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Business Intelligence in the Business Curriculum

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Abstract:

There has been widespread investment in business intelligence/business analytics within industry because of the potential for improved managerial decision-making through mining the vast quantities of data collected by modern corporations; however, despite major recent curriculum changes in business schools, there has been very little attention given to this field. This has been true of both research and teaching and is compounded by inadequate quantitative literacy possessed by U.S. students and antipathy towards quantitative literacy among faculty. This paper documents the importance of business intelligence within business and the programs offered by the 50 leading business schools. A pioneering minor in the field offered by one school is described.

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I. INTRODUCTION

Major changes have occurred in business schools over the last few years. Of particular importance to the focus of this paper are two overarching curriculum changes—away from a "silo" approach of focusing on specialized managerial functions and a related emphasis on business processes—as well as a continuing trend in faculty research toward rigor at the expense of practical relevance. We argue that these developments have completely disregarded an exceedingly important need of the business community, namely the incorporation of business intelligence in the business curriculum. This has come about because of a confluence of factors: (a) a low level of competence in mathematics among U.S. high school students (and by extension, college students); (b) a lack of appreciation for numeracy, i.e. quantitative literacy, within the ranks of U.S. university faculty members; (c) a mismatch between teaching, research, and practical relevance (not keeping up with developments in industry); and (d) inability to break down the silo approach to teaching insofar as decision sciences, statistics, and information technology are concerned. It will be seen that each of these problems can be addressed to some extent by incorporating business intelligence into the business curriculum. (Note: The term "business intelligence" is used by the information technology community, whereas "business analytics" is preferred by the business community. The two terms are synonymous and will henceforth be referred to as BI/BA.)

Much of the literature regarding overhauling business school curricula has focused on MBA programs, because these tend to be the flagship programs at business schools, and because the most famous business schools in the world offer only graduate programs; however, it is fairly safe to assume that undergraduate business programs are undergoing similar transformations, because the same considerations apply, and the faculty and administrations are almost universally the same people in a given business school.

A common denominator that characterizes the shift in curricula is that they are moving away from a focus on the functions prevalent in most businesses, namely finance, accounting, marketing, manufacturing, information systems, engineering, R&D, and so on. One such recent, well-publicized move has been that of the Yale business school. Their dean describes the change as follows:

> …replacing the disciplinary courses that mapped onto the functional silos in organizations with new courses that are actually organized around the key constituencies that a manager needs to engage in order to be effective..
>
> We now offer a course on the customer rather than a course in marketing, a course on the investor rather than a course in finance. All of them are multidisciplinary in both their design and their delivery. And then we have a course called the integrated leadership perspective at the end which sort of brings together all the different perspectives. [Miller 2006]

Another approach to moving away from the "silo" approach is to focus on business processes rather than specialized functions. It is argued that businesses have to perform a myriad processes, and they usually cut across the different business functions. For example, bringing a new product to market is a fundamental business process and would require the participation of R&D, engineering, information systems, production, accounting, finance, and of course, marketing. Other examples would be bidding on a project, acquiring another company, implementing a major project, negotiating an outsourcing contract, and so on. The essence of the new approaches is their multidisciplinary nature.

Despite these moves toward curricular integration and a focus on business processes, our analysis of business school programs shows almost no attention given to the incorporation of business intelligence programs. This is puzzling because the field of BI/BA (described in detail later) presumes an integrated view of the enterprise and provides the necessary tools to manage it.

A related development without quite as much traction as those described previously, is the move toward making business school teaching and research more valuable to practicing managers. In an effort to avoid being labeled "trade schools" and being treated as second-class citizens by the older disciplines within their universities, over the last half-century, business school research has steadily become more rigorous and "scientific," with the result that publications in the top business research journals (with commensurate rewards and recognition) are unfathomable for the majority of practitioners and for faculty in other disciplines. The dean at MIT's Sloan School of Management describes the situation as follows:

> But now, management school faculty often focus on academic fields such as game theory or econometrics, not on management practice, and their work may have little to do with real business problems. And as business faculty have sought ever more academic status, describing what managers actually do has tended to crowd out prescriptive work on what they should do. Critics charge that such faculty (some who may not even know or care much about business) can teach business students little or nothing about how to actually manage—in other words, to accomplish things with and through other people. [Schmalnsee 2006]

Again, there is a surprising dearth of research in the field of BI/BA, despite widespread acceptance and significant spending across the entire business spectrum. Almost all the published literature about the field comes from trade publications and is written by industry specialists. It is true, however, that seminal academic contributions to the field have been made since 1992, such as the large number of articles and books by Robert Kaplan and David Norton. Other very significant contributions have been made by Thomas Davenport [2006, 2007]. Kaplan is with the Harvard Business School, while Davenport teaches at Babson College. Their work is widely taught in the mainstream business curriculum and are excellent examples of how research is closely linked to teaching.

On the teaching front, the aforementioned innovations in curricula failed to recognize the urgent need to introduce courses and specializations in the emerging field of BI/BA. It so happens that this burgeoning field solves several problems simultaneously. It meets standards for rigor and sophisticated analysis sought by business schools, while at the same time addressing practical problems. It focuses on business processes which are inherently multidisciplinary. Most importantly, the emphasis on business processes is very appropriate because it is one of the only areas left that permits differentiation for competitive advantage.

The purpose of this paper is to demonstrate the importance of BI/BA as an academic focus, as demonstrated by (a) the need for competence in quantitative literacy; (b) the poor standing of U.S. students in this regard; (c) the corresponding lack of enthusiasm amongst faculty; (d) the rapidly growing application of BI/BA in industry; and (d) the dearth of suitable academic training in business schools. A description of perhaps the first minor in BI/BA is provided as an example of an academic program aiming to fill this void. The next section will describe why the field of business analytics is critical and how it fits well with the objectives for curriculum change described earlier.

II. THE NEED FOR BUSINESS INTELLIGENCE/BUSINESS ANALYTICS

The environment in which business enterprises operate today is radically different from previous decades, requiring a reassessment of how students in business schools are taught. This environment has been shaped by deregulation, globalization and the Internet, which have combined to produce an intensely competitive situation, in which companies generally produce similar products and have access to similar technologies. They therefore have to compete by differentiating their business processes, which requires the widespread use of business analytics in order to be done effectively [Davenport 2006; Davenport and Harris 2007].

Two of the central themes of this paper are (a) that quantitative methods can and should be applied to a very wide array of decision making scenarios; and that (b) all business students should have an adequate level of quantitative literacy (QL) in order to make calculated decisions in our increasingly complex, information-oriented, knowledge-based world. We subscribe to the definition of quantitative literacy adopted by the International Life Skills Survey which is as follows:

> An aggregate of skills, knowledge, beliefs, dispositions, habits of mind, communication capabilities, and problem solving skills that people need in order to engage effectively in quantitative situations arising in life and work. [International Life Skills Survey 2000]

Although the term "quantitative literacy" is a super set of the term "numeracy" [Lange 2003], we shall use both interchangeably. We strongly believe that numeracy relates to numbers exactly as literacy relates to words. College education should stress the two equally, which is simply not the case at most institutions. It is common to see pleas for an increase in literacy among the population (including the student population), but how often does one hear the same for numeracy? Unfortunately, quantitative literacy is often mistakenly equated with mathematics, but it is more of an approach to solving problems and a state of mind. QL cannot be achieved by taking more courses in the mathematics department any more than literacy can be achieved by adding more courses in English literature. The focus on QL needs to be in every course in every department, just as it should be for literacy [Steen 2004]. Richardson and McCallum[2004] make the same arguments. As will be evident from the following section defining business analytics, some degree of QL is required if one is to excel in BA. Unfortunately, the prevailing disdain for QL makes it more difficult for business schools to generate interest and excellence in the field. It can be argued, however, that the introduction of academic programs in BI/BA will help redress the situation to some extent in business schools.

Mathematics has been steadily transforming business field after field, after doing so with science and engineering. In business, mathematics transformed finance, and is now changing how a wide array of (hitherto untouched) business activities are being conducted, from advertising campaigns and newsroom research to building customer relationships [Baker 2006]. It is very likely that faculty members resisting the use of quantitative techniques are not aware of these recent developments in industry. The situation is not unlike the rapid intrusion of computer graphics into advertising, which essentially rendered a large number of conventional commercial artists obsolete.

An example that underscores the shift in applying mathematics to business problems is a recent strategic move at IBM (the nation's top R&D company for 14 years running, measured by patents received). In July 2008, the company's incoming Research Director, John E. Kelly III, decided to shift the technology giant's research focus and make a few enormous bets. They are now focusing on four top research priorities, with each project getting $100 million over the next two or three years [Hamm 2008]. The projects are: (a) inventing a successor to the semiconductor; (b) designing computers that process data more efficiently; (c) building clusters of computers that behave like a single machine ("cloud computing"); and (d) *using math to solve complex business problems* (author's emphasis).

In a recent study of 32 organizations that have committed to "quantitative, fact-based analysis," Davenport found that virtually all were leaders in their fields [Davenport 2006]. They emphasized business analytics as an overarching strategy championed by their top leadership and pushed this down to decision-making at every level (our emphasis). Three of his recommendations are particularly relevant for this paper:

1. You hire not only people with analytical skills but a lot of people with the very best analytical skills—and consider them a key to your success.

2. You not only employ analytics in almost every function and department but also consider it so strategically important that you manage it at the enterprise level.

3. You not only are expert at number crunching but also invent proprietary metrics for use in key business processes.

Curricular Inertia

On the one hand, business schools teach how swiftly the business environment is changing, while on the other, preparation in quantitative methods has barely changed in almost half a century. It is well known that academic institutions are exceedingly reluctant to change their curricula in quantum leaps [Bok 2005]. Major external forces are necessary to bring about such change. We believe that the changing nature of business; the loss of U.S. competitiveness (only six of the top 25 information technology companies are based in the U.S.); globalization and offshoring; the threat of India, China and South Korea as major economic powers (14 of the world's top 25 IT companies are based in Asia); and the emergence of a knowledge-based economy in which 82 percent of the work force is in the service sector, are these forces.

An astonishing level of faculty resistance to increasing the quantitative literacy of business students was observed by the author from service on two faculty task forces. One task force was charged with overhauling the *core* undergraduate business curriculum at his school, whereas the other task force had the same charge for the entire MBA curriculum. Representatives from the usual functional areas served on these task forces, i.e., Accounting, Decision Sciences & Information Systems, Economics, Finance, Management and Marketing. These representatives were voicing not only their personal views, but also those of their colleagues. The general view of the undergraduate task force (apart from the author) can be summarized as follows:

- All business students do not need much mathematics beyond high school except for a course in statistics.

- Calculus is an unnecessary hurdle. "I've never used calculus in all these years" was a common refrain.

As for the MBA task force, it voted to weaken the decision sciences and information technology components of the curriculum, and strengthen "soft" skills in the areas of leadership, interpersonal skills, entrepreneurship, and organizational behavior.

This reluctance to increase the emphasis on quantitative literacy has resulted in the following unfortunate situation, according to Kolata:

Quantitative literacy, in my view, means knowing how to reason and how to think, and it is all but absent from our curricula today. [Kolata 1997]

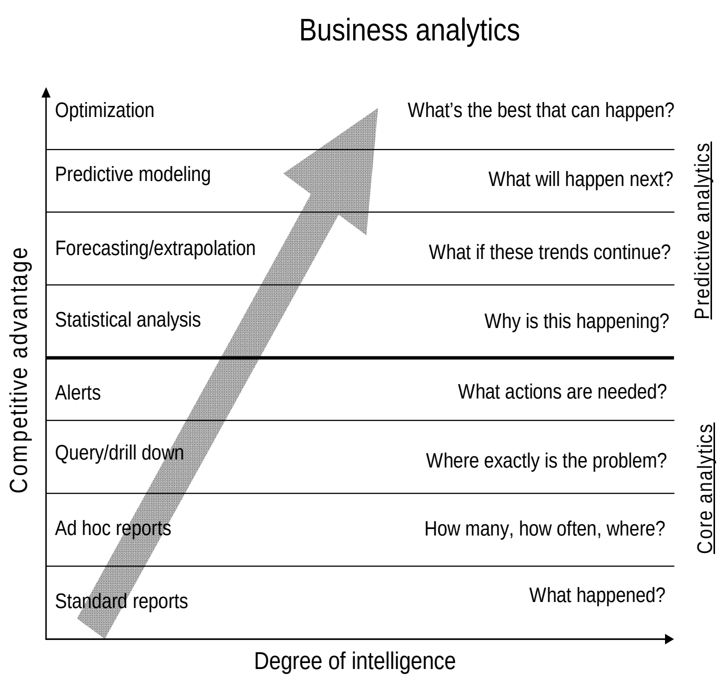
Despite the headwinds described before, the objective of this paper is to argue that, in order to compete globally and prepare American business students for the future, the following are necessary: (a) the increased use of quantitative methods in the core of the undergraduate business program, i.e. the required courses; (b) a modification of the quantitative tools covered to meet emerging requirements in business; (c) the use of sophisticated computer software, now commonly available to all organizations, in order to make even complex computations relatively straightforward for the ordinary manager; and (d) the use of BI/BA wherever possible. In the next sections we define the field of BA/BI, highlight the low standard of math education in U.S. high schools, and show that even selective business schools are affected.

III. A DEFINITION OF BUSINESS INTELLIGENCE/ BUSINESS ANALYTICS

The burgeoning field of BI/BA is the latest battlefield for corporations seeking to gain competitive advantage, or simply to survive in a fiercely competitive business environment. The focus is on collecting data in real-time about a firm's many business processes (such as filling orders, hiring employees, or purchasing supplies) and keeping track of exactly how the firm is performing in these areas. Managers can react quickly to rapidly changing circumstances as the need arises. This is the field of *descriptive analytics*. The most sophisticated firms are attempting to go beyond this and determine the effects of potential changes in their business processes. This is the field of *predictive analytics.* It allows firms to anticipate customer needs, create opportunities and beat their competition.

BI/BA is defined as "the extensive use of data, statistical and quantitative analysis, exploratory and predictive models, and fact-based management to drive decisions and actions" [Davenport 2006]. This requires collecting, managing, and analyzing large data sets. As can be seen in Figure 1, BI/BA techniques are divided into core analytics and predictive analytics.

It should be noted that the top two topics (optimization and predictive modeling) generally fall under the domain of decision sciences, and the next two under the umbrella of statistics and data mining. The capabilities listed below these are the domain of executive information systems, management reporting, and the like. Additionally, for all of this to be possible, accurate data are required in the form of data marts or data warehouses.



Source: Adapted from Figure 1-2 of Davenport, Competing on Analytics (Harvard Business School Press, 2007), which was adapted from a graphic produced by SAS.

Figure 1. Business Analytics

BI/BA thus requires excellence in three fields. Vast amounts of data need to be collected, stored, accessed, and disseminated, as transactions occur throughout the enterprise. This activity constitutes part of what is covered in information technology management. The data has then to be appropriately analyzed and presented to managers to aid in their decision-making, which is the field of data analysis and statistics. Moreover, the firm's business processes must be carefully analyzed and optimized for maximum efficiency and effectiveness, which is the field of management science. The intersection of these areas of study constitutes the field of business analytics as shown in Figure 2.

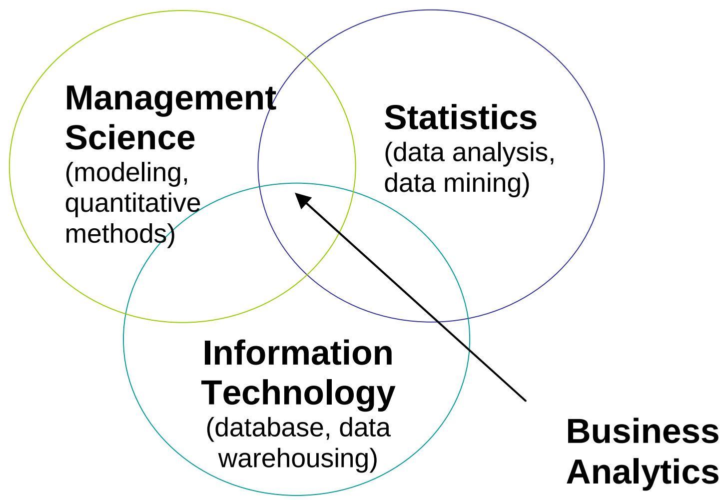


Figure 2. The Field of BI/BA

Information systems can be pre-programmed to handle the core analytics techniques. But the predictive analytics techniques answer questions that are at the higher-value and more proactive end of the continuum. Predictive analytics goes beyond pre-programmed information systems' capabilities. In a Gartner survey of 1,400 Chief Information Officers (CIOs), technology associated with business analytics was the most highly ranked technology priority of 2006 [CRM Today 2006].

Although it is theoretically possible to implement BI/BA without modern information technology, it would be impossible in practice because of the dependence on data warehouses and the enormous amount of computing necessary.

> In principle, analytics could be performed using paper, pencil, and perhaps a slide rule, but any sane person using analytics today would employ information technology. The range of analytical software goes from relatively simply statistical and optimization tools in spreadsheets (Excel being the primarily example, of course), to statistical packages (e.g., Minitab), to complex business intelligence suites (SAS, Cognos, BusinessObjects), predicting industry applications (Fair Isaac), and the reporting and analytical modules of major enterprise systems (SAP and Oracle)…
>
> Good analytical capabilities also require good information management capabilities to integrate, extract, transform, and access business transaction data. Some people, then, would simply equate analytics with analytical information technology. But this would be a huge mistake…, as it's the human and organizational aspects of analytical competition that are truly differentiating. [Davenport 2006].

IV. NEED FOR MATHEMATICS PROFICIENCY IN BUSINESS

A necessary precondition for the study of business analytics is a modicum of QL. We have not found statistics that specifically show the mathematics proficiency of undergraduate business school students. This will have to be inferred from the data that is available for American high school and college students in general.

An international survey was performed by the Organization for Economic Cooperation and Development's Program for International Student Assessment (PISA) in 2003, testing 15-year-olds [3]. Unlike previous international assessments, PISA measured not just whether students had learned a set math curriculum, but whether they could apply math concepts outside the classroom. In the U.S., 262 schools and 5,456 students participated in the two-hour, paper-and-pencil assessment. Most answers were constructed responses, not just the multiple choice format.

Of the 41 nations participating in PISA 2003, 25 ranked higher than the U.S. average, including Korea, Japan, the Czech Republic, as well as Hong Kong and Macao in China. Only eight ranked measurably below the U.S.: Greece, Turkey, Mexico, Thailand, Serbia, Montenegro, Uruguay, Indonesia, and Tunisia.

The U.S. 15-year-olds scored measurably better than their counterparts in only three of the 30 nations in the Organization for Economic Cooperation and Development. Even the highest U.S. achievers in mathematics literacy and problem solving were outperformed by their peers in industrialized nations.

The PISA test was conducted again in 2006, with 57 countries participating. The results are shown in the appendix. It can be seen that U.S. students ranked 35th in the math portion of the test.

Once in college, moreover, the students face the following prospect described by none other than a former president of Harvard University:

> Most college seniors do not think that they have made substantial progress in improving their competence in writing or *quantitative methods* (our emphasis), and some assessments have found that many students actually regress. [Bok 2005].

It follows that greater attention needs to be paid to the quantitative literacy of business school applicants, and more emphasis needs to be placed on quantitative methods within the curriculum, if BI/BA is to play a significant role. This will partially mitigate the problem of competitive disadvantage the country faces owing to the poor quantitative literacy of our high school students at least insofar as business undergraduates are concerned. We now examine how U.S. industry is making use of BI/BA.

V. BUSINESS INTELLIGENCE IN INDUSTRY

The growing popularity of BI/BA in industry has been anecdotally reported in the business press, most notably the outlets devoted to information technology. CIO Insight, a leading publication for chief information officers, recently completed a survey of 251 qualified respondents, who were asked to select the five technologies that will make the most significant contributions to business strategy in 2008 [The Year Ahead, 2008]. Business intelligence and data mining was chosen by more respondents (44 percent) than any other technology (see Figure 3).

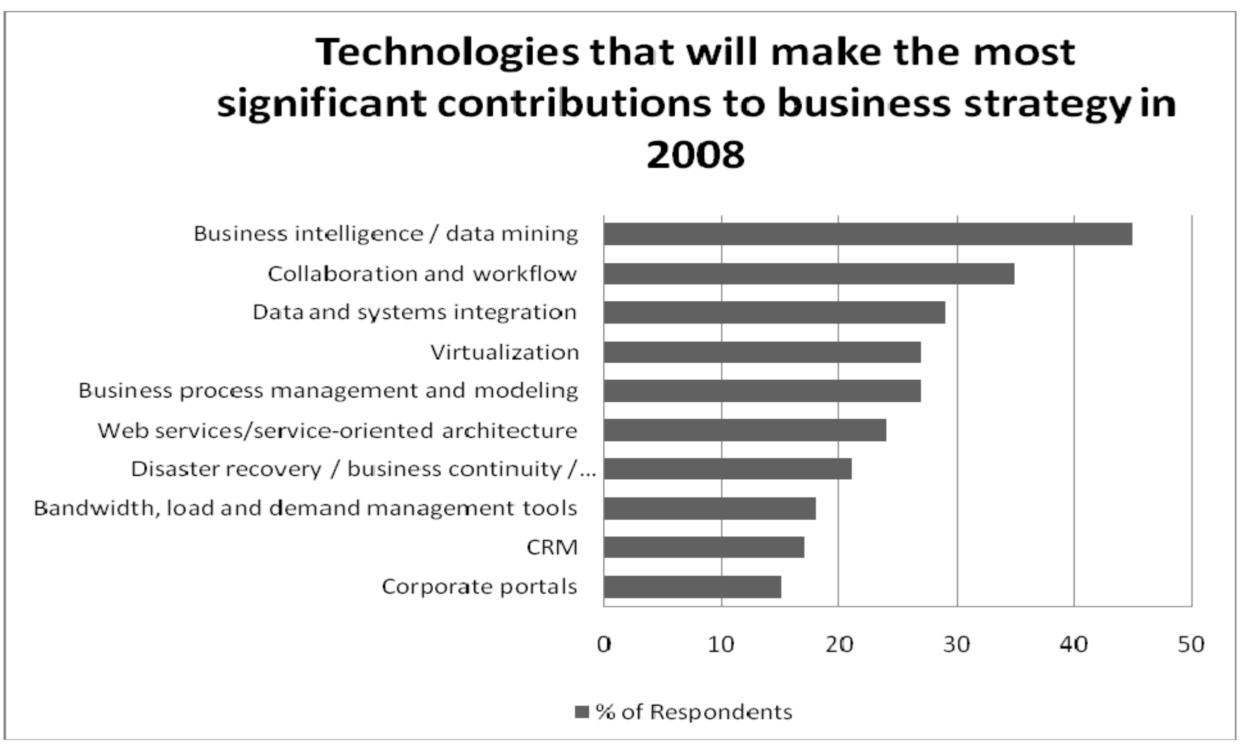


Figure 3. Importance of BI/BA to Industry [eWeek 2008]

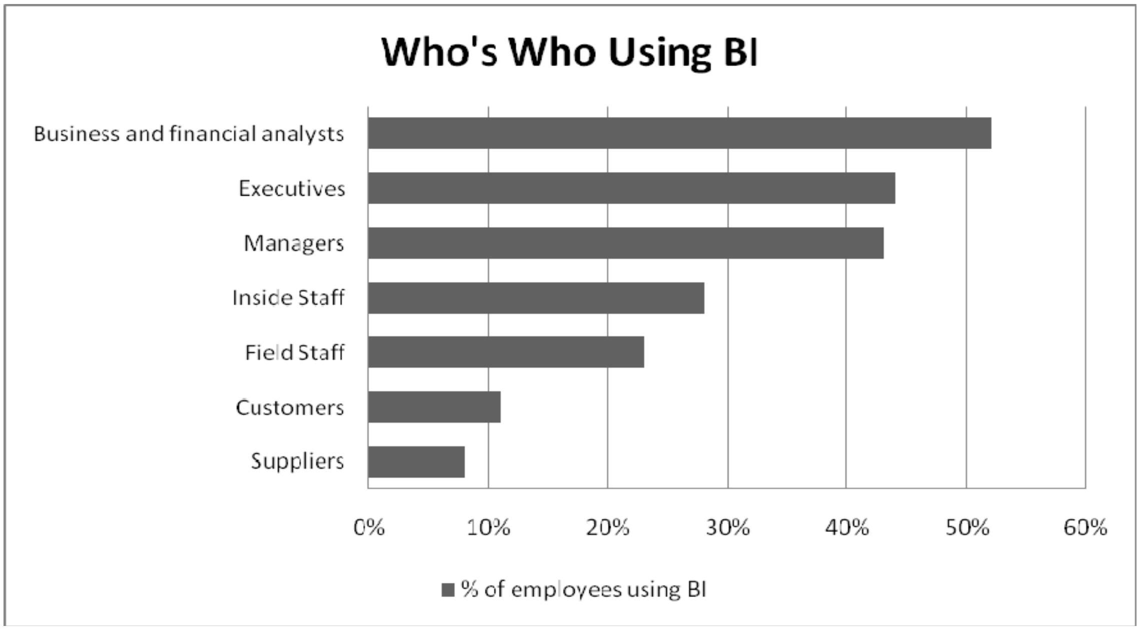


Figure 4. Usage of BI/BA in Industry [Howson 2008]

Another recent survey was conducted by Howson [2008]. She reports surveying 513 employees in a number of companies and found that 25 percent of workers were using BI/BA tools. The article did not provide information about the nature of the companies or how the workers were selected (see Figure 4). Regardless, the distribution of workers who make use of BI/BA is useful.

The market for BI/BA software continues to grow rapidly. Estimates for worldwide revenue from new licenses was estimated to be $2.5 billion in 2006 and projected to increase to $3 billion in 2009 by Gartner, Inc [CRM Today 2006]. There is thus convincing evidence that industry is making widespread use of BI/BA with increasing usage almost certain.

The well-known consulting firm Accenture surveyed more than 250 executives in July 2008 about their companies' use of and investment in business analytics to remain competitive [Wailgum 2009]. Of those respondents who said their companies still make decisions based on judgment rather than business analytics, 23 percent of respondents said "insufficient quantitative skills in employees" were a main impediment at their company, and 36 percent said their company "faces a shortage of analytical talent." Nearly three-quarters (72 percent) of the Accenture survey respondents say they are striving to *increase* their organization's business analytics and BI use.

In a time of severe recession, it is quite eye-opening to see where tight IT budgets are being spent. *InfoWorld* consulted a range of analysts and CIOs to arrive at a consensus: the five technologies IT shops must continue to invest in despite the recession [Sullivan 2008]. The common theme, says International Data Corporation chief analyst and senior vice president Frank Gens, is that "any technologies that can save companies money or reduce expenses will continue to thrive." The top two priorities were both related to BI/BA. The number-one priority in their survey was storage because of the enormous amounts of data that companies feel they are compelled to store, some of it because of regulatory requirements. Second was BI/BA partly because companies need to leverage their investment in data and make sense of an otherwise inscrutable mass of data. Companies feel they needed to target their spending on analytics that “cut costs, avoid errors, predict behavior of customers before they lose them, grow market opportunities." Of particular importance are applications that improve customer insight and retention.

In sharp contrast to the perspective within business, no U.S. business school has introduced a major in the field of business analytics and only one just introduced a minor. This will be explored further in Section VI.

VI. BUSINESS INTELLIGENCE OFFERED IN SCHOOLS OF BUSINESS

Business Week magazine publishes a list of the Top 50 undergraduate business schools annually [LaVellem 2007]. The Web sites of these schools were analyzed to determine their offerings of BI/BA courses, minors and majors. The results are listed in Table 1. Note that only seven of the 50 schools offer course in BI/BA. Five others offer courses in Knowledge Management, which can be assumed to cover BI/BA topics. It is important to note that courses in the individual components of BI/BA have been offered for a long time, i.e. courses in Decision Sciences, Statistics and Information Technology; however, for a single course to qualify as a bona fide BI/BA course it must include topics from all three areas, as shown in Figure 1 and Figure 2. Of course, if suitable courses in the individual fields are packaged together, then the whole package would be appropriately considered a BI/BA minor or major, depending on the number of credit hours offered; however, only one of the schools listed offers a minor in BI/BA, and none offers a major. A description of the sole minor offered follows, gathered from departmental documents.

Table 1. BI/BA Offerings of the Top 50 Undergraduate Business Schools [LaVelle 2007]

Rank	School Name	BI Course	BI Minor	BI Major	Rank	School Name	BI Course	BI Minor	BI Major
1	Pennsylvania				26	Northeastern			
2	Virginia				27	Santa Clara	X		
3	UC-Berkeley	X			28	Wisconsin			
4	Emory				29	William & Mary			
5	Michigan				30	Maryland			
6	MIT				31	Bentley	X		
7	Notre Dame	X			32	Rutgers			
8	Brigham Young				33	Babson			
9	NYU	X			34	Fordham	X*		
10	Cornell				35	Miami U.	X*	X	
11	Georgetown				36	Penn State			
12	Villanova				37	Boston U.	X		
13	Texas				38	Baylor			
14	Boston College				39	Texas Christian			
15	North Carolina				40	Rensselaer Polytech			
16	Washington U.				41	Ohio State			
17	Wake Forest				42	Minnesota	X*		
18	Indiana				43	Florida			
19	USC	X			44	Georgia Tech	X*		
20	Lehigh				45	Clemson			
21	Carnegie Mellon				46	San Diego			
22	Illinois				47	U. of Miami			
23	Richmond				48	Michigan State			
24	SMU				49	Marquette			
25	U. of Washington				50	Texas A&M	X*		

**Knowledge Management*

VII. A PIONEERING BUSINESS ANALYTICS MINOR

In response to the considerations outlined earlier, the Decision Sciences and Management Information Systems at a well-regarded business school in the midwest spent a little over the last year debating if an academic program should be launched in Business Analytics, and if so, what the nature and contents of such a program should be. Several proposals were debated over many months and the outcome was that a minor in Business Analytics was offered beginning fall 2008, comprising the following courses:

- Courses already in the business core curriculum (semester credit hours in parentheses):

    1. Business Statistics (4)
    2. Information Technology in Modern Organizations (3)

- Courses in the Business Analytics Minor:

3. Applied Regression Analysis in Business (3) Prerequisite: Course 1 above
4. Quantitative Analysis of Business Problems (3) Prerequisite: Course 1 above
5. Database Theory and Practice (3) Prerequisite: Course 2 above
6. Introduction to Data Mining in Business (3) Prerequisite: Course 3 above

- Capstone course:

7. Business Intelligence and Knowledge Management (3) Prerequisite: Course 5 above

These courses are tightly knit into an integrated whole as shown in Figure 5. It is important to note that two branches of knowledge (management science on the left and statistics on the right) rest on information technology in the middle, especially the platform provided by the database and data warehouse course. As pointed out earlier, both management science models and statistical models require data from a database or data warehouse for inputs. Two points are of importance here (a) the subject matter of these course closely corresponds to the topics/capabilities shown on the vertical axis of Figure 2, which defines the field of business analytics; and (b) courses covering each of these *individual* fields cannot be called BI/BA courses, which by definition would have to incorporate elements of all these topics, usually with the addition of knowledge management. However, if these courses were to be *packaged together*, then the whole package could be legitimately considered a minor or major in BI/BA, depending on the number of credit hours offered. Sample descriptions of the courses in the BI/BA minor itemized above are provided on the following Web site: http://www.fsb.muohio.edu/departments/dsc-mis/undergraduate/minor-requirements/business-analytics.

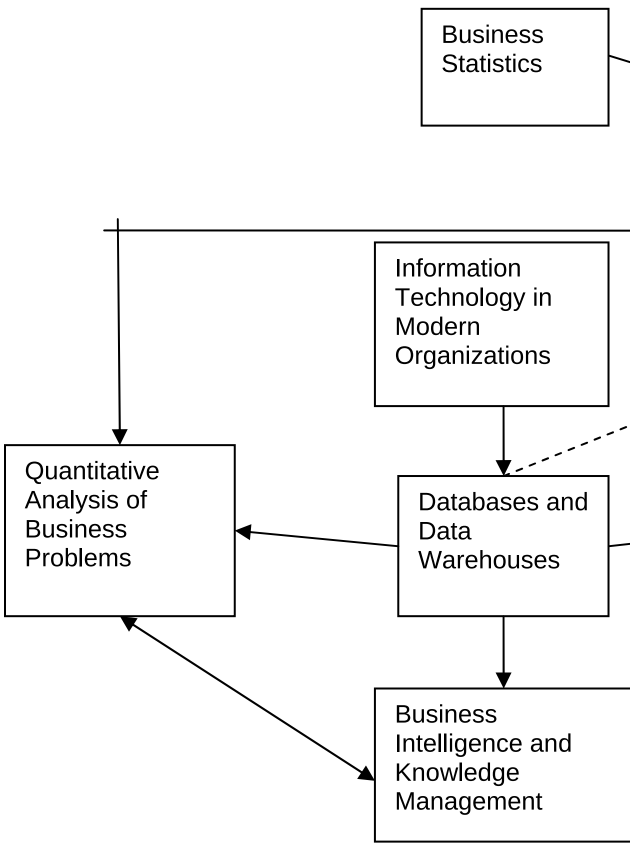


Figure 5. Courses in the BI/BA Minor

Interest in the newly offered minor has been encouraging. The Business Advisory Council for the department, comprising senior managers from 20 companies, is very enthusiastic about the potential for graduates of the program, and several students from across the spectrum of majors have signed up.

VIII. CONCLUSION

There is a widespread trend in schools of business to move away from a focus on traditional business functions such as marketing, finance and production (the "silo" approach), to one that concentrates on an integrated approach to solving business problems, which usually requires the participation of several functions. One solution to the integrated approach is to study business processes—arguably one of the best ways for enterprises to differentiate themselves from their competition. The most sophisticated practitioners in industry of this approach use business analytics, a multidisciplinary field encompassing statistics, management science, and information systems. There is therefore an urgent need for business schools to follow suit and offer curricula to address the demand for adequately qualified graduates in this area. A highly ranked business school has therefore just begun a pioneering Business Analytics minor to address this need, with courses from all three major components. The success of this new program will obviously be watched in several quarters. It is anticipated that many more minors and possibly even majors in BI/BA will eventually be offered by schools of business.

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EDITOR'S NOTE: The following reference list contains the address of World Wide Web pages. Readers, who have the ability to access the Web directly from their computer or are reading the paper on the Web, can gain direct access to these 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.
3. The authors of the Web pages, not CAIS, are responsible for the accuracy of their content.
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APPENDIX: 2006 PISA EXAM RESULTS SCORES [WALL STREET JOURNAL 2008]

COUNTRY	SCIENCE	READING	MATH
Taiwan	532	496	549
Finland	563	547	548
Hong Kong	542	536	547
S. Korea	522	556	547
Netherlands	525	507	531
Switzerland	512	499	530
Canada	534	527	527
Liechtenstein	522	510	525
Macao-China	511	492	525
Japan	531	498	523
New Zealand	530	521	522
Australia	527	513	520
Belgium	510	501	520
Estonia	531	501	515
Denmark	496	494	513
Czech Republic	513	483	510
Iceland	491	484	506
Austria	511	490	505
Germany	516	495	504
Slovenia	519	494	504
Sweden	503	507	502
Ireland	508	517	501
France	495	488	496
Poland	498	508	495
United Kingdom	515	495	495
Slovak Republic	488	466	492
Hungary	504	482	491
Luxembourg	486	479	490
Norway	487	484	490
Latvia	490	479	486
Lithuania	488	470	486
Spain	488	461	480
Azerbaijan	382	353	476
Russian Federation	479	440	476
United States	489	-	474
Croatia	493	477	467
Portugal	474	472	466
Italy	475	469	462
Greece	473	460	459
Israel	454	439	442
Serbia	436	401	435
Uruguay	428	413	427
Turkey	424	447	424
Thailand	421	417	417
Romania	418	396	415
Bulgaria	434	402	413
Chile	438	442	411
Mexico	410	410	406
Montenegro	412	392	399
Indonesia	393	393	391

Jordan	422	401	384
Argentina	391	374	381
Brazil	390	393	370
Colombia	388	385	370
Tunisia	386	380	365
Qatar	349	312	318
Kyrgyzstan	322	285	311

Source: Wall Street Journal, February 29, 2008, p. W10

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