Benchmarking the redesign of "business process reengineering" curriculum

A continuous process improvement (CPI)

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Abstract

Purpose – The purpose of this paper is to illustrate the application of business process reengineering (BPR) and benchmarking principles to redesign an undergraduate course on BPR to achieve continuous improvements. The principles are applied on a course on BPR in the curriculum of engineering management (EM) program at Stevens Institute of Technology. The EM program aims to provide the students the knowledge and skills, which are necessary to work effectively at the interface between technology, management, and engineering. BPR course (EM435) is recently added to EM program's curriculum to support the need for providing the bridge between the engineering of systems and business operations.

Design/methodology/approach – The research approach design is laid out from the time the EM435 course is first offered in the fall of 2006 to the senior year EM students. The students are surveyed and areas of redesign and improvements are identified based on benchmarking against ABET criteria and their associated outcomes, student expectations, similar academic courses, and industry expectations of skills and knowledge.

Findings – The identification of the improvement areas in the BPR curriculum leads to a continuous process improvement (CPI) initiative, which has been continued in a more structured manner. Research findings indicate a strong support for more case studies, use of BPR tool, and real-life project in their investigation of effective pedagogy for teaching BPR to engineering undergraduates.

Research limitations/implications – This paper demonstrates the value of applying benchmarking and CPI methodology in maintaining effective teaching and learning of BPR concepts. More empirical metrics can be developed in future to measure the success of course, improvements.

Practical implications – The findings of this research will promote adoption of courses on BPR and lay a foundation for BPR curriculum in engineering. The CPI approach will provide opportunities to analyze improvements over a period of time.

Originality/value – This paper is unique in its application of benchmarking and CPI for improving BPR curriculum at an undergraduate engineering level.

Keywords Business process re-engineering, Education, Benchmarking, Professional associations, Standards, Curricula

Paper type Research paper

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1. Benchmarking business process reengineering

Business process reengineering (BPR) targets to achieve quantum improvements by rethinking and redesigning the way that business processes are carried out with the help of information technology (IT) as the primary facilitator. Some critical success factors for successful implementation of BPR are teamwork and quality culture, quality management system and satisfactory rewards, effective change management, less bureaucratic and participative, IT/information system (IS), effective project management, and adequate financial resources (Ahmand *et al.*, 2007). To remain competitive in today's global economy, there is an urgent need to rethink and transform the existing business processes for improved quality and efficiency, reduced costs, and increased profitability. Recently, one of the eight most important responsibilities of IT is reengineering business processes and workflow – show how IT systems can help reengineer and how you do the work and make it more efficient (Mary, 2008). BPR was an important activity 1990s and there is a dramatic re-emergence of organizations' interest in the topic (Rigby and Bilodeau, 2005). A survey conducted by a reputable consulting firm of 960 companies published in 2005 confirmed this trend. The use of BPR as a management tool was reported to have gone down from 69 percent in 1995 38 percent in 2000, and revived again to 61 percent in 2004 (Rigby and Bilodeau, 2005). Published literature on the application of benchmarking concepts to industry and service sectors started appearing in a noticeable way only after the 1980s. The contributions in the form of technical papers on general aspects of benchmarking are maximum in number during the period 1992-1995. This is probably due to the initial curiosity and interest generated on the topic (Dattakumar and Jagadeesh, 2003).

BPR was first introduced as a concept for getting radical improvements and better business results by Hammer (1990, 1996) and Hammer and Champy (1993) followed by Champy (1995) and Davenport (1993a, b) and several others in the literature (Davenport and Short, 1990). Since its initiation it has become a popular management tool for dealing with technological and business changes in the competitive environment. BPR was widely used and accepted from 1993 to 1997, however, a downturn in its usage started around the late 1990s due to unaccomplished and unrealistic expectations. However, there is a re-emergence of interest in the topic since 2002 and as of 2004 BPR became as popular as in mid-1990s (Rigby and Bilodeau, 2005). In the later years, the authors who pioneered in publishing on the BPR related topics or the practitioners who have applied BPR programs revisited the subject and evaluated the claims, which appeared in the earlier publications (Champy and Weger, 2005; Davenport, 2003; Hammer, 2005). This second generation literature discussed the pros and cons of BPR concepts, provided insights for success and failure factors and most importantly revealed the unrealistic expectations and misconceptions from the concept admitting what was missing in the earlier literature. For example, Michael Hammer's confession appears in a *Wall Street* article late in 1996 stating that he reflected his engineering background but failed to appreciate the human dimensions of the reengineering programs (White, 1996). Even though the criticism of the topic was on the rise, researchers and authors continued to synthesize the success and failure factors of BPR, looked for the development of new tools and techniques, and emphasized organizational and human aspects of BPR. As a result of all these efforts, BPR matured as a management and engineering tool. As evidenced by a recent multi-industry, multi-national survey (Rigby and Bilodeau, 2005), this new interest in BPR is being accelerated by global competition. As one company becomes dramatically more productive, others in the industry must follow. But, what distinguishes most of today's projects from the reengineering boom of the

1990s is that they are enabled by large IT efforts. And the internet has made technology an even more important enabler of process change (Ahadi, 2004).

Recently, BPR is a mature concept which has evolved in time and which is supported by extensive literature. This literature is a result of various academicians' and practitioners' valuable work and thoughts on the subject. When we planned to add BPR to our engineering management (EM) curriculum, we had no doubt that BPR was a topic which was backed by stable and mature material worthy of being taught.

2. Research objectives and methodology

So far, we discussed the benefits of BPR and why a course on BPR is required. Now, we would like to discuss how this course became a case for studying the application of BPR principles for course improvements. We adhered to the quote, "Follow what you preach." Hence, we decided to apply BPR and benchmarking principles for continuous course improvement. The course curriculum was selected after reviewing literatures on similar courses in business and engineering courses. This review provided the academic benchmark. The student feedback and expectations were gathered and discussed for benchmarking against stakeholder expectations. The areas of improvements and redesign were identified and prioritized for continuous implementation and thereby aim for continuous improvements. A sample of industries that hire BPR students were interviewed for their expectations from the new hire. This served as the industry stakeholder benchmark and as a measure of course success. The students were surveyed on their understanding of BPR concepts before and after the course to measure the success of the course and its improvements. There seem to be noticeable differences between the different terms like comparative performance assessment, benchmarks, benchmarking, and the implementation of seeking best practices for process improvement in the literature. Authors have proposed that a more precise terminological use of true benchmarking practices should be promoted and used by management leaders, educators, and writers (Alstete, 2008).

3. A course in BPR, its need and program overview

The curriculum of EM program at Stevens Institute of Technology emphasizes the integration of management, human, and technology issues and targets to produce graduates who can work effectively at the interface between technology, management, and engineering (Farr *et al.*, 2006). EM discipline faces massive changes due to changing trends in business and technology world and the curriculum of the EM program is aligned to cope with the changes and complexity of the business and technology world. In today's world, engineers are required to have management and business related skills in addition to the technical skills traditionally associated with engineering. The importance of mastering in business and management principles is also highlighted as one of the "key attributes of future engineers" besides carrying strong analytical and technical skills in *The Engineer of 2020* published by National Academy of Engineering (2005).

Traditionally EM discipline is defined as a bridge between engineering and management disciplines however due to the emerging issues facing the world, the EM discipline is reshaped by the emerging trends and issues (Kotnour and Farr, 2005). Business environment trends and challenges including globalization, short-term profit focus, increased regulatory, environmental and ethical focus, and changing demographics of workforce create specific challenges for technical organizations. These trends specific to technical organizations are listed in Kotnour and *et al.* as forging partnerships, operating networks of relationships, implementing a process-based organization, continuously managing change, and gaining, maintaining employee loyalty and commitment. When we look at these trends, implementing a process-based organization and continuously managing change led us to add BPR topic within the EM curriculum.

BPR is a systematic approach to helping an organization analyze and improve its processes. This provides an opportunity to view the organization-wide processes from a systems perspective. A systems perspective focuses on looking at a set of problems as a whole and the context that creates the holistic view rather than looking at a set of problems as individually isolated events (Jain *et al.*, 2007). All systems are designed, developed and engineered to support the business processes within an organization. Therefore, an understanding of the business processes is crucial for engineering students for making decisions on designing, building, and managing systems.

The concept of reengineering traces its origins back to management theories developed as early as the nineteenth century. BPR integrates methods from total quality management (TQM), technology and innovation management, strategic planning, systems engineering, and organizational design (Winter, 2002; Zairi and Sinclair, 1995). The Stevens EM program has been offering courses related to these topics and integrating BPR in the curriculum was only natural. It aimed to provide our students an understanding of the BPR as a concept, learning of the tools and techniques and the ability to find similarities and differences between TQM and IT and business operations.

4. The EM435 BPR course: a case study for CPI

The BPR curriculum was selected as a case study for studying the impact of benchmarking and continuous process improvement (CPI) on course improvement. The authors understand the constraints of using benchmarks and were careful in making sure that we collect course assessment data over several semesters before we could understand the true impact. In another study on use of benchmarks on a building innovation project it was noted that any researchers who are considering using benchmarking as a means of enhancing understanding of the issues affecting a product or process should ensure that sufficient time is allocated in their research design to accommodate the use of in-depth case studies to truly understand the cause and effect relationships (Jones and Kaluarachchi, 2008).

The BPR course was added to EM program's curriculum as a senior year course and offered first time in the Fall semester of 2006. The course content was carefully selected based on an extensive literature review in the BPR field. The course was designed to provide knowledge on BPR and its main concepts; the technologies and the strategies for implementing business transformation; and best BPR practices by emphasizing the role of BPR in managing technology and the engineering functions.

The course provides knowledge on BPR and its main concepts; the technologies and the strategies for implementing business transformation; and best practices on BPR. It emphasizes the role of BPR in managing technology and the engineering functions. The course covers the strategic, operational and technological aspects of BPR by relating it to quality improvement and IT. It introduces the main concepts underlying the transformation of business processes, explains the enabling role of IT, and demonstrates the application of different tools to the redesign of business processes.

The major learning objectives of the course are to understand the importance of processes and BPR, and appreciate how BPR bridges the business operations and engineering of systems; to understand how business processes can be radically improved, dramatically reducing process cycle time and cost, and improving the quality of the process products or outcomes; to identify business processes those are candidates for improvement; to model current business processes and to diagnose problems; to model and develop improved business processes those require IT and organizational redesign; and to develop measures and benchmarks for business processes.

4.1 Course content

In the development of the course, our main approach was to include topics, which would cover certain knowledge and skills required for BPR. Before we decided on the content of the course, we extensively reviewed BPR related literature. At the same time, we also did a survey on how BPR is being taught in other universities and programs. Our survey revealed that BPR related courses are mainly taught at the graduate level business programs (MBA programs), and undergraduate and graduate level (IS and management information system) programs. (This information is based on the publicly available course syllabi for these programs.) These courses either emphasize the business and organizational aspect of the topic or are built from a very technical perspective. However, we realized that in order to do justice to the topic, we had to emphasize both the business and technical aspects of BPR. BPR uses IT to radically change or redesign the business processes within organizations to dramatically increase their efficiency and effectiveness. There are five essential elements that define BPR:

(1) BPR consists of radical or at least significant change;

(2) BPR's unit analysis is the business process;

(3) BPR tries to achieve major goals or dramatic performance improvements;

(4) IT is a critical enabler of BPR; and

(5) organizational changes and human issues are critical enabler of BPR and must be managed accordingly (Jain *et al.*, 2007).

We built our BPR course around these five elements and specially tailored our curriculum to address the need to produce EM graduates who can work effectively at the interface between technology, management, and engineering.

5. Redesign of the BPR course

The BPR course was evaluated after the first time teaching in Fall 2006. The evaluation was based on the primary author's own experience of teaching the course, the formal and informal feedback of the students, and students' performance on each of the course objectives, student grades on the individual assignments as well as the mid-term and the final project. The instructor also took into account the level of difficulty that the students had in understanding a concept and then relating it to a real process example. The course was redesigned during the summer of 2007 and the revised version of the course was taught in the Fall of 2007.

While analyzing the students' performance assessment data of the BPR course from Fall 2006, it became evident that the following two outcomes were not achieved to our satisfaction:

(1) understand how business processes can be radically improved, dramatically reducing process cycle time and cost, and improving the quality of the process products or outcomes; and

(2) identify business processes that are candidates for improvement.

We analyzed the possible reasons for the unsatisfactory performance of the students on the above two learning objectives. We then tried correlating it to the instructor's observation from the class. Based on the student feedback and instructor's observations from the previous year the following changes were made to improve these two outcomes and also provide students more hands-on experience through modeling and case analysis:

- A capstone team lab exercise (X-ray process) was provided to the students. Each week each step of BPR for the X-ray process was discussed and worked on in class as teams.
- Extend, BPR modeling and simulation software was introduced early on in the course. This was also used significantly in the capstone project. The modeling and simulation helped student understand the steps in BPR through hands on experience.
- Instead of students trying to find a BPR project and collect data for their final project Harvard Business Case Studies were provided. In the previous year, students exhibited difficulty in getting corporate BPR cases and the data and metrics required for reengineering. To overcome this challenge and provide all the teams similar cases a set of BPR case studies were provided to students for case analysis as a team.
- In the previous year, two textbooks were used and the students felt it was challenging to cover both the books within the semester. Hence, this year only one textbook was used. This also resulted in removing lectures redesigning processes for online businesses and future of computer based tools for process analysis and improvement. This lecture time was used for capstone exercise and these chapters were listed as suggested readings for the students.

6. Student learning as a result of course, redesign

The modifications and improvements were made to the BPR course for 2007. In order to study the impact of these changes to the course, we analyzed the course outcomes based on student performances for both the years (2006 and 2007). The course outcomes for BPR course (EM 435) and their mapping with the program outcomes, curriculum outcomes and ABET criteria are provided in Jain *et al.* (2007). The course outcomes are a direct reflection of the achievement of the course objectives. These outcomes of EM 435 are directly tied with the EM program outcomes and the ABET criteria. The course outcomes for the purpose of our analysis for this paper are shown in Table I.

The student performances across these eight course outcomes has been calculated for 2006 and 2007 and shown in Figure 1. The differences in these outcomes across 25th percentile, median, and 75th percentile is shown in Figure 2. Both these figures

Table I.
BPR course outcomes

Curriculum outcomes	ABET	Program outcomes	EM 435 outcomes
I. Broad based technical expertise			
2. *Engineering foundations.* The ability to use applied scientific knowledge	3.e. An ability to identify, formulate, and solve engineering problems	Be able to analyze systems using an EM approach	(2P1) Model and develop improved business processes that require IT and organizational redesign. Mapped to fundamentals of BPR success and failures
3. *Experimentation.* The ability to design experiments, conduct experiments, and analyze experimental data	3.b. An ability to design and conduct experiments, as well as to analyze and interpret data	Be able to design, conduct, and analyze experiments through the use of engineering economics analysis, statistical, life cycle and integrated product and process development models, probability applications and word problems that use examples from manufacturing or service applications	(3P1) Model current businesses processes and diagnose problems. Mapped to topic business process modeling and simulation
4. *Technical design.* The technical ability to design a prescribed engineering subsystem	3.c. An ability to design a system, component, or process to meet desired needs	Be able to determine the scientific and EM variables of interest and processes to manage engineering design alternatives and management planning	(4P1) Identify business processes that are candidates for improvement. Mapped to topics fundamentals of BPR and business process measurement
5. *Design assessment.* The ability to develop and assess alternative system designs based on technical and non-technical criteria	–	Be able to assess the ergonomic, economic, social and environmental requirements, needs and constraints of the system and its impact on the global society	(5P1) Develop measures and benchmarks for business processes. Mapped to topics business process measurement, and business process benchmarking
6. *Tools.* An ability to use the relevant tools necessary for engineering practice	3.k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	Be able to use computational tools and management software and theories for finding graphical, statistical and analytical solutions to problems necessary for the practice of EM	(6P1) Use process-mapping software. Mapped to topics business process design tools and techniques, and business process modeling and simulation

(*continued*)

Curriculum outcomes	ABET	Program outcomes	EM 435 outcomes
II. Professional advancement and communications			
7. *Professionalism.* The ability to recognize and achieve high levels of professionalism in their work	3.f. An understanding of professional and ethical responsibility	Be able to use EM analysis and TQM to develop production plans and effective task breakdowns and project plans based on life cycle, material and information processes and customer feedback of a product, service, or system	(7P1) Understand how business processes can be radically improved, dramatically reducing process cycle time and cost, and improving the quality of the process products or outcomes. Mapped to topic process management and improvement evolutionary change vs revolutionary change
10. *Communication.* The ability to communicate effectively and persuasively	3.g. An ability to communicate effectively	Be capable of submitting periodic oral and written progress reports as well as final written and oral reports on the entire project and be capable of critiquing and evaluating such	(10P1) Create a project plan that implements a new business process. Mapped to topic business process design framework
III. Worldview and personal development			
14. *Entrepreneurship.* Have a fundamental knowledge and an appreciation of the technology and business processes to nurture new technologies from concept to commercialization	–	Be able to understand the items necessary to get a product, process or service from conception to marketplace (design, project management, sources of capital, intellectual property, marketing, and principles of quality)	(14P1) Learn the importance of processes and BPR and understand what BPR can do for organizations. Mapped to topics fundamentals of BPR, and BPR success and failures

Table I.

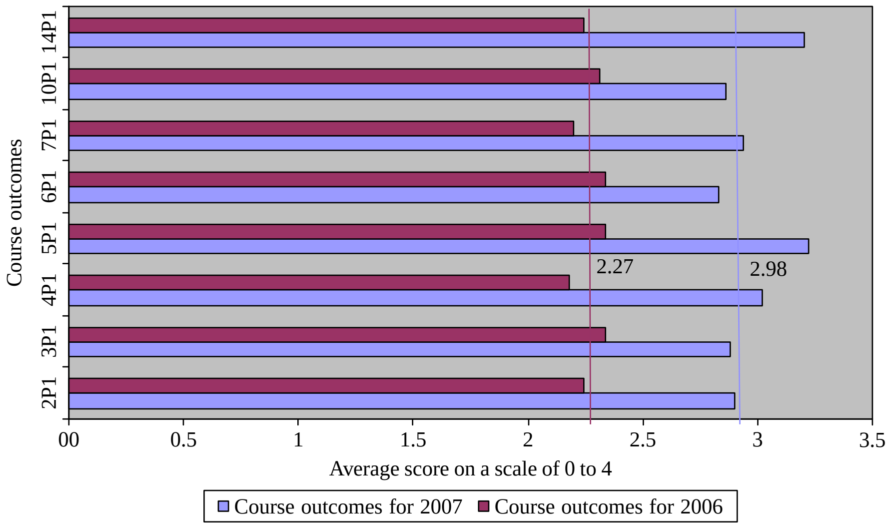

Figure 1.
Comparison of average scores across the course outcomes for 2006 and 2007

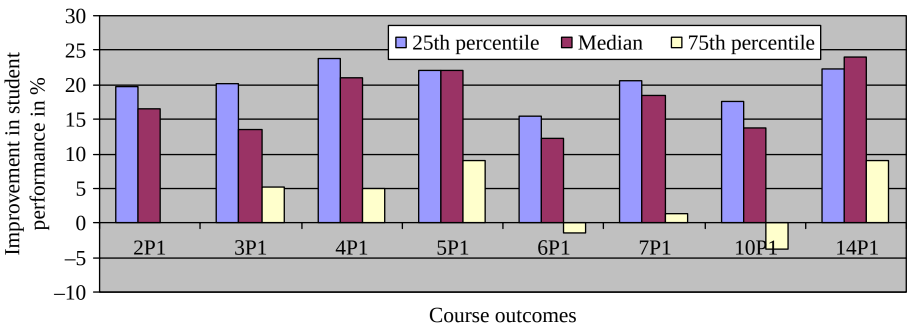

Figure 2.
Improvements in student performance in the redesigned BPR course

show that the students' performance across all eight-course outcomes has increased significantly. One of the major goals of redesigning this course is to improve the lower quartile performance of 2006. In 2006, the lowest level grades in this quartile for all course outcomes ranged from 1.53 to 1.71 out of four. We can see such an improvement in lower quartile performance in 2007 compared to 2006 in Figure 2. On an average there was a 20 percent improvement (average improved from 1.6 in 2006 to 2.4 in 2007) in the lower quartile performance.

Student learning improvement by changes

Inclusion of capstone team lab exercise (X-ray process): a case study of an inefficient X-ray process as it exists currently with its process sequences, descriptions, parameters, and resources was provided to the students. The students were required to perform As-Is process mapping and model it in Extend. The simulation results showed the areas of problems and process inefficiencies. The students were then asked to reengineer this process by applying the framework and concepts taught in the class. They were asked to perform To-Be process mapping and model the improved design in Extend. The students were also asked to identify metrics for performance and resource allocation. By simulating the new process and comparing the results with the old process and with industry benchmarks the students were asked to document the resulting radical improvements and reiterate for better results. The course outcomes 3P1, 4P1, 5P1, 6P1, and 10P1 are related to this capstone exercise. Based on analyzing the student performances on these five course outcomes, we concluded that introducing the capstone X-ray process resulted in a 15 percent average improvement on these five course outcomes over the previous year.

Early introduction of Extend (a BPR modeling and simulation software) in the course: our improved understanding of the importance of the role of tools in BPR and students' feedback, led us to introduce Extend early-on in the course and implement it through the capstone team exercise in the course over the semester. The students modeled the current and the improved processes and were able to compare the process performance and resource constraints by simulating these process models. These changes in the course are reflected in the course outcomes 3P1 and 6P1 (business process modeling and simulation, and tools and techniques) are related to this change. Based on analyzing the students' performance on these two outcomes of the course we ascertained that introduction of the capstone X-ray process resulted in a 12 percent average improvement on these two outcomes over the last (2006) year when it was taught.

Final project *Harvard Business Review* (*HBR*) case studies: based on the students' feedback and also understanding their difficulties associated with getting access to corporate BPR projects or process-related information a set of *HBR* cases on BPR were selected for the team projects. This team project was included as the final requirement for the course. The final project was changed from the students having to reengineer a process to analyzing the success or failure of the given *HBR* case by applying the concepts and principles discussed in-class during the semester. The experience of having to reengineer a process was compensated by the X-ray capstone lab exercise discussed earlier in this paper. The final project addresses all the outcomes of the BPR course based on analyzing the student performances on all the course outcomes we can say that this change in course is one of the reasons for an average improvement of 15 percent over the previous year.

Reduction of textbooks: based on the instructor's experience of teaching the course in 2006, she realized that having two text books resulted in repetition and overlap of the topics, too much emphasis on student assignments, inadequate time for covering both the books during the semester without compromising on participative learning for students through exercises, etc. Discontinuing one of the textbooks for 2007 teaching has provided the instructor more time to spend on the lectures, discussions, and in-class exercises. The instructor was also able to include the X-ray capstone exercises in the revised course content. This reduction in workload for the students could also be a factor for significant improvements in course outcomes.

Effective ways of learning for BPR students

As part of the authors' investigation into potential areas for improving the BPR course they also studied which mode of teaching was more effective for students' learning. The students were asked to rate the six different ways used in the class to cover the course materials in terms of which ones of these helped them learn the most as shown in Figure 3

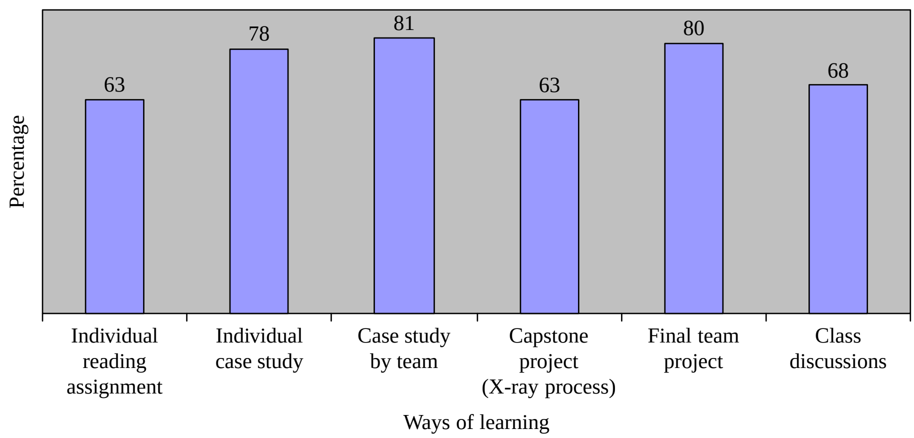

Figure 3. Effective ways of learning for BPR students

on a five-point scale. These were case studies – team assignments, individual assignments, final project, capstone project, individual reading assignments, and class discussions. The weighted averages of the students' responses were then converted into percentages as shown in the figure. The case study and final team project were rated as the most effective ways of learning by the students. In total, 81 and 80 percent of the students rated these two as most effective ways of learning BPR. As mentioned earlier the final team project was also a case study. Except that the final project was done over a period of 14 weeks during the entire semester while the other case studies were analyzed and submitted by the teams as week-long team assignments. The cases done over a week were shorter compared to the final project case studies and were based on the topic taught that week in the class. The final project case studies require an understanding of all the concepts taught in the course during the entire semester. The case studies and final project are closely followed (78 percent of the students) by case study analyzed and submitted individually by the students. These findings are very self-explanatory and support earlier similar findings that for a BPR course the most effective way of learning is through case studies with a slight preference of team-based analysis over self-study. Overall, all the six ways of learning were rated over 50 percent. This demonstrates that the modes or ways of learning used in the redesigned course were effective. Even though, the lowest two effective modes were the capstone team project and the individual reading assignment they were still rated as effective by 63 percent of the students. These will be areas that the authors will focus for future improvements of the course.

7. Students' understanding of BPR concepts

A part of the BPR course redesign also included conducting of a survey to study the level of importance to the potential employers of the BPR topics covered in this course. This importance rating was provided by the potential employers for hiring of an undergraduate for an entry-level position involving BPR related work. This study was done to understand the BPR areas of high importance to the employers and customize the BPR course to emphasize these topics of importance to the industry. A redesigned BPR course strengthened by such a study could prepare the students for their entry-level roles related to BPR in the industry. This study and its findings are reported in Jain *et al.* (2009). The students of the redesigned course were asked to rate their understanding on these same topics/concepts before and after taking the course. The BPR topics covered in this study are shown in Table II.

This section of the paper discusses, the student learning across these BPR topics and concepts and also compares with the level of importance rated by the industries. For the purpose of readability and clarity of the charts these BPR topics are listed as numbers. Table II describes these BPR topics for your reference.

The students' understanding of BPR concepts before the class, after the class, and as a result of taking the class is shown in Figure 4. The improvement in students' learning as a result of taking the class is shown in Figure 5.

The students' understanding of the BPR concepts before, after, and as a result of taking the class is shown in Figure 4. To highlight the difference, in our case the improvement in students' understanding of the BPR concepts as a result of taking the class, these improvements are also shown in a separate chart in Figure 5.

No.	BPR topics
1	Understanding of the importance of processes, process management, and improvement tools and techniques
2	Understanding of the difference between various process improvement and management techniques (such as TQM, BPR, Six Sigma, and, etc.)
3	Understanding of what BPR can do for organizations
4	Understanding of how business processes can be radically improved, dramatically reducing process cycle time and cost, and improving the quality of the process products or outcomes
5	Ability to plan and implement a new business process model and develop improved business processes that require IT and organizational redesign
6	Ability to diagnose problems, select processes to be reengineered and justify the selection
7	Ability to define and document current and reengineered processes by identifying the following: Process boundary, inputs and outputs; main activities; business rules and decision points; activity/process owners; applications and technology infrastructure required for the process; relevant performance metrics, volumes, processing times; and activities need to be decomposed for further clarification
8	Ability to use a process-mapping software (business process design tools and techniques – Extend and Visio)
9	Ability to research and review available data; collect data by conducting one-on-one or group interviews, etc
10	Ability to analyze process-related data
11	Ability to prioritise potential improvements by identifying: redundant and unnecessary activities; inefficient process layouts; rework process steps; recurring delays; and major checkpoints which create major delays
12	Ability to develop measures and benchmarks for business processes
13	Ability to redesign/reengineer the current process by: eliminating non-value added activities; reducing cycle time; improving service and product quality; minimizing inefficiencies; and balancing flow and capacity
14	Ability to define metrics to measure the current and reengineered process and evaluate the improvement potential
15	Ability to model current and reengineered business processes to diagnose problems using modeling and simulation techniques
16	Ability to create an implementation plan for the reengineered process discussing the implementation issues such as cost, time, improvement potential, and likelihood of success
17	Understanding of the factors that lead to the success and failure of BPR initiatives

Table II.
BPR topics included in the study

Figures 4 and 5 show that the students improved the most (45 percent) in terms of their understanding of the factors that lead to success and failure of BPR closely followed by something similar – what BPR can do for organizations (44 percent). Students' ability to define and document current and reengineered processes improved 43 percent after taking the course. This ability was described as identifying the following: process boundary, inputs and outputs; main activities; business rules and decision points; activity/process owners; applications and technology infrastructure required for the process; relevant performance metrics, volumes, processing times; and activities need to be decomposed for further clarification. Another aspect of learning that showed high level of improvement (39 percent) was understanding of how business processes can be radically improved, dramatically reducing process cycle time and cost, and improving the quality of the process products or outcomes.

BPR topics and concepts with least learning as a result of taking the class are as follows: ability to analyze process-related data (28 percent improvement), and ability to research and review available data; collect data by conducting one-on-one or group interviews, etc. (20 percent improvement). As the Figure 4 shows the students' reported a high level of understanding on these two categories prior to taking the class. As a result even such low level of improvements added to a significantly high level of understanding of 80 percent after taking the class (lower only to four other categories).

The five categories where the students reported the highest levels (more than 85 percent) of understanding of the BPR topics and concepts after taking the course were:

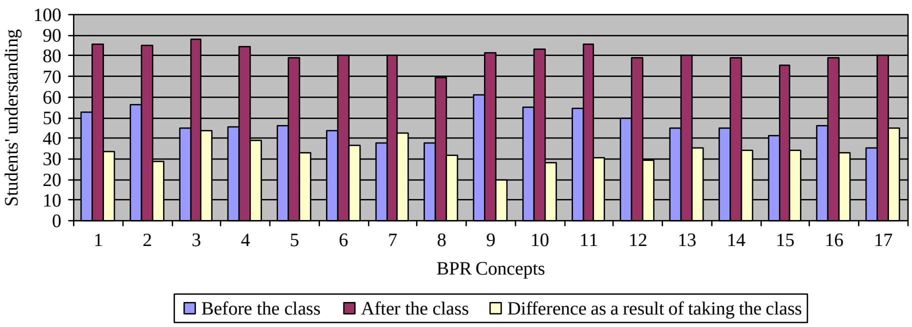

Figure 4.
Students' understanding of BPR concepts before taking the class, after taking the class, and as result of taking the class

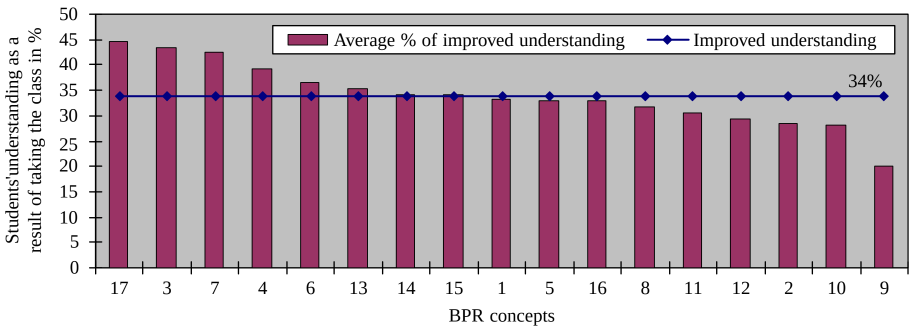

Figure 5.
Improved (difference in) students' understanding of BPR concepts as a result of taking the class

(1) understanding of what BPR can do for organizations (88 percent);
(2) understanding of the importance of processes, process management, and improvement tools and techniques (86 percent);
(3) ability to prioritize potential improvements by identifying: redundant and unnecessary activities; inefficient process layouts; rework process steps; recurring delays; and major checkpoints which create major delays (85 percent);
(4) understanding of the difference between various process improvement and management techniques (such as TQM, BPR, Six Sigma, and, etc.) (85 percent); and
(5) understanding of how business processes can be radically improved, dramatically reducing process cycle time and cost, and improving the quality of the process products or outcomes (85 percent).

Understanding of BPR topics prior to taking the class

The students came into the class with some knowledge of some of the BPR topics covered in this course. The areas where they reported more than 50 percent understanding prior to coming to the class are: ability to research and review available data; collect data by conducting one-on-one or group interviews, etc. (61 percent), understanding of the difference between various process improvement and management techniques (such as TQM, BPR, Six Sigma, and, etc.) (56 percent), ability to analyze process-related data (55 percent), ability to prioritize potential improvements by identifying: redundant and unnecessary activities; inefficient process layouts; rework process steps; recurring delays; and major checkpoints which create major delays (55 percent), and understanding of the importance of processes, process management, and improvement tools and techniques (53 percent).

The BPR topics and concepts on which students rated themselves low prior to attending the class were also generally those on which they learned the most after attending the course. These were usually related to application (how) of BPR rather than what and why. The students' ability to use a process-mapping software (business process design tools and techniques – Extend and Visio) was rated at 38 percent. It improved by 32 percent as a result of taking the class. Similarly, their ability to define and document current and reengineered processes was only at 38 percent but improved to 81 percent as a result of taking the class. The most significant improvement by 45-80 percent as a result of taking the course was noted in the students' understanding of the factors that lead to the success and failure of BPR initiatives.

The analysis of students' understanding of BPR concepts before and after taking the class shows some interesting trends such as:

- the students had good understanding of pre-required concepts of BPR;
- the course improved fundamental understanding of BPR; and
- the course needs to focus on improving understanding of concepts of BPR implementation.

These trends are discussed below:

- The students (seniors) who took the BPR course had a good understanding of business processes, their importance, and various process improvement techniques other than BPR. The students also had a good understanding of how to perform research and data collection, and how to synthesize the results and identify potential process improvements. We can state that the students had good understanding of concepts that are pre-required for the BPR course.

- The course helps students to better understand the BPR topics and concepts that they have the least understanding prior to the class. This shows that the course builds on students existing knowledge and focuses on new and relevant BPR topics. The course had a high impact on students understanding of some fundamental and important BPR topics such as success and failure of BPR, importance and benefits of BPR, radical process improvements, and process documentation.
- Though the course significantly improved students' fundamental understanding of BPR it could have focused more on the implementation aspects of BPR such as planning, modeling, measuring, and benchmarking. These BPR topics where the students had 70 percent understanding after the class could be focused in future to obtain a higher degree of understanding.

Improved learning and understanding compared to industry rated level of importance

A survey was conducted to understand the relevance of the topics covered in the class to the industry. The industry experts where asked to rate the level of importance of these BPR topics and their knowledge for an entry-level applicant's skill set. The survey and the results have been documented in detailed in the paper (Jain *et al.*, 2009). The results of this survey are shown in this paper for comparison of students' understanding and industry expectations of a BPR related entry-level candidate. The levels of importance of these BPR topics for the industry are shown in Figure 6 on a five-point scale (0-4). The trend in the level of student understanding across these BPR topics after taking the class is very similar and with par with the level of importance rated by the industry. The industries rated:

- Researching, understanding (mapping), analyzing, and prioritizing processes for redesigning as the most important (>90 percent extremely and very important).
- The knowledge and ability required to do so as the next to most important (>70 percent extremely and very important).

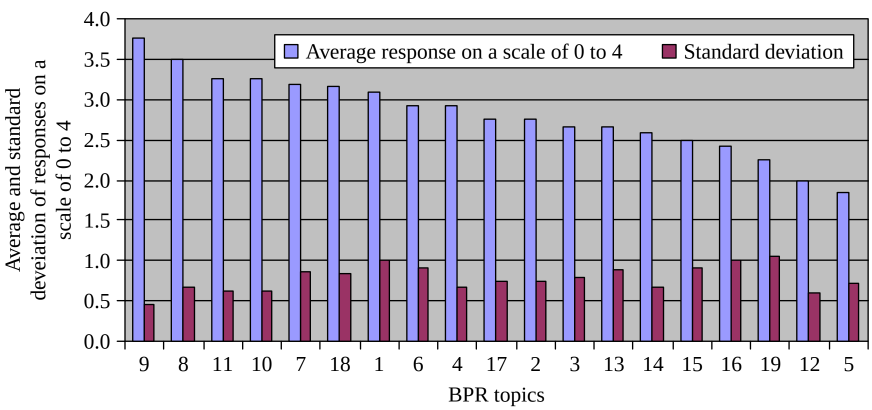

Figure 6.
Average and standard deviation of responses on all BPR topics

- The fundamental knowledge of BPR as the next level of importance (>50 percent extremely and very important).
- Developing metrics, benchmarks, plans, models and simulations were the less important factors (≤50 percent extremely and very important). In other words measurement and modeling is the least important.

8. Future potential for further improvement

Based on the student feedback and student performance, the following two outcomes were not achieved to the estimated par:

(1) identify business processes that are candidates for improvement (BPR and concept of "As-Is" to "To-Be"); and

(2) plan and implement a new business process model and develop improved business processes that require IT and organizational redesign (business process design framework).

Students had difficulty identifying the candidates for improvement in a business process. The students looked at candidates with existing constraints such as resources and infrastructures. But the students did not look at potential processes of improvement based on technology and process execution (sequential vs concurrent). Lack of exposure to business processes can partly be held responsible for this. These issues and how to look beyond the physical aspects of the process and think about behavior and technology was addressed at the end of the semester upon assessing their performance. This also led to the difficulty in developing an improved business process. For the next year, these issues will be addressed earlier in the course and help students identify the best candidates for process improvements.

Also, more Extend introduction and illustrations will be provided. Some students felt that one class of introduction and X-ray process Extend modeling help each week was not sufficient to understand and model in Extend. Hence, additional illustrations and instructions will be provided to students in the next year.

Apart from these conceptual understanding improvements, focus will be needed on the following areas:

- How to make students equally contribute in the team projects?
- How to perform improved case study analysis?

9. Conclusion

This paper provides an overview and insight into how simple BPR and benchmarking principles could be applied for continuous curriculum improvements. The measures of improvement derived from students and industry indicate that the course improvements have benefited its audience and are at par with the benchmark. As a future work more empirical metrics can be developed to measure the success of course, improvements. This study clearly shows the effectiveness and simplicity of applying process reengineering and benchmarking principles for course redesign and improvements. Similar applications of benchmarking, BPR, and CPI can also be extended to other curriculums, seminars, and trainings within academics and industry in order to deliver value to the stakeholders.

Note

1. ExtendSim is a modeling and simulation software used to create dynamic models from building blocks, explore the processes involved, see how they relate, and then optimize the process (www.extendsim.com).

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