krathwohl's (2002) revised taxonomy, and we incorporated multi-level feedback from faculty and industry experts. Overall, this was a long-term effort that resulted in model curriculum guidelines.

Keywords: Business Intelligence, Analytics, Big Data, Curriculum Development, Model Curriculum.

I. INTRODUCTION

Business intelligence (BI) is a term used to describe a broad category of applications, technologies, architectures, and processes for gathering, storing, accessing, and analyzing operational data to provide business users with timely competitive information to enable better insights for operational and strategic decision making (Negash, 2004, Watson, 2009). Organizations are increasingly facing the challenge of managing "big data". Big data is characterized by higher volume, velocity, and variety (the three Vs) of data than traditional database management tools can handle (Zikopoulos, Eaton, Deroos, Deutsch, & Lapis, 2012). The phrases analytics and big data have become synonymous with BI in some vendor circles, and, to others, these phrases incorporate traditional BI but add elements such as predictive analytics, data mining, and operations research/management science approaches and tools. For our purposes, we use the term business intelligence and analytics (BI&A) to represent the broadest interpretation of the field.

In May 2011, the McKinsey Global Institute predicted there would be a debilitating shortage in the coming years of talent who possess depth in BI&A (Manyika et al., 2011). Similar reports have echoed the trend toward a need for organizational harvesting of knowledge from the vast amounts of data now being generated. McKinsey estimates an unanswered need for 140,000 to 190,000 workers with deep analytic skills, plus 1.5 million managers and business analysts who can put big data to use to support better organizational decision making, innovate new product and service solutions, and improve and optimize business processes and performance. While the purview of a growing number of masters of science in business analytics programs will likely be to address the need for deep analytic skills, new BI&A model curriculum is needed to prepare the future managers and business analysts discussed in the McKinsey report.

In this paper, we describe the ongoing effort to improve BI&A model curriculum to deal with the shortage of managers and analysts who can put BI&A to use. In addition to the workforce issues, the need to advance curriculum initiatives in this space has been catalyzed by increasing student interest and enrollment in BI&A courses, and by a recent, dramatic increase in the number of dedicated master of science in BI&A programs cropping up across the world. Due to BI's multidisciplinary nature, BI&A courses may have topic overlaps with courses in other fields such as computer science, IS, marketing, and so on. Many authors such as Bullen, Abraham, and Galup (2007), Chiang, Goes, and Stohr (2012), Sircar (2009), and Wixom et al. (2011) emphasize the need to integrate BI knowledge with understanding of client-facing capabilities such as management and communication. In addition, Chiang et al. (2012) argue that BI&A should be taught at business schools, whereas the more technical data science courses should be assigned primarily to computer engineering and computer science. The focus of our effort to date has been on designing business school-based curriculum that is or could be included in most information systems (IS) programs in universities (Dinter, Goul, & Gupta, 2012).

Our work builds on existing efforts in curriculum design—most notably the Association for Information Systems' and Association for Computing Machinery's joint IS 2010 (Topi et al., 2010, 2008) and MSIS 2006 (Gorgone, Gray, Stohr, Valacich, & Wigand, 2006) curriculum guideline efforts (see Section 2).

II. RELATED WORK IN CURRICULUM DEVELOPMENT

Discussion in the *MSIS 2006 Model Curriculum* (Gorgone et al., 2006) asserts the differences between accrediting standards and model curriculum—the latter is what we have developed for BI&A elective courses at the undergraduate (UG), master of science (MS), and masters of business administration (MBA) levels and is what we discuss here. A model curriculum is more of a generic guide: it suggests a program of study that professional societies recommend, and it provides examples or guidelines from which institutions adapt or customize specific courses. In contrast, accrediting standards are specific guidelines to ascertain the suitability and fit of a course or program to an accrediting agency's benchmarks. In the curriculum model of MSIS 2006, there are two levels of courses; for example, data management is included as a level 1 course. Level 1 courses are those offering the fundamentals, while level 2 courses are richer and more sophisticated. For example, MSIS 2006's emerging technologies course in level 2 includes data mining and other technologically advanced content circa 2006.

With IS 2010 (Topi et al., 2010), the editors sought to embrace a broader, global perspective that went beyond the typical North American business school model. This undergraduate model curriculum addresses seven core courses including: 1) foundation of information systems and 2) data and information management. In the IS 2010 course

descriptions, learning objectives, and topics sections, there is more content directly related to BI&A than in MSIS 2006. In the foundation of information systems core course, content is incorporated to introduce students to BI&A vocabulary and related concepts. In the data and information management course, content is included in the broader area of business performance evaluation. Going beyond the core, editors who framed the IS 2010 model curriculum saw the need for an elective in what was referred to as a data mining/business intelligence course. They envisioned this elective as especially needed by business analysts, database administrators, database analysts, and IT architects. However, the curriculum model does not include the more detailed discussion provided in IS 2010 core courses. This is an important gap in terms of the workforce issues we discuss earlier. Also, Wixom et al. (2011) and Sircar (2009) emphasize the need for BI model curricula to prepare an appropriate BI workforce.

For MBA programs, the information system core course has been included in some model curricula and not in others. Some MBA programs offer concentrations in BI&A or concentrations that include a BI&A course as an elective. Some programs offer the BI&A course in both the master of science and MBA platforms. As Richard Herschel (2011) observes, the MBA concentration differs from a master of science dedicated to typically a single field of business:

> An MBA degree is granted after one to two years of graduate-level university study… The MBA is basically an academic document that certifies you have a general competency in all the major functional management roles you'll find in the modern corporation… Hence, we should not put too much stock in the ability of an MBA program to make someone an expert in any field. It is not the intent of the degree. The alternative to MBA programs is an MS in business. Business MS programs are specifically focused on a particular field of study. For example, an MBA with a concentration in finance might have two to four courses in finance, while an MS might have 10 to 12 (or more) courses in finance. In MS programs, the goal is to educate an expert, not a generalist. Over time, employers have demonstrated continued support for their employees' pursuit of MBA degrees. Today their support for MS degrees in business is rapidly gaining more traction.

In this research work, we targeted the development of model curriculum for BI&A electives at:

1) The undergraduate level for information systems majors who may have completed a data and information management-type course
2) The master of science level for programs that are likely making BI&A courses a regular core course, and
3) The MBA level BI&A course as an elective.

In the following sections, we discuss our approach to building the model curriculum, our findings along the way, and we discuss the results of the effort and include specific model curriculum for each of the three electives above.

III. METHODOLOGY

To build the model curriculum, we used an iterative approach including several evaluations during and after development phases. From a research point of view, we chose a multi-methodological approach by incorporating a literature review, expert interviews, focus groups, and surveys (plus subsequent empirical analysis). Finally, we integrated all relevant stakeholder groups (i.e., faculty, students, and experts in industry).

Figure 1 illustrates the steps in the first phase of the methodology (requirements definition). As a starting point, we overviewed existing BI curricula. We mainly focused on material (syllabi, assignments, etc.) provided as content on the Teradata University Network's (TUN) webpages (www.teradatauniversitynetwork.com). TUN is a Web-based portal for faculty and students in BI, data warehousing, analytics, and databases. Currently, it has over 4500 faculty members representing over two thousand universities in ninety-nine countries. It also has thousands of student users. The network is led by industry experts and faculty from various universities who provide and share content. Due to the reasons below, we regard TUN as an appropriate resource for the model curriculum:

1) It includes BI-specific material
2) It focuses on the teaching perspective (mainly at universities)
3) It has a long tradition and reflects the BI domain's development over the years, and
4) The spectrum of participating faculty is broad and diverse in terms of number, educational organizations, and internationality.

The TUN student usage patterns from all over the world also allow one to generalize conclusions about their needs and usage patterns with regard to BI teaching material. We analyzed TUN syllabi (uploaded by faculty from diverse universities) to get a first draft of the topic areas the model curriculum could potentially cover. We distinguished

different levels (UG, MS, MBA) in our analysis of these materials. Targeting an international perspective, this analysis included alignment with BI syllabi from universities across the world that we discovered through a comprehensive Web search.
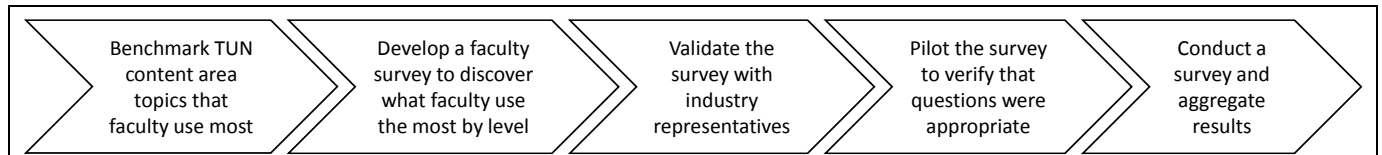
| Benchmark TUN content area topics that faculty use most | Develop a faculty survey to discover what faculty use the most by level | Validate the survey with industry representatives | Pilot the survey to verify that questions were appropriate | Conduct a survey and aggregate results |

Figure 1. Phase 1: Requirements Definition

In the next step of Phase 1, we developed a faculty survey to discover how relevant faculty members regarded different BI topic areas at the three levels (UG, MS, and MBA). We validated this survey with BI&A topic content analysis provided by BI industry representatives to ensure the content areas' coverage was consistent with what is needed in practice. We revised the survey according to industry expert feedback and also the input we received from selected, experienced faculty members who have taught BI for several years. We then broadly administered the survey to participants at a BI event at the Americas Conference of Information Systems (AMCIS) 2011, Detroit, MI. Approximately 42 attendees (a majority of whom were tenure-track professors with current or former experience in teaching BI) completed the survey. One confirmed result of the survey was that BI courses have gained relevance. In addition, faculty indicated that more IS departments offer BI courses as electives compared to offering them as required core courses.

Results from the survey analysis guided us in the second phase of the model curriculum development effort (see Figure 2) where we built the first curriculum model drafts by level. Both BI faculty and BI industry representatives then reviewed the drafts of UG, MS, and MBA curricula models, and we iteratively revised and refined them based on these individuals' feedback. We paid careful attention to ensure consistency across the three curricula in terms of structure, topic areas, and terminology. Finally, we also included a list of relevant and free content titles for cases, research papers, webinars, videos, software, assignments, presentations, and so on that were easily accessible at TUN for each BI topic in each curriculum. These titles provide concrete examples of concepts, methods, hands-on applications, and practitioner analyses for each topic area. We describe further details about the second phase below. We presented the resulting model curricula to a gathering of faculty attending a BI event organized at the 2012 Americas Conference on Information Systems (AMCIS), Seattle, WA.
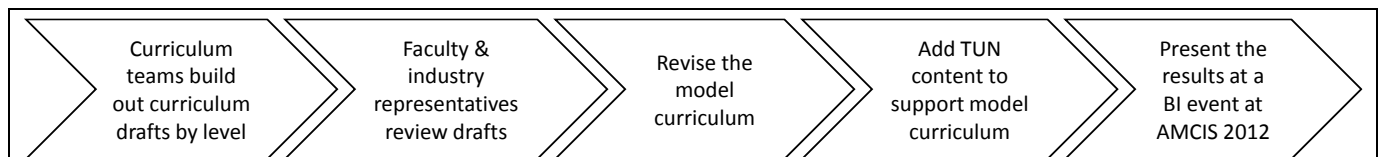
| Curriculum teams build out curriculum drafts by level | Faculty & industry representatives review drafts | Revise the model curriculum | Add TUN content to support model curriculum | Present the results at a BI event at AMCIS 2012 |

Figure 2. Phase 2: Model Curriculum Build-Out and Content Targeting

One critical step in the design of the model curriculum was to ensure the consistency of terminology, definitions, structure, and topics, and, in this case, we sought to also ensure that there was scaffolding of BI topics between undergraduate and graduate curricula. We developed a matrix that detailed the comparison of BI topics across the three curricula.

The initial matrix clearly highlighted the many differences among the three model curricula in terms of terminology usage and the overlap of BI topics. To solve these challenges, we researched the BI literature and, through that research, arrived on common terminology and definitions to use across the three curricula. This also helped in adjusting topics to ensure there was differentiation between undergraduate and graduate curricula in terms of depth of coverage. MBA coverage predominantly focused more on strategically applying BI tools and technologies and solving business problems for competitive advantage, the MS coverage emphasized learning how to build BI applications using BI tools, and the undergraduate coverage focused on understanding BI and its tools for solving business problems. The matrix was helpful in leading us to using a homogeneous BI terminology and to dividing the BI domain into topic areas that fit all three curricula.

In addition to providing opportunities to ensure internal definitional consistency across the curricula, with the matrix, we checked for sufficiency and completeness by topic area and depth of coverage. For this, we used Krathwohl's

revised taxonomy (Krathwohl, 2002) that uses two dimensions to frame a learning outcome in a curriculum: knowledge and cognitive process. The knowledge dimension consists of factual (FK), conceptual (CK), procedural (PK), and metacognitive knowledge (MK). The cognitive process dimension has six components: remember (Re), understand (Un), apply (Ap), analyze (An), evaluate (Ev), and create (Cr). For the three BI model curricula, for each BI topic learning outcome, each author took the lead in evaluating the intent and depth of coverage along Krathwohl's two dimensions for each of the UG, MS, and MBA curriculum. Table 1 depicts the coverage of BI topics across three BI curricula (marked in grey color). For example, BI topic 1 (intro to BI) requires factual knowledge and conceptual knowledge, in both cases with the cognitive processes understand and analyze. Thus, by rigorously examining various drafts in phase one and two with surveys and by evaluating learning objectives using the matrix in Table 1, we developed and integrated various BI topics across three BI model curricula.

Next, we summarized the level of coverage (low, medium, high) of each BI topic's learning outcomes in each curriculum by mapping them across Krathwohl's two dimensions (see Table 2). This helped ensure that the learning focus appropriate to each level was maintained. For example, MBA coverage of topics shows that the learning outcomes are focused on acquiring metacognitive knowledge across all six components of the cognitive process. This is in alignment with the MBA elective course focus on being able to strategically apply BI tools to solve business problems.

Table 1: BI Topics Coverage Across UG, MS, and MBA BI Model Curricula																			
	UG						MS						MBA						
BI Topics	Re	Un	Ap	An	Ev	Cr	Re	Un	Ap	An	Ev	Cr	Re	Un	Ap	An	Ev	Cr	
1 Intro to BI		■		■				■		■									FK
								■						■					CK
																			PK
																			MK
2 DBMS	■																		FK
	■	■							■				■						CK
																			PK
																			MK
3 Dimensional modeling		■	■	■					■										FK
													■			■			CK
									■	■									PK
																	■		MK
4 BI Infrastructure – Data Warehouse		■	■	■															FK
								■	■				■						CK
																			PK
			■				■												MK
5 BI infrastructure – end user tools such as OLAP, dashboards, scorecards		■	■																FK
		■						■	■					■					CK
																			PK
																			MK
6 Data visualization		■	■																FK
								■	■							■			CK
																			PK
																■			MK
7 Data/text mining		■	■	■				■	■										FK
										■					■	■	■		CK
																			PK
																			MK
8 Executive Information System (EIS)							■												FK
														■					CK
																			PK
													■						MK
9 BI applications		■						■											FK
		■	■	■	■				■										CK
		■						■					■	■		■	■		PK
		■																	MK
10 Business justification for BI Application								■	■	■									FK
			■	■															CK
																			PK
							■						■	■	■	■	■	■	MK
11 BI management								■	■	■									FK
		■	■	■				■									■	■	CK
		■															■	■	PK
							■												MK
12 Strategic uses of BI																			FK
		■	■	■				■	■	■									CK
		■																	PK
							■						■	■	■	■	■	■	MK
13 Data security/privacy																			FK
		■		■				■	■	■			■						CK
																			PK
				■															MK
14 Ethical issues in BI																			FK
	■	■		■				■	■				■	■		■			CK
																			PK
		■											■						MK
15 Web based BI																			FK
													■	■					CK
																			PK
																			MK
16 Future/emerging trends								■	■	■									FK
		■												■	■				CK
								■											PK
							■						■						MK
17 Business performance management																			FK
		■						■	■									■	CK
																			PK
		■											■	■	■	■			MK
18 BI and organizational issues such as culture																			FK
	■	■						■	■				■	■					CK
																			PK
	■						■						■	■	■	■			MK

Table 2: Curriculum Content Coverage Using Krathwohl's Taxonomy						
Undergraduate	**Remember (Re)**	**Understand (Un)**	**Apply (Ap)**	**Analyze (An)**	**Evaluate (Ev)**	**Create (Cr)**
Factual Knowledge (FK)	Low	High	Medium	Low	Low	
Conceptual Knowledge (CK)	Medium	High	Medium	Medium	Medium	Low
Procedural Knowledge (PK)		Medium				
Metacognitive Knowledge (MK)	Low	Medium		Low	Low	
Master of Science						
Factual Knowledge (FK)		High	High	High	Low	
Conceptual Knowledge (CK)		High	High	High	Low	
Procedural Knowledge (PK)		High	High	Medium	Low	
Metacognitive Knowledge (MK)	Medium	Medium				
MBA						
Factual Knowledge (FK)						
Conceptual Knowledge (CK)	High	High	Medium	Low	Medium	Low
Procedural Knowledge (PK)	Low	Low		Low	Low	
Metacognitive Knowledge (MK)	Medium	Medium	Medium	Medium	Medium	Medium

In Section 4, we describe the content and structure of the three curricula models in more detail.

IV. STRUCTURE OF THE MODEL CURRICULUM

As we discuss in Section 3, at the end of Phase 2, we had developed three model curricula for an elective business intelligence course at the undergraduate level (see Appendix A), MS level (see Appendix B), and MBA level (see Appendix C). In this section, we provide some details of the structure of each curriculum.

We consciously tried to make the model curricula across three levels (UG, MS, and MBA) consistent in terms of terminology and formatting. To develop the three curricula, we were guided by the methods used in IS 2010. Each model curriculum had a similar structure with the following common elements: title, course description, pre-requisites, learning objectives, topics, discussion, and references. Table 3 overviews the curriculum items for each curriculum type.

Table 3: Structure of Undergraduate, MS, and MBA BI Model Curricula			
Curriculum items	**Undergraduate**	**MS**	**MBA**
Title	Business intelligence	Business intelligence	Business intelligence & analytics
Course description focus	Understanding both BI topics and how to use BI applications	Understanding of BI topics from technical and managerial perspective	Understanding of BI topics from executive perspective
Any pre-requisites	None	Knowledge of fundamentals of ERD modeling	None
Bi topics	Focus on understanding basic BI terminologies and its interrelation to other technologies in the organization to solve business problems	Focus on understanding, applying, and evaluating BI technologies in depth to create applications to solve business problems	Focus on understanding and applying BI technologies strategically in different contexts to solve business problems
Discussion	Mostly provides understanding of topics with some projects for students to experience BI hands-on	Mostly provides understanding of topics with team projects for students to experience BI hands-on	Mostly provides understanding of BI and its strategic importance to an organization hands-on projects, and possible case teaching methodology

Each model curriculum is differentiated from other curricula by the details embedded in each of the aforementioned elements. For example, the course description of each model curriculum is designed to consider the level at which

the course is being offered. At the undergraduate level, the course description provides a thorough understanding of important concepts in BI and its role in strategic and operational decision making. At the MBA level, the course description focuses on how the BI concepts and tools can be applied to executive leadership and strategic decision making at the enterprise level. At the MS level, the course description focuses on technical aspects of BI such as designing and developing BI infrastructure to support operational and strategic decision making.

The pre-requisites differ for the three levels. For undergraduate and MBA programs, there are no pre-requisite requirements. Based on feedback from faculty from many universities, an introductory business intelligence course is usually offered as an elective rather than a required course in the undergraduate business administration programs. The same is true in MBA programs. The undergraduate pre-requisites follow from the IS 2010 model (Topi et al., 2010). Therefore, course design needs to be flexible enough to accommodate topics such as fundamentals of database management, an understanding that is needed to thoroughly grasp BI topics. For the master of science programs, however, feedback from faculty indicated that students taking a BI course in MS curricula would be able to come in with pre-requisite knowledge base of fundamentals of database management, which follows the MSIS 2006's (Gorgone et al., 2006) the core and elective course philosophy.

We paid attention to designing the learning objectives at each of the three levels to reflect students' pre-requisite knowledge, course objectives, and what students should be able to do at the end of their learning in the course. For example, at the undergraduate level, there is more focus on students being able to understand BI topics and tools and how these can be applied to various business scenarios, while the learning objectives focus in MS level is on both understanding BI tools and developing BI applications to solve business problems. At the MBA level, learning objectives focus on how BI tools are applied for strategic advantage at the enterprise level. Therefore, topics and content for the three model curricula reflect the theme of the learning differences among the three levels (see also Table 2). Undergraduate-level BI topics reflect the intent to introduce BI to students and to make them aware of all aspects of BI and its importance to a business. BI topics in the MS-level curriculum reflect the need for students to be more technologically proficient in BI tools and being able to design a BI solution for solving a business problem. MBA-level BI topics reflect the intent to ensure that students are constantly evaluating each BI topic and tool in the context of strategic investment in information technologies in different business domains.

A discussion section in each model curriculum reflects notes of pedagogy, constraints, or special directions for a particular level that would be useful in designing the activities for the course.

Pedagogical Support by the Teradata University Network Platform

Once we finalized the three model curricula, we considered how to support the models with relevant content. Such content should include pedagogical tools to support faculty teaching a course. For example, content needs to enhance lectures and/or assignment activities. The TUN site is a rich resource for BI related content: it provides case studies of BI applications in industry, white papers on various BI tools, software resources for building BI applications, and much more. We linked each topic in each of the three model curricula to appropriate content at the TUN site. During this exercise, we also identified any gaps in content availability.

As we mention earlier, we presented and distributed the final versions of the three curricula (Appendices A, B, & C) to faculty attendees of a meeting designed for this very purpose during AMCIS 2012.

V. NEXT STEPS: DIFFERENTIATING MS AND MBA BI PROGRAM CONTENT

While the model curricula we developed share some common elements, there are some distinctive, non-overlapping elements across the three BI courses:

- Undergraduate BI curriculum emphasizes an understanding of the BI tools and how they are applied in a business context using IS.
- MBA BI curriculum emphasizes understanding how BI implementations can benefit businesses tactically and strategically at the enterprise level, and on gaining necessary analytical skills for interpreting business data and managing BI projects.
- MS BI curriculum emphasizes understanding BI techniques and developing BI applications using state-of-the-art tools to solve business problems in enterprises.

As more universities move toward developing graduate programs in BI&A, there are different philosophies evolving on how best to prepare for industry demand for data analysts/scientists with advanced skills: some are offering analytics certificates or specializations in an MBA program, while many are opting for an MS in analytics program. Some universities are doing both. There is a growing realization that there is very little consensus on how to differentiate the master of science and MBA BI&A curricula. This issue is further complicated by the fact that there

are different models of graduate program offerings throughout the world. For example, in many German institutions, a majority of students completing undergraduate degrees enroll in an MS program; they can enroll in an MBA program only after completing an MS first. This is of course different from the U.S. approach.

Thus, a systematic understanding of the objectives of MBA and MS BI&A curricula is needed. As a first step, we designed a pilot survey. This survey identified the general areas of curriculum focus for specialized master of science in BI&A programs that graduate analytics professionals/semi-professionals; and general areas of focus for MBA concentrations/specializations/dual degrees in BI&A intended to graduate analytics managers. We took survey items—knowledge and skills required for each category of graduates, analytics professionals/semi-professionals, and analytics managers—from job postings for related job titles. Our propositions, based on best practices in teaching of BI courses, are that:

- An analytics manager BI program should focus primarily on graduates understanding BI concepts and their application in different management scenarios for more efficient decision making, understanding how BI implementations can benefit businesses tactically and strategically at the enterprise level, and gaining the necessary analytical skills for interpreting business data and managing BI projects.

- An analytics professional (or semi-professional) BI program should focus on understanding BI techniques and developing BI applications using state-of-the-art BI tools to solve business problems at the enterprise level.

We distributed the pilot survey to faculty and industry experts attending the BI Congress 3: Driving Innovation through Big Data Analytics, a pre-ICIS conference sponsored by TUN/SIGDSS in Orlando, Florida, on December 15 and 16, 2012. We received 16 valid responses from faculty members who have been following the field for some time and who represent multiple fields and industry. Appendix provides the pilot survey and results.

The pilot survey results are surprising. Preliminary results strongly suggest that, while technical BI skills, as expected, are indeed important for analytics professional (or semi-professionals), soft skills such as "effectively presenting findings to diverse audiences using strong verbal and written communication skills", "identify[ing] key metrics that drive business growth ", "[the] ability to interpret complex trends and tell a concise story with the data", and "work[ing] in a team setting, with managers, IT administrators, programmers, statisticians, graphic designers, and experts in the company's products or services" are equally (or even more) important than they are for the analytics manager.

The most unexpected result was the high importance of the statement "have requisite experience as an analytics professional or semi-professional before moving into a champion role" for analytics manager. This has implications for the MBA versus MS BI program and curriculum structure that needs to be further explored. Pilot survey results inform that there is need to further examine the general approach (at least in US) of the generalist MBA and technical MS program focus. Additional investigation is needed to clarify whether MBA specializations can produce BI&A managers, or if they are more likely to train managers who have excellent command of and can make strategic use of BI&A in corporate settings.

The pilot survey results also provided us with information on the constructs that matter in attempting to make a direct comparison. Next, we plan to refine the survey to look more closely at these constructs. We plan to administer the resulting survey to faculty teaching in BI&A graduate programs on an international scale. Coupled with a case method approach, results would clarify the MS versus MBA curriculum focus and identify gaps in existing MS and MBA programs in various schools—gaps identified from direct comparison to industry needs.

VI. CONCLUSIONS

In this paper, we present an early effort in the model curriculum development process as part of an ongoing effort to meet the curricula needs of BI&A programs that are beginning to appear to address the industry needs for managers and analysts with BI&A skills. We presents three model curricula developed for an elective BI course at the undergraduate, MS, and MBA levels. Curricula development was guided at each step by observations, suggestions, and feedback from experts in BI domain using surveys, focus groups, and interviews (we interviewed faculty teaching in BI&A and industry professionals working in BI&A). We ensured internal consistency, sufficiency of coverage, and completeness in learning objectives, topics, and depth in each area. We also took care to ensure consistency with IS 2010 and MSIS 2006—the model curriculum that has guided institutions for many years now. Finally, we leveraged the model curriculum at each level to provide faculty with information on content at TUN site that will, in effect, support syllabus development and course activity design and implementation.

This work provides a starting point for building a BI program complete with many BI related courses. Much work still remains to be done. We identify some of the immediate next steps:

1. A natural next extension is to assess the opportunity to leverage what has been learned in this effort to begin work on model curriculum for complete MS in BI&A programs that are becoming increasingly popular. We described our current progress including pilot study results in the preceding section.

2. There is a need to design learning activities and pedagogy—lectures activities, case studies, assignments, projects—at each level so that they better reflect the intent of the three curricula for scaffolding between undergraduate and graduate levels.

3. There is a need to share content to fill the existing gaps and need for more-recent content reflecting the rapid changes in BI technologies over last few years.

4. The level of coverage (low, medium, high) of learning outcomes of each BI topic in each curriculum developed by mapping them across Krathwohl's two dimensions in Table 2 represents the authors' views and, therefore, further work is needed in this area to overcome this limitation.

5. The multi-disciplinary nature of BI&A and the proliferation of MS in BI&A in and outside of business colleges makes it difficult to design generic curricula that can serve across different fields' needs. This is especially true for the MS programs that are emerging across the world. While this research focuses on curriculum model for the MS introductory BI&A course in a business school, there is need for more research on how this model might accommodate needs of MS programs offered outside of the business school.

As universities worldwide begin to wrestle with different approaches to developing BI&A programs and courses to meet industry requirements for a trained workforce, we contribute by providing model curricula with associated pedagogical material for introductory BI&A elective courses in undergraduate and graduate programs. These model curricula articulate the differences in learning objectives at undergraduate and graduate levels. We also identify the gaps in available instructional material that may spur efforts to develop teaching material to support BI&A curricula—mini-cases, case studies, exercises and assignments, and textbooks.

ACKNOWLEDGMENTS

REFERENCES

Editor's Note: The following reference list contains hyperlinks to World Wide Web pages. Readers who have the ability to access the Web directly from their word processor or are reading the paper on the Web, can gain direct access to these linked references. Readers are warned, however, that:
1. These links existed as of the date of publication but are not guaranteed to be working thereafter.
2. The contents of Web pages may change over time. Where version information is provided in the References, different versions may not contain the information or the conclusions referenced.
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Bullen, C., Abraham, T., & Galup, S. D. (2007). IT workforce trends: Implications for curriculum and hiring. *Communications of the Association for Information Systems*, *20*, 545-554.

Chiang, R. H. L., Goes, P., & Stohr, E. A. (2012). Business intelligence and analytics education, and program development: A unique opportunity for the information systems discipline. *ACM Transactions in Management Information Systems*, *3*(3), 12:1-12:13.

Davenport, T. H., & Harris, J. G. (2007). *Competing on analytics: The new science of winning.* Boston, MA: Harvard Business School Press

Davenport, T. H, & Harris, J. G. (2007). The dark side of customer analytics. *Harvard Business Review*, *85*(5), 37-48.

Davenport, T. H., Harris, J. G., & Morison, R. (2010). *Analytics at work: Smarter decision, better results*, Boston, MA: Harvard Business School Press.

Dinter, B., Goul, M., & Gupta, B. (2012). *Facing the challenges of "big data": Towards model curriculum for business intelligence in undergraduate and graduate IS and MBA programs*. Paper presented at the Proceedings of the Business Intelligence Conference 3, Orlando, Florida.

Field, A. (2011). Testing, monitoring, and adjusting strategic objectives through data analytics at Northwestern Mutual. *Balanced Scorecard Report*, *13*(1), 7-10.

Gorgone, J., Gray, P., Stohr, E. A., Valacich, J. S., & Wigand, R. T. (2006). MSIS 2006: Model curriculum and guidelines for graduate degree programs in information systems. *Communications of the Association for Information Systems*, *17*(1), 121-196.

Herschel, R. (2011). Business intelligence, MS and MBA. *BeyeNetwork.* Retrieved 5 March, 2015, from http://www.b-eye-network.com/view/14854

Krathwohl, D. R. (2002). A revision of Bloom's taxonomy: An overview. *Theory into Practice, 41*(4), 212-218.

Manyika, J., Chui, M., Brown, B., Bughin, J., Dobbs, R., Roxburgh, C., & Byers, A. H. (2011). Big data: The next frontier for innovation, competition and productivity. *McKinsey Global Institute.* Retrieved 5 March, 2015, from http://www.mckinsey.com/insights/business_technology/big_data_the_next_frontier_for_innovation

Negash, S. (2004). Business intelligence. *Communications of the Association for Information Systems*, *13*, 177-195.

Sircar, S. (2009). Business intelligence in the business curriculum. *Communications of the Association for Information Systems*, *24*, 289-302.

Topi, H., Valachich, J. S., Wright, R. T., Kaiser, K. M., Nunamaker, J. F., Sipior, J. C., & de Vreede, G. J. (2010). IS 2010: Curriculum guidelines for undergraduate degree programs in information systems. *Communications of the Association for Information Systems*, *26*, 359-428.

Topi, H., Valachich, J. S., Wright, R. T., Kaiser, K. M., Nunamaker, J. F., Sipior, J. C., & de Vreede, G. J. (2008). Revising undergraduate IS model curriculum: New outcome expectations. *Communications of the Association for Information Systems*, *23*, 591- 602.

Watson, H. J. (2009). Tutorial: Business intelligence—past, present, and future. *Communications of the Association for Information Systems*, *25*, 487-510.

Wixom, B. H., & Ariyachandra, T. (2011). State of Business Intelligence in Academia 2010. *BI Congress II*. Retrieved 5 March, 2015, from http://www2.commerce.virginia.edu/bic3/content/2010-State-of-BI-Report.pdf

Wixom, B., Ariyachandra, T., Goul, M., Gray, P., Kulkarni, U., & Phillips-Wren, G. (2011). The current state of business intelligence in academia. *Communications of the Association for Information Systems*, *29*, 299-312.

Zikopoulos, P. C., Eaton, C., Deroos, D., Deutsch, T., & Lapis, G. (2012). Understanding big data: Analytics for enterprise class Hadoop and streaming data. *McGraw-Hills.* Retrieved 5 March, 2015, from http://public.dhe.ibm.com/common/ssi/ecm/en/iml14296usen/IML14296USEN.PDF

TERADATA University Network

Undergraduate Business Intelligence Course Standards
Teradata University Network BI Standards Committee

Title: Business Intelligence

Course description:
Business intelligence (BI) is a term used to describe a broad category of applications, technologies, architectures, and processes for gathering, storing, accessing, and analyzing operational data to provide business users with timely competitive information to enable better insights into operational and strategic decision making (Negash, 2004; Watson, 2009). Business intelligence services based on data mining techniques of capturing, cleansing, validating, storing, and analyzing data help decision makers improve the timeliness and quality of inputs to the decision process. BI can help organizations in strategic and operational decision making by improving corporate performance management, optimizing customer relations, monitoring business activity, and supporting traditional decision making processes (Negash, 2004). This course provides a thorough understanding of the concepts of managing data resources and the development of business intelligence capabilities using data warehousing, data mining, online analytical processing (OLAP), decision support systems (DSS), data visualization, and other business intelligence topics.

Pre-requisites: None.

Learning objectives:
At the end of this course, the student should be able to:
1. Understand the role of data in supporting decision making in organizations. Understand definitions of terms (e.g., data, information, knowledge, semantic design), relational database design (normalization, etc.), issues in data quality, integration, and continuity.
2. Understand concepts of business intelligence, frameworks, BI architectures and their components, BI data types and sources, and structured, semi-structured, and unstructured data.
3. Understand how data warehouses are used to drive business outcomes and how to successfully gather, structure, analyze, understand, and act on information stored in data warehouses, dimensional modeling, fact tables, schemas (e.g., star, snowflake, etc.), existing and emerging architectures and design methodologies in data warehouses.
4. Understand ETL-extraction, transformation and loading, metadata and master data repositories; querying a real-world, large data warehouse, and understanding key methods of classifying, predicting, and exploring data mining.
5. Understand the difference between on-line transaction processing (OLTP) and OLAP, and the relationship between these concepts and business intelligence, data warehousing, and data mining.
6. Describe and explain online reporting systems such as dashboards and score cards OLAP, MOLAP, ROLAP, and Hybrid OLAP.
7. Understand data visualization using BI tools to create forecasts based on historical data, past, and current performance.
8. Understand the business uses and value of BI, security, scalability, and ethical issues in BI system integration, understand the role of BI in advancing competitive strategy, and describe the emerging trends and directions for BI including mobile BI and geospatial BI.

Topics
1. Introduction to business intelligence (overview)
   a. Definition
   b. Classification
   c. Principles of executive information systems and decision support systems

   TUN resources:
   - ARTICLE: *The Current State of Business Intelligence*
   - VIDEO: Introduction to business intelligence with MicroStrategy

2. Types of database management systems
   a. Data, information, and knowledge
   b. Types of data (e.g., atomic, quantitative, qualitative, unstructured, etc.)

    c.   File processing/organizing concepts and models
    d.   Review of relational database and SQL
         i.   Relational database design (normalization, etc.)
        ii.   SQL to perform complex database queries, triggers, and stored procedures
    e.   Issues in data quality, integration, and continuity
    f.   Database tuning and optimization
    g.   Data administration and security

TUN resources:
- SOFTWARE: Entity-Relationship diagram (ER) modeling tool
- SOFTWARE: Teradata SQL assistant/Web edition
- HANDS-ON ASSIGNMENT: Entity-Relationship Diagram (ERD) problems

3. Data warehouse
    a.   Dimensional modeling and fact tables and schemas (e.g., star, snowflake, etc.)
    b.   Data staging, ETL, ELT
    c.   Warehouse architectural alternatives (federated, single source of the truth, etc.)
    d.   Designing a data warehouse schema using a dimensional modeling tool
         i.   Querying a real-world, large data warehouse using SQL
    e.   Warehouse data quality, metadata, and security management planning
    f.   Data warehouse requirements definition and analysis
    g.   Warehouse readiness assessment methodologies and approaches
    h.   Role of data warehousing in advancing competitive strategy

TUN resources:
- TUTORIAL: Data warehousing concepts tutorial
- INTEGRATED MATERIAL SET: Data integration
- TUTORIAL: Dimensional modeling tutorial
- SOFTWARE: Dimensional modeling tool
- INTEGRATED MATERIAL SET: Dimensional modeling and OLAP
- ARTICLE: *Data Warehouses, Metadata, and Middleware*
- RESEARCH REPORT: *In Search of a Single Version of Truth: Strategies for Consolidating Analytic Silos*
- ARTICLE: *Key Factors in Selecting a Data Warehouse Architecture*
- ARTICLE: *Hadoop and the Data Warehouse: When to Use Which*
- CASE: Data Warehousing Supports Corporate Strategy at First American Corporation
- STUDENT WORK: What do I need to understand to plan for and design the schemas for a data warehouse?

4. Data visualization
    a.   Evolution and need for data visualization
    b.   Creating visualizations
    c.   GIS

TUN resources:
- ARTICLE: *Information Visualization for Business: Past & Future*
- INTEGRATED MATERIAL SET: Data Visualization and Dashboard Design
- SOFTWARE: Tableau and SAS-VA
- HANDS-ON ASSIGNMENT: Tableau Software Project, SAS VA project

5. Data mining
    a.   What is data mining?
    b.   Data partitioning
    c.   Training, validation and holdout samples
    d.   Open ended exploration as opposed to a strict view on inference

TUN resources:
- WEB SEMINAR: What Is Data Mining?
- A data mining primer for the data warehouse professional

- ARTICLE: *Business Intelligence through Text Mining*

6. Using an executive information system/dashboards/scorecards

   TUN resources:
   - ARTICLE: *Dashboard Design: Beyond Meters, Gauges, and Traffic Lights*
   - ARTICLE: *Dashboards and Scorecards*

7. Online analytic processing: OLTP, OLAP, MOLAP, ROLAP, Hybrid OLAP

   TUN resources:
   - ARTICLE: *Maximizing the Return on OLAP and Data Mining Analysts*
   - ARTICLE: *From ER Models to Dimensional Models: Bridging the Gap between OLTP and OLAP Design, Part I*

8. BI applications
   a. Business justification for a BI application
   b. Doing SQL analytics to address a business problem
   c. Conducting drillable OLAP analysis and creating static reports
   d. Using an excel-based BI application
   e. Using a DSS/specific DSS
   f. Doing data mining, text mining, web mining, sentiment analysis, etc.
   g. Emerging BI tools/applications (e.g., deploying mobile BI apps, big data, self-service BI)
   h. Cross-functional BI application areas such as clickstream analytics, fraud detection, churn analysis, credit scoring, compliance reporting, and forecasting

   TUN resources:
   - POWERPOINT PRESENTATION: Valuing IT- Enabled Business Processes through Information Flow Simulation: A Data Quality Perspective
   - WEB SEMINAR: Developing a BI Strategy for CRM/ERP Data
   - RESEARCH REPORT: *Big Data Analytics*
   - RESEARCH REPORT: *Big Data Analytics: Profiling the Use of Analytical Platforms in User Organizations*
   - ARTICLE: *Business Intelligence through Text Mining*
   - VIDEO: BSI: Teradata Case of the Retail Tweeters (sentiment analysis)
   - ARTICLE: *Promoting Effective Decision Making Using Analytics in a Virtual Technology Lab*
   - WEB SEMINAR: BI Tools and Excel Spreadsheets-Friends or Foes?

9. BI vendor analysis, software and hardware selection
   a. Proprietary BI tools
   b. Open-source BI tools
   c. Web-based BI tools

   TUN resources:
   - ARTICLE: *How To Choose Among The Four Bright Lights of BI*
   - ARTICLE: *Business/Corporate Performance Management: Changing Vendor Landscape and New Market Targets*
   - CASE: Teradata Reborn
   - ARTICLE: *Decision Support Systems: To Buy or Build*
   - ARTICLE: *The Rise of Analytic Applications: Build or Buy*?

10. Data security, privacy and ethical issues in using BI tools

    TUN resources:
    - ARTICLE: *The "Soft Side" of Real-Time BI*
    - VIDEO: Analytics and Ethics, Interview with Frank Buytendijk at the 2012 TDWI World Conference
    - VIDEO: The Dark Side of Big Data

11. Future trends in BI
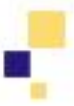
TUN resources:
- TUTORIAL: Business Intelligence: Past, Current, and Future
- ARTICLE: *Future Directions for BI Software*
- ARTICLE: *Analytics as a Service: From Data in the Cloud to Sandbox Innovation*
- POWERPOINT PRESENTATION: The New Know
- ARTICLE: *Wall Street Firm Uses Algorithms to Make Sports Betting Like Stock Trading*

Discussion
- The course will provide knowledge about the difference in structure between relational databases and multidimensional data warehouse architectures, relationship between facts tables and dimension tables, and basic star and snowflake schemas.
- The course will provide opportunity for the student to design online analytical processing (OLAP) models, build multidimensional cubes that are capable of providing summary information, and drill down for detailed data using a BI tool.
- The course should incorporate opportunities for student to not only understand what BI is but also to build actual working experience by strengthening the application of the BI knowledge.
- The course should emphasize the importance of understanding of various business functional areas to enable good BI analytical approach to problem solving (dispel the myth that BI is data driven) (Wixom & Ariyachandra, 2011).

APPENDIX B: MASTER OF SCIENCE COURSE STANDARDS

Master of Science Course Standards
Teradata University Network BI Standards Committee

Title: Business Intelligence (Elective)

Course description:
Business intelligence (BI) can be defined as a broad category of applications, technologies, and processes for gathering, storing, accessing, and analysing data to help business users make better decisions (Watson, 2009). Organizations are beginning to perceive tremendous value in business intelligence since high-quality information about their capabilities and those of their competition is essential for effective decision making to be competitive.

This course comprehensively overviews implementing and managing business intelligence in organizations from a technical and a managerial perspective (Gorgone et al., 2006). The technical perspective focuses on designing and developing BI infrastructure such as integrated data stores and a wide variety of analytical tools for operational and strategic decision making. The managerial perspective addresses the governance, oversight, and business value gained from business intelligence in organizations.

Pre-requisites: Fundamentals of database management (RDBMS, SQL, entity relationship modeling)

Learning objectives:
At the end of this course, the student should be able to:
1. Understand the common language, terminology, and concepts related to business intelligence, data warehousing, and the components of their frameworks such as operational data stores, data warehouses, data marts, and analytical tools. Differentiate between operational systems (i.e., transaction processing systems) and BI systems and understand how these systems work with each other.
2. Understand the processes and technology involved in constructing BI infrastructure including requirements analysis, the development of data warehouse architecture, and its operations.
3. Understand the data modeling techniques for both relational data models (entity relationship modeling) and multidimensional data models and apply them in a given situation.
4. Understand the data management topics relevant for data warehousing, such as data quality management, meta data management, and master data management. Analyze which techniques can be how applied to

certain scenarios. In particular, understand and apply ETL (extraction, transformation, loading) processing using data profiling, cleansing, conversion, and integration.
5. Understand the various roles and responsibilities associated with BI efforts in organizations. Be familiar with governance, change, and project management frameworks for BI.
6. Understand that BI consumers differ in terms of needs and skills. Recognize the end user tool categories and representative applications available for BI users for data access and information delivery such as data visualization, dashboards, and scorecards. Apply data mining techniques to organizational data and analyze when to use which technique.
7. Understand how organizations build sustainable competitive advantage with BI. Be aware of BI is a management task that requires strategy, justification (including appropriate business cases), and knowledge of key success factors. Analyze real-world situations and derive possible procedures from a management point of view.
8. Understand the emerging trends in the BI field that may influence and advanced current BI practices such as big data, social BI, self-service BI, and search optimization. Recognize the increasing relevance of operational BI as the convergence of operational and analytical information systems.

Topics
1. Fundamentals of BI (concept overview)
   a. Definition and general framework
   b. Related BI terminology and components (e.g., data warehouse)
   c. History of decision support systems (DSS) and executive information systems (EIS)
   d. Distinguish between transaction processing systems and BI solutions

   TUN resources:
   - VIDEO: Ten-minute introduction to business intelligence
   - ARTICLE: *The Current State of Business Intelligence*
   - ARTICLE: *What Happened to Executive Information Systems*?

2. Review database management
   a. Basic concepts
   b. Entity Relationship modeling
   c. Relational database design (normalization, etc.)
   d. Overview of SQL

   TUN resources:
   - SOFTWARE: Entity-Relationship diagram (ER) modeling tool
   - SOFTWARE: Teradata SQL Assistant/Web Edition
   - ASSIGNMENT: Entity-relationship diagram (ERD) problems

3. Dimensional Modeling
   a. Introduction to the multidimensional data model (elements, operations, exemplary notation)
   b. Advanced topics in dimensional modeling (e.g., slowly changing dimensions, conformed dimensions, constellations, etc.)
   c. Multidimensional modeling in RDBMS (star/snowflake schema)

   TUN resources:
   - INTEGRATED MATERIAL SET: Dimensional modeling and OLAP
   - TUTORIAL: Dimensional modeling tutorial
   - SOFTWARE: Dimensional modeling tool
   - STUDENT WORK: What do I need to understand to plan for and design the schemas for a data warehouse?

4. BI infrastructure: the data warehouse
   a. Definition and data warehousing framework
   b. Data warehouse components and major architectures
   c. Data staging and integration approaches (ETL, ELT, EAI, etc…)
   d. Data quality (profiling, cleansing, etc.) and meta data management

   TUN resources:
   - TUTORIAL: Data warehousing concepts tutorial
   - ARTICLE: *Key Factors in Selecting a Data Warehouse Architecture*

- RESEARCH REPORT: *In Search of a Single Version of Truth: Strategies for Consolidating Analytic Silos*
- INTEGRATED MATERIAL SET: Data Integration
- ARTICLE: *Data Warehouses, Metadata, and Middleware*
- ARTICLE: *Customer Data Quality: Building the Foundation for a One-to-One Customer Relationship*
- ARTICLE: *Data Profiling: A Tool Worth Buying (Really)*
- ARTICLE: *Dirty Data No More: Five Tips for Data Governance*
- ARTICLE: *Metadata Management Maturity Model*

5. BI infrastructure: end user tools
   a. Different types of business analytic consumers
   b. OLAP: definition and various architectures (MOLAP, ROLAP, etc.)
   c. Performance dashboards and scorecards
   d. Data/text mining and predictive analytics
   e. Data visualization

   TUN resources:
   - ARTICLE: *From ER Models to Dimensional Models: Bridging the Gap between OLTP and OLAP Design, Part I*
   - ARTICLE: *Understanding BI Users' Value Proposition*
   - ARTICLE: *Maximizing the Return on OLAP and Data Mining Analysts*
   - ARTICLE: *Dashboard Design: Beyond Meters, Gauges, and Traffic Lights*
   - ARTICLE: *Dashboards and Scorecards*
   - WEB SEMINAR: What Is data mining?
   - A data mining primer for the data warehouse professional
   - ARTICLE: *Business Intelligence through Text Mining*
   - VIDEO: People Analytics: Using Data to Drive HR Strategy and Action
   - SOFTWARE: The Planners Lab
   - INTEGRATED MATERIAL SET: Data Visualization and Dashboard Design
   - ARTICLE: *Information Visualization for Business: Past & Future*
   - SOFTWARE: Tableau, SAS-VA

6. BI applications
   a. Analytical CRM, fraud detection, churn analysis, etc.
   b. Business performance management
   c. Operational BI

   TUN resources:
   - INTEGRATED MATERIAL SET: Business performance management
   - PODCAST: Facing the Challenges of Operational Business Intelligence
   - WEB SEMINAR: Turning Active Enterprise Intelligence Into Competitive Advantage

7. Management of BI
   a. Requirements analysis
   b. BI strategy, success factors, and maturity model
   c. Business value (justification and ROI analysis) and impact of BI (i.e., role of BI in advancing competitive strategy)
   d. BI governance, roles and responsibilities
   e. Ethical Issues in BI

   TUN resources:
   - STUDENT WORK: What do I need to understand to plan for and design the schemas for a data warehouse?
   - ARTICLE: *Requirements Gathering: Don't Be Naïve*
   - ARTICLE: *A Method for Demand-Driven Information Requirements Analysis in Data Warehousing Projects*
   - ARTICLE: *The Requirements for Being an Analytics-Based Organization*
   - CASE STUDY: Data Warehousing Supports Corporate Strategy at First American Corporation
   - ARTICLE: *Sherwin-Williams' Data Mart Strategy: Creating Intelligence Across the Supply Chain*

- ARTICLE: *Strategic Analytics Effectiveness: Devising an Analytics Information Maturity Model*
- CASE STUDY: *Harrah's High Payoff from Customer Information*
- ARTICLE: *Best Practices in Building a Data Warehouse Quickly*
- CASE STUDY: *Data Warehousing Supports Corporate Strategy at First American Corporation*
- PODCAST: The ROI Case For An Active Enterprise Data Warehouse
- ARTICLE: *Assessing BI Readiness: A Key to BI ROI*
- CASE STUDY: Data Warehouse Governance at Blue Cross and Blue Shield of North Carolina
- ASSIGNMENT: Governance and the Data Warehouse Project
- VIDEO: Analytics and Ethics, Interview with Frank Buytendijk
- VIDEO: The Dark Side of Big Data

8. Emerging trends in BI
   a. Big data
   b. Social BI
   c. Mobile BI
   d. Agile BI
   e. Self-service BI
   f. Operational BI

   TUN resources:
   - TUTORIAL: Business intelligence: past, current, and future
   - ARTICLE: *Future Directions for BI Software*
   - ARTICLE: *Analytics as a Service: From Data in the Cloud to Sandbox Innovation*
   - POWERPOINT PRESENTATION: The New Know
   - ARTICLE: *Wall Street Firm Uses Algorithms to Make Sports Betting Like Stock Trading*
   - RESEARCH REPORT: *Big Data Analytics*
   - RESEARCH REPORT: *Big Data Analytics: Profiling the Use of Analytical Platforms in User Organizations*
   - ARTICLE: *10 Big Predictions About Big Data*
   - VIDEO: BSI: Teradata Case of the Retail Tweeters (sentiment analysis)
   - WHITE PAPER: *Beyond Surface Social Media*
   - ARTICLE: *U.S. Express: Where Trucks and BI Hit the Road*
   - POWERPOINT PRESENTATION: Teaching Agile BI Infrastructure and Application Development with Logical Data Models
   - ARTICLE: *Analytics as a Service: From Data in the Cloud to Sandbox Innovation*

Discussion
- If there are no database management fundamentals pre-requisites, the topic module on review database management should be emphasized.
- Introducing the multidimensional model and its operations can be complemented by an exercise in Excel (pivot tables, etc.) or with a modeling tool (e.g., FatFreeStar) and/or hands on exercises with BI tools such as MicroStrategy.
- The hands-on application component of the course will reinforce knowledge and skills gained about the BI topics covered in the course. For example, students can examine operational data sources, design dimensional models, and implement the cubes in relational databases. Querying the operational sources versus querying the cube they constructed would give students a first-hand understanding of the difference between operational versus analytical data stores. A wide variety of BI tools are available for educational use.
- Real-world projects can be simulated by student teams with different roles and knowledge (end user/business team, ETL developer team, database administrator, etc.) who perform role-specific tasks and have to communicate among each other in a joint project aiming at building a BI solution together. Typical and relevant project stages (requirements analysis, implementation, test, etc.) can be addressed in such a case study.

TERADATA University Network

Master of Business Administration Model Curriculum
Teradata University Network BI Standards Committee

Title: Business Intelligence & Analytics (Elective)

Course description:
An executive leadership perspective to business intelligence and analytics (BI&A) that provides insights for evaluating, strategically aligning, planning for, and directing investments in BI&A tools, resources, and people, and addresses the governance of, processes for, and continuous renewal of BI&A[1] deployments in business and government. The course reinforces the role of decision support for sound personal decision making strategies and for creating and maintaining an enterprise-level culture of evidence/fact-based decision making. It also addresses ethical issues in the management of customer data, enterprise-level support for experimentation-based innovation, and embedding analytics in business processes and managing enterprise performance management approaches linked to the balanced scorecard.

Pre-requisites: None.

Learning objectives:
At the end of this course, students should be able to:
1. Leverage a conceptual understanding of infrastructure, data management processes, data quality, and architectural considerations to appraise current status and align new enterprise-level BI&A requirements to competitive strategy.
2. Understand how to build and evaluate business cases for BI&A investments that enable sustainable competitive advantage through inimitable analytics that support distinctive enterprise capabilities.
3. Understand the typical organizational journey through which the full benefits of BI&A investments enable an organization to compete using analytics.
4. Understand the linkages between the balanced scorecard and BI&A-supported enterprise performance management using dashboards.
5. Understand the role of and responsibilities for typical BI&A personnel including data scientists, data warehouse administrators, fact table/schema designers, BI&A vendor relationship managers, etc.
6. Recognize the types and nature of business processes that lend themselves to BI&A-based solutions and be able to assess options for embedding BI&A into business processes ranging from: a) fully automating decision rules to b) establishing trigger/alert/alarm control support mechanisms and c) providing passive decision support for human decision makers.
7. Demonstrate familiarity with common BI&A application areas including visualization, customer management (e.g., predictive scoring, targeting, fraud detection, pricing, evaluating customer profitability), retail (promotion, shelf management, forecasting replenishment, warehouse management, inventory optimization), operations management (e.g., scheduling, routing, demand forecasting, new product development, supply chain optimization), services (staffing, customer loyalty, yield management, pricing, case management, warranty analysis, feedback summary), e-commerce (website metrics, clickstream analysis, site design, search), and regulatory compliance.
8. Understand ethical considerations in BI&A and potential dark side risks, particularly in the customer analytics area where everyone in the organization needs to be responsible for maintaining the organization's values and principles in data management processes to maintain customer trust and respect customer privacy..
9. Understand the importance of exploiting ongoing experimentation as supported by BI&A for purposes of supporting enterprise innovation; understand experimentation prioritization processes and be capable of evaluating the strategic alignment, completeness, and sufficiency of an experimental design.
10. Gain awareness of emerging BI&A solutions including those for big data, unstructured data, spatial analytics, campaign management, master data management, predictive analytics, text mining, sentiment analysis, marketing relationship management, search optimization, etc.

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[1] Business intelligence (BI) can be defined as a broad category of applications, technologies, and processes for gathering, storing, accessing, and analyzing data to help business users make better decisions (Watson, 2009).

Topics:
1. Introductory concepts (overview)
   a. Enterprise-level BI&A infrastructure, processes, and approaches to advancing the quality of personal decision making (as reinforced through hands-on experiences with authentic BI tool suites)
   b. Approaches to designing and using inimitable analytics that support distinctive enterprise characteristics
   c. Introduction to changing enterprise culture to reinforce the importance of fact/evidence-based decision-making
   d. Introduction to the role of predictive analytics as supported by data/text mining, etc.

   TUN resources:
   - ARTICLE: *The Requirements for Being an Analytics-Based Organization*
   - CASE: Harrah's High Payoff from Customer Information
   - VIDEO: Management's Worldview: Four Critical Points About Reality, Language, And Knowledge Building To Improve Firm Performance
   - VIDEO: Ten-minute introduction to business intelligence
   - ARTICLE: *Business Analytics: Six Questions To Ask About Information And Competition*
   - ARTICLE: *The Case for Investing in Business Analytics Technology*
   - ARTICLE: *Norfolk Southern Travels the BI Track*
   - ARTICLE: *Bridging the IT/Business Chasm*
   - PODCAST: CIO Talk Radio Podcast: Don Campbell, IBM and Stephen Brobst, Teradata
   - ARTICLE: *Disruptive technologies: Advances that Will Transform Life, Business, and the Global Economy*
   - ARTICLE: *Secrets of Analytical Leaders: Insights from Information Insiders*

2. Frameworks and use cases
   a. Frameworks and approaches to strategic decision making with respect to investments in Information Technology (IT)
   b. Use cases demonstrating IT investment analysis in BI&A that reinforce alignment with competitive strategy

   TUN resources:
   - VIDEO: Uncommon Insights: The Crunchy Questions That Lead to Deep Data Exploration
   - ARTICLE: *Architecture for Business Analytics: A Conceptual Viewpoint*
   - VIDEO: "Big data" analytics weighs a mix of the old and new
   - ARTICLE: *All About Analytics*

3. Evolution of BI&A in an organization
   a. Example BI&A organizational journeys that started with initial BI&A support for decision making and progressed to "competing on analytics"
   b. Challenges and opportunities faced in evolving BI&A

   TUN resources:
   - ARTICLE: *Competing on Analytics*
   - CASE: Business Intelligence at Guthy-Renker: The Promise and Challenges of Sensing the Pulse
   - CASE: Real-time Business Intelligence: Best Practices at Continental Airlines
   - ARTICLE: *The Rise of Analytic Applications: Build or Buy?*
   - CASE: RetailStore.com
   - CASE: Continental Airlines Takes Off with Real-time Business Intelligence
   - CASE: Continental Airlines Continues to Soar with Business Intelligence

4. Enterprise performance management
   a. Concepts and examples
   b. Linkage to balanced scorecard methods and approaches
   c. Strategic vs. operational dashboards
   d. Best practices

   TUN resources:
   - INTEGRATED SET: Business Performance Management:

- ARTICLE: *Turning Strategy Into Action*
- CASE: Real-Time Dashboards at Western Digital
- ARTICLE: *The New Faces of BI: Dashboards and Scorecards*
- ARTICLE: *How Business Intelligence Should Work: The Connection Between Strategic, Analytical and Operational Initiatives*
- ARTICLE: *Best Practices in Business Performance Management: Business and Technical Strategies*
- ARTICLE: *Deploying Dashboards and Scorecards*

5. Limitations of BI&A
   a. Examples of the limitations of BI&A for certain types of business processes
   b. Reinforcement that BI&A is not a panacea

   TUN resources:
   - ARTICLE: *Data Warehousing Failures*
   - ARTICLE: *Ten Worst Practices of the Unsuccessful Data Warehouse Project Manager*
   - ARTICLE: *Business Intelligence Project Pitfalls*

6. BI&A for human resource management and culture change
   a. Examples of how BI&A enables a performance-based culture that is reinforced through a meritocracy-based reward system
   b. Human resources and workforce analytics

   TUN resources:
   - VIDEO: People Analytics: Using Data to Drive HR Strategy and Action

7. Business processes and BI&A
   a. Approaches to embedding BI&A into business processes
   b. Frameworks for evaluating levels of transparency and automation for embedded BI&A

   TUN resources:
   - ARTICLE: *Spokane Teachers Credit Union's Innovative Use of Customer Information*
   - ARTICLE: *The Case for Investing in Business Analytics Technology*

8. BI&A workforce
   a. Examples of the structure of and common job responsibilities for BI&A personnel

   TUN resources:
   - PANEL PRESENTATION: Developing the Next Generation Workforce—Thought From Practice

9. Enterprise application areas
   a. Customer management (e.g., predictive scoring, targeting, fraud detection, pricing, evaluating customer profitability)
   b. Retail (promotion, shelf management, forecasting replenishment, warehouse management, inventory optimization)
   c. Operations management (e.g., scheduling, routing, demand forecasting, new product development, supply chain optimization) and services (staffing, customer loyalty, yield management, pricing, case management, warranty analysis, feedback summary)
   d. E-commerce (website metrics, site design, search) and regulatory compliance

   TUN resources:
   - WEB SEMINAR: Turning Active Enterprise Intelligence Into Competitive Advantage
   - CASE: BSI: Case of the Defecting Telco Customers
   - CASE: BSI: The Sad Case of Stagno Bank
   - CASE: BSI: Case of the Dropped Mobile Calls
   - CASE: BSI: Case of the Misconnecting Passengers
   - CASE: BSI: Case of the Fragrant Sleeper Hit
   - CASE: BSI: Case of the Retail Tweeters

10. Predictive analytics and data mining
    a. Hands-on data mining experience
    b. Data mining and scoring
    c. Model lift
    d. Value of predictive analytics to business
    e. Collecting the data necessary for predictive analytics
    f. Selecting the appropriate predictive analytics approach

    TUN resources:
    - TOOLS: KXEN and data mining
    - ARTICLE: *Data Mining in the Insurance Industry*
    - INTEGRATED SET: Data Mining

11. Visualization
    a. Exposure to advances in BI&A-based visualization
    b. When to apply visualization
    c. Limitations of visualization
    d. Role of visualization in decision support and enterprise performance management including dashboards and scorecards

    TUN resources:
    - INTEGRATED SET: Data Visualization and Dashboard Design:
    - PARTNER PROFILE: Tableau Software
    - HANDS-ON ASSIGNMENT: Tableau Software Project, SAS-VA Project
    - DEMO: Demo of Palantir Software and subprime lenders

12. BI&A ethics
    a. Understanding of common ethical considerations in the design and deployment of BI&A-based applications particularly in customer relationship areas
    b. Understanding the 'dark side' risk of BI&A

    TUN resources:
    - ARTICLE: *Economist Special Report: Data Data Everywhere*
    - VIDEO: Analytics and Ethics, Interview with Frank Buytendijk at the 2012 TDWI World Conference

13. Experimentation and innovation
    a. Basic concepts
    b. Experimentation and its role in innovation
    c. BI&A-enabled experimentation
    d. Experimental design and applications to e-commerce
    e. Customer relationship management
    f. Campaign management

    TUN resource:
    - CASE: eBay Analytics: Innovation Inspired by Opportunity

14. BI&A resource management
    a. Use cases in BI&A vendor analysis
    b. Software and hardware selection
    c. Vendor relationship management

    TUN resources:
    - ARTICLE: *How To Choose Among The Four Bright Lights Of BI*
    - PARTNER PROFILE: MicroStrategy
    - BOOK CHAPTER: *The Data Warehouse RFP*
    - ARTICLE: *Big Data Analytics*
    - CASE: Teradata Reborn

15. Advanced topics
    a. Emerging BI&A approaches, solutions and challenges

    b.   Hands-on experiences with emerging approaches to unstructured data (e.g., text mining and document clustering)

TUN resources:
- ARTICLE: *Hadoop and the Data Warehouse: When to Use Which*
- ARTICLE: *The Database Revolution*
- VIDEO: Links for Selected Videos Related to Big Data
- ARTICLE: *MapReduce and the Data Scientist*
- KEYNOTE ADDRESS: The New Know and How to Get There

Discussion
- The course positions BI&A into the context of strategic investment in information technologies; therefore, it requires students to gain at least a conceptual understanding of relevant data management technologies, conceptual design approaches, and administrative issues

- The course requires hands-on experiences with authentic BI&A software (including SQL) to reinforce the importance of an enterprise-wide evidence/fact-based decision making culture.

- The course is highly amenable to case-based teaching pedagogy, particularly in topical areas that stress the importance of use cases.

- The course emphasizes strong linkages between BI&A and: a) the nature and design of business processes, b) the balanced scorecard and executive information systems, c) merit-based personnel management reward systems (meritocracies) that align with a fact/evidence-based decision making culture, and d) experimentation-driven innovation.

- There are significant business ethics/"dark side" issues in the BI&A space that are important to integrate and weave throughout the course, particularly in the area of customer data management.

APPENDIX D: BUSINESS INTELLIGENCE/ANALYTICS CURRICULUM SURVEY

Purpose of survey:
This survey is intended to aid in identifying the general areas of curriculum focus for specialized master of science in analytics/business intelligence programs intended to graduate as analytics professionals/semi-professionals. In addition, the survey seeks to identify general areas of focus for MBA concentrations/specializations/dual degrees in analytics/business intelligence intended to graduate as analytics managers.

For purposes of this survey, business intelligence (bi) refers to a broad category of applications, technologies, and processes for gathering, storing, accessing, and analyzing data to help business users make better decisions (Watson, 2009).

PART 1: Analytics/Business Intelligence Professional (or Semi-professional)—MS Degree
This part of the survey aims to establish the depth of skills students need to be successful in industry as **an analytics professional (or semi-professional)**. Typically, specialized curriculum with **at least seven or more advanced level BI courses** is expected to provide knowledge and skills to prepare a student to be an Analytical Professional. Sample positions for graduates include:
- Analytics analyst
- Applications analyst
- Business analyst
- Business technology analyst
- Credit risk analyst
- Data mining analyst
- Data modeling analyst
- E-commerce business analyst
- Fraud analyst
- Informatics analyst
- Marketing analyst
- Marketing database analyst
- Operations research analyst
- Programmer/analyst
- Research analyst

- Risk analyst
- SAS analyst, promotional planning
- Senior analyst, advanced modeling and simulation
- Senior business analyst, business intelligence
- Senior business analyst, display ads optimization
- Senior decision science analyst
- Senior health outcomes analyst
- Statistical analyst
- Strategic business analyst
- Technical specialist—information analytics

Please indicate your level of agreement to each of the following statements:

An analytics professional (or semi-professional) needs to be able to:	Strongly agree	Somewhat agree	Neutral	Somewhat disagree	Strongly disagree
Perform data-mining, modeling, and hypothesis generation in support of high-level business goals	15	1			
Extract, transform, and leverage syndicated data for client use	10	5		1	
Use and interpret datasets that may not have standard data formats	10	5	1		
Have advanced SPSS/SAS/other data management/manipulation skills	12	2	2		
Have a aptitude for business, mathematics, statistics, and technology	13	3			
Identify key metrics that drive business growth	10	4	1	1	
Mine data for patterns that lead to business results	12	4			
Develop advanced algorithms to solve analytical problems with incomplete data sets	1	5	5	5	
Effectively present findings to diverse audiences using strong verbal and written communication skills	13	3			
Have the ability to interpret complex trends and tell a concise story with the data	12	4			
Use data visualizations, e.g., heat maps, to analyze and present complex trends	8	6	1	1	
Have computer programming skills—such as SQL, Python, Unix, PHP, R and Java—which they use to modify or develop custom analytical solutions	3	5	6	1	1
Work in a team setting, with managers, IT administrators, programmers, statisticians, graphic designers, and experts in the company's products or services	11	5			
Have knowledge of IRI, Nielsen syndicated, scanner, and panel data as well as measures	2	8	3	2	1
Have good communication, problem-solving, and analytical skills	11	4			
Stay current with emerging tools and techniques in machine learning, statistical modeling, and analytics	7	9			
Have a doctorate degree in BI or statistics	1	1	5	8	1
Mine relevant information coming from social networks	3	9	2	1	1
Other: "Able to see big picture and how	1				

An analytics professional (or semi-professional) needs to be able to:	Strongly agree	Somewhat agree	Neutral	Somewhat disagree	Strongly disagree

analytics supports strategic goals"

Please provide any additional comments regarding analytics professional skills:
> Strong stat background; communicate and understand IT people; they can learn business context and adapt to new situations

Please provide any additional comments regarding how BI program might better prepare a student to be analytics professional:
> Training in social skills; strong stats

PART 2: Analytical Managers: MBA Specialization/Focus/Dual Degree

This survey aims to establish the depth of skills students need to be successful in industry as an **analytical manager**. Typically, specialized curriculum with **at least four or more advanced level BI courses** is expected to provide knowledge and skills to prepare a student to be an analytical manager. Sample positions for graduates include:

- Consultant
- Analytical consultant
- Life sciences consultant
- Marketing consultant
- Principal consultant
- Senior consultant
- Senior research & modeling consultant
- Strategy consultant
- Senior scientist
- Manager, forecasting and analytics
- Manager, data analytics
- Manager, sales analytics
- Manager, pricing and analytics
- Manager, strategy and analytics
- Project manager, product development
- Director, analytics
- Director, quantitative analytics
- Director, web analytics
- Vice president, analytic infrastructure
- Vice president, operations
- Vice president, risk analytics and business intelligence
- Vice president, senior marketing analysis manager
- Chief, quantitative methods section

Please indicate your level of agreement to each of the following statements for:

Analytics managers need to be able to:	Strongly Agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly Disagree
Perform data-mining, modeling, and hypothesis generation in support of high-level business goals	4	8	3	1	
Extract, transform, and leverage syndicated data for client use		4	6	5	1
Use and interpret datasets that may not have standard data formats	2	7	6	1	
Have advanced SPSS/SAS/other data management/manipulation skills		8	5	3	
Have an aptitude for business, mathematics, statistics, and technology	5	10	1		
Identify key metrics that drive business growth	13	1			
Identify analytics opportunities and	14	2			

Analytics managers need to be able to:	Strongly Agree	Somewhat Agree	Neutral	Somewhat Disagree	Strongly Disagree
lead initiatives					
Develop advanced algorithms to solve analytical problems with incomplete data sets		1	6	5	4
Effectively present findings to diverse audiences using strong verbal and written communication skills	14	2			
Have the ability to interpret complex trends and tell a concise story with data	10	6			
Use data visualizations (e.g., heat maps) to analyze and present complex trends	7	8		1	
Have computer programming skills—such as SQL, Python, Unix, PHP, R and Java—which they use to modify or develop custom analytical solutions			4	7	5
Work in a team setting with IT administrators, programmers, statisticians, graphic designers, and experts in the company's products or services	9	5	2		
Have knowledge of IRI, Nielsen syndicated, scanner, and panel data as well as measures	1	7	5	2	
Have good communication, problem-solving, and analytical skills	14	1			
Stay current with emerging tools and techniques in machine learning, statistical modeling, and analytics	3	6	7		
Have a doctorate degree in BI or statistics.		1	3	3	9
Mine relevant information coming from social networks	1	8	2	4	1
Work with HR to establish a path to, and provisions for hiring and utilizing the requisite analytics professional talent in the organization	7	8	1		
Have requisite experience as an analytics professional or semi-professional before moving into a champion role	4	9	2	1	
Other: "People skills"	1				

Please provide any additional comments regarding analytics manager skills:
        Understand technology, statistics/math

Please provide any additional comments regarding how BI program might better prepare a student to be Analytics Manager:

Part 3: Respondent Demographic Information

Do you currently hold a faculty appointment?   Yes   12   No 1   Other _____

Please indicate your current faculty rank:
   _3_ Assistant professor   _1_ Adjunct professor
   _3_ Associate professor   ___ Clinical professor
   _6_ Full professor   ___ Department chair/dean
   ___ Not a faculty   _1_ Other ___ PhD researcher_____

What academic discipline do you represent (check all that apply)?

_12 MIS, IS, or IT in the business school	___ Information studies
___ Accounting	_1_ Marketing
___ Computer science	_2_ Operations research
_2_ Decision sciences	_1_ Statistics
___ Finance	___ Systems engineering
_1_ Other ____supply chain_____	

Please provide your university/college name and location (optional):

University/College Name: _____

State/Province: _____   Country: _____

Do you *currently* offer BI or business analytics (BA) content at your university? (Check all that apply):

Currently offer BI/BA content	Undergraduate	MS	MBA	Executive education	Continuing education/certificate program
BI content embedded in another course (e.g., intro to IT, database mgmt)	6	3	5	3	
Full BI or BA course	7	7	6	2	
BI or BA concentration/major	1	3	2	1	1
BI degree program	2	1			
Non-degree program				1	

Are you planning to offer BI or BA content at your university in foreseeable future? (Check all that apply):

Plan to offer BI/BA content	Undergraduate	MS	MBA	Executive education	Continuing education/certificate program
BI content embedded within another course (e.g., intro to IT, database mgmt)	6	2	4	2	1
Full BI or BA course	5	3	6	1	1
BI or BA concentration/major	3		2		
BI degree program		3		2	
Non-degree program				2	2

Have you taught BI or BA course (check all that apply):

_11 Have been teaching for at least one semester
_3_ Have never taught it but plan to teach it in next 1 or 2 years
_1_ No immediate plan to teach yet

If you have taught BI or BA course(s), please tell us the name of course and their level?

Name(s) of course(s): _____

Level of course(s) (check all that apply):

_7_ Undergraduate	_8_ M.S.
_7_ MBA	_2_ Executive MBA
___ Ph.D.	_1_ Continuing education/certificate program
___ Other _____	

Do you have any experience working as a data analyst?

Yes   6   No   8

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Michael Goul is Professor and Chair of the Department of Information Systems, W.P. Carey School of Business, Arizona State University. His research and teaching bridge business intelligence/analytics and services computing. He was Co-PI on grants from Intel and American Express at the intersection of these areas, and he recently authored a case on eBay's use of analytics for innovation. These collaborations are consistent with his focus on intelligent systems and decision support; he edited special issues and published in *Decision Sciences, Decision Support Systems,* the *Journal of the Association for Information Systems*, the *Journal of Management Information Systems, Information Systems and Management, Communications of the ACM, IEEE Systems Man and Cybernetics,* and many others. His work in these areas led to a one-year appointment as a Distinguished University Scholar at the Clinton School of Public Service. Here he investigated the economic implications of investments in IT by developing countries*.*

Barbara Dinter is Professor and Chair of Business Information Systems at Chemnitz University of Technology, Germany. She holds a PhD from the Technische Universität München, Germany, where she previously earned a master's degree in computer science. Barbara worked for several years at University of St.Gallen, Switzerland as a Post-Doc and project manager. In her role as an IT consultant, she worked with a variety of organizations. Her research interests include business intelligence and analytics, big data, data driven innovation, and information management. She has published in renowned journals such as *Decision Support Systems*, *Journal of Database Management*, and *Journal of Decision Systems*, and on conferences such as ICIS, ECIS, and HICSS.