A Pedagogical Experience in Designing and Teaching a Report-Oriented Business Intelligence Course

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Abstract

As the demand for business intelligence professionals is growing dramatically in industries, business intelligence educators are facing the challenge that there is often a lack of alignment between the needs of practitioners and of providing a broader range of BI skills using an interdisciplinary approach. To address this issue the current paper presents a new pedagogical method called "report-oriented learning" that is based on problem-based learning approach and case-based learning approach for instructors. The report-oriented method balances concept learning and practical application. It requires students to reflect on their gained knowledge and apply critical thinking through different types of reports. This article reports the results of introducing the report-oriented method applied in a business intelligence course that consists of three core learning components: (1) basic concepts and quizzes, (2) hands-on projects, and (3) reports. The results indicate that it was well received and perceived by students as having improved their thinking and skills in applying BI techniques and professionally presenting their findings. The paper concludes with limitations and future research.

Keywords: Business Intelligence, Report-Oriented Learning, IS curriculum, Pedagogical Experience

1. INTRODUCTION

Business intelligence (BI) is "a broad category of applications, technologies, and processes for gathering, storing, accessing, and analyzing data to help business users make better decisions" (Watson, 2009). As the demand of BI professionals is growing dramatically in industries, BI is becoming a hot area of information systems (IS) education (Presthus and Bygstad, 2012; Wang, 2015; Watson, 2009; Wixom et al., 2011, 2014). In response to the increasing demand for BI professionals in industries, over 130 academic programs have offered undergraduate and graduate degrees in BI or similar degrees (e.g., business analytics, data science) (Wixom et al., 2014).

A BI course usually incorporates content from statistics, database management, management information systems, computer science and various business disciplines. Given the nature of BI, BI or similar courses have been taught in many different ways.

Some educators focus on teaching computerized BI tools (e.g., Microsoft Power BI, Python, SAS Enterprise Miner, Tableau; Teradata SQL; WEKA) to help students build solid skills of applying the tools (Jeyaraj, 2019; Mrdalj, 2007; Zhang et al., 2020). Other educators emphasize the importance of BI concepts to help students grasp the entire picture of BI in business (Wang & Wang, 2019). Yet other educators utilize case studies to focus on of the ways that BI operates in real businesses (Pomykalski, 2014； Presthus and Bygstad, 2012; Mitri, 2015). Although those

teaching methods have proved effectively supporting student learning on either technical side or conceptual side, BI education is still facing challenges reflected in Wixom et al.'s comprehensive report (2011). BI educators need to align with the needs of different industries and provide a broader range of BI skills using an interdisciplinary approach.

The goal of this research is to address the challenge through developing a new pedagogical method to balance concepts learning and practical application. Report-oriented learning is developed based on instructional methods, problem-based learning. To present the core of report-oriented learning in the BI course, this paper details the experience of teaching a report-oriented BI course with the learning objectives, course topics, assignments, technological tools, reports design, and timeline.

The remaining sections of this paper review the literature in problem-based learning and develop the new pedagogical method, report-oriented learning. Next, the report-oriented BI course design with learning objectives and curriculum modules is introduced. Following the description of the course implementation, the reflection from the students is included. Last, this article concludes with suggestions for teaching the report-oriented BI course.

2. LITERATURE REVIEW

Problem-Based Learning

Problem-Based Learning (PBL) is an instructional learner-centered approach that encourages creative thinking on real-world problems with open-ended solutions (Hmelo-Silver, 2004; Savery, 2006). PBL originated from health sciences and is widely adopted in multiple domains education such as information systems, MBA, chemical engineering, economics (Savery, 2006). In contrast to traditional lecture approaches, PBL focuses on the learning process for the students than the answers reached (Presthus and Bygstad, 2012; Woods, 2020). In PBL, students work in small collaborative groups and should be active learners as they need to apply the concepts or tools taught in the class to solve the real-world problems. To achieve a well-developed solution, students may need to think creatively and explore some new methods learned from other related courses or outside of the courses. On the other hand, the instructor plays a role of a tutor to facilitate the students' learning in a creative manner rather than lead their works. As such, the core parts of PBL could be adopted in the new pedagogical method are: (1) providing learning materials closely related to practice to students; (2) evaluating students' performance in terms of their learning process and creativity.

Case-Based Learning

Case-Based Learning (CBL) is the approach helping students institute skills of critical thinking and synthesizing knowledge in a specific context (Pomykalski, 2014). Like PBL, CBL as a pedagogical method has been widely using in many fields. For instance, healthcare (Srinivasan et al., 2007), business intelligence (Pomykalski, 2014). Compared to instructors in PBL, instructors are more likely to be coaches who provide both systematic knowledge and expert guidance to the solution (Savery, 2006). The cases used in CBL are usually adapted from real events/entities and composed with organized structure and key elements associated with teaching. To evaluate students' knowledge gained, case study is usually conducted as an individual project or a group project after students have learned related knowledge.

Report-Oriented Learning

To adopt the advantages from both PBL and CBL, report-oriented learning (ROL) was coined as the BI course was being designed and taught. This newly pedagogical method aims to balance curriculum where students can align systematical knowledge and skills to real business practice and can conduct practical projects guided by instructor. In ROL, instructor is not only a knowledge provider (role in CBL) but also a tutor (role in PBL) facilitating students to think logically and creatively and to address practical problems through various instruments. On the other hand, in ROL, students learning is driven by report which is a form to conclude and evaluate learning outcome from both basic concept perspective and practical application perspective. In the report process, students play the role of summarizing knowledge and sharing their own outcome of addressing practical problems, while instructor is a facilitator and evaluator. This pedagogical method is necessary for BI teaching because students need to build a solid skill sets with rich BI related knowledge to solve various business problems. But the reality on teaching side is that to fully cover all BI related materials/topics in a course is impossible. Instead of focusing on teaching a large amount of new emerging knowledge and software, the ROL approach attempts to institute students' the capability of synthesizing knowledge and practical application which is comprehensively evaluated through different types of report. As such, student learning turns from test-driven learning to report-

driven learning which is more practical and close to real business environment.

The key requirement of report-oriented learning is twofold. First, all the learning objectives need to be evaluated through reports. Specifically, the content taught in the course such as basic concepts, hands-on projects, or cases should be reflected in different types of reports by students. The formats could be individual presentation, group presentation, or oral presentation and written report. When the course starts, students should be advised by instructor and well understand that all the learning activities in each module will be concluded by reports. Second, students should be guided with critical thinking and design thinking, which can not only help them think differently but also initiate their reports diversely.

3. COURSE DESIGN

A report-oriented BI course was designed for upper-level undergraduate students majoring in information systems (IS), business analytics, or information technology. As the prerequisite of this course, the core IS courses (e.g., introduction of IS, management of database systems) highly related to BI are required to be completed prior to enrolling in the course.

Learning Objectives
This course focuses on BI concepts, processes, techniques, and role of BI in enterprise decision making. After completing the course, students should understand the basic concepts of BI and its role in an organization (LO1), identify and address business problems by using BI concepts and tools (LO2), professionally report the outcome and findings of hands-on projects through different techniques (LO3).

Curricular Modules
The curricular modules consisted of three core components: (1) basic concepts and quizzes; (2) hands-on projects; (3) reports. The concepts and quizzes were lecture-based material derived from the textbook "Business Intelligence, Analytics, and Data Science: A Managerial Perspective, 4th edition" (Sharda et al., 2018) used in the course and its teaching materials. After learning the concepts in class, students were expected to acquire a basic understanding of the key concepts and were evaluated by quizzes. Hands-on projects were the cases composed by manipulated data and scenarios for teaching software application related to BI. Each hands-on project focused on addressing one or two practical questions and was taught after concepts lecture. Students were expected to not only be able to handle the software but also understand the purpose/logic of each step of the software operation. Following hands-on projects, a report session was conducted to conclude the section which consists of two to three modules. In contrast to traditional tests (e.g., multiple-choice questions), reports in this course were the approach to comprehensively evaluate students' learning outcome through a series reports with different formats. In the report session, the tasks covered both the key concepts taught in the class and hands-on projects. Each student was assigned with different questions derived from lectures and their submitted hands-on projects.

The example of report 1 instruction is provided in Appendix B.

The course design had twelve modules for a one semester schedule (i.e., fifteen weeks). Most of the modules were designed for teaching in one week. The outline of the modules with readings and assignments is listed in Appendix A. To align with the learning objectives, each module has objectives of concepts learning adopted from the chapter objectives in Sharda et al.'s textbook (2018), objectives of hands-on projects, or objectives of report.

Module 1: Overview of BI and Problem Identification

Objectives of concepts learning: Understand the need of BI and its evolution; Describe BI methodology and concepts; Understand the various types of analytics; Understand the analytics ecosystem to identify various key career opportunities.

Objectives of hands-on projects: Enable to conduct a BI project through the BADIR approach (An acronym for the five steps of data to decisions: Business Question, Analysis plan, Data collection, Derive Insights, Recommendations) (Aryng, n.d.); Enable to identify business questions through Root Cause Analysis.

Module 2: Business Intelligence and Data Warehousing

Objectives of concepts learning: Understand the basic definitions and concepts of database management systems and data warehousing; Describe the processes used in developing and managing data warehouses; Explain data warehousing operations; Explain the role of data warehouses in decision support.

Objectives of hands-on projects: Enable to create a database with Access, edit and link related tables, create and run query to merge the relational tables, and export Access database into Excel.

Module 3: Nature of Data, Statistical Modeling, and Visualization

Objectives of concepts learning: Understand the nature of data; Describe statistical modeling and its relationship to business analytics; Understand the importance of data/information visualization; Learn different types of visualization techniques.

Objectives of hands-on projects: Understand in what circumstance to use Pivot Table/Chart; Enable to create a Pivot Table/Chart by using Excel and interpret the outcomes; Understand different types of charts and dashboard; Enable to select the appropriate a chart or dashboard to convey information; Enable to create charts and dashboards with Excel.

Module 4: Report 1

Objectives of report: review and summarize the modules 1 to 3.

Module 5 to 6: Data Mining Process, Methods, and Algorithms

Objectives of concepts learning: Understand the objectives and benefits of data mining; Learn the standardized data mining processes; Learn different methods and algorithms of data mining; Build awareness of the existing data mining software tools; Understand the privacy issues, pitfalls, and myths of data mining.

Objectives of hands-on projects: Enable to conduct simple and multiple regression with Excel and interpret output; Understand classification analysis and decision tree algorithm; Enable to conduct classification analysis with WEKA and interpret outcomes; Understand clustering analysis and k-means algorithm; Enable to conduct clustering analysis with WEKA and interpret outcomes; Understand association rule analysis and market basket analysis; Enable to conduct market basket analysis with WEKA and interpret outcome.

Module 7: Report 2

Objectives of report: review and summarize the modules 5 and 6.

Module 8: Text, Web, and Social Media Analytics

Objectives of concepts learning: Understand and differentiate among text analytics, text mining, and data mining; Understand the different application areas for text mining; Understand sentiment analysis and its popular applications.

Objectives of hands-on projects: Understand the mechanism of sentiment analysis; Enable to conduct sentiment analysis with WEKA and interpret outcome; Understand Google Analytics and its terminology and features; Enable to analyze a website traffic and write a professional report based on the data from Google Analytics.

Module 9: Report 3

Objectives of report: review and summarize the module 8.

Module 10: Optimization and Simulation

Objectives of concepts learning: Understand simulation models for decision support; Describe how spreadsheets can be used for analytical modeling and solutions; Explain the basic concepts of optimization and when to use them.

Objectives of hands-on projects: Enable to conduct optimization and Monte Carlo simulation with Excel.

Module 11: Big Data, Future Trends, and Privacy in BI

Objectives of concepts learning: Understand big data and get familiar with the technologies and services for big data analytics; Understand the need and applications of stream analytics; Explore some of the emerging technologies in BI; Describe the major ethical and legal issues of BI implementation; Identify key characteristics of a successful BI professional.

Module 12: Report 4

Objectives of report: review and summarize the modules 10 and 11.

4. COURSE IMPLEMENTATION

The twelve-modules were incorporated into a one semester course (i.e., fifteen weeks). The content in each module was normally conducted in one week except the modules with the complex hands-on projects or reports, which needed extra days to be completed. The three core components (i.e., basic concepts and quizzes, hands-on projects, reports) were implemented as follows:

Basic Concepts and Quizzes
The basic concepts and corresponding quizzes were derived from Sharda et al.'s textbook (2018) and its teaching materials. In this part, teaching focused on the basic concepts in BI aligning with the structure of eight chapters in the textbook. There were one or two topics/chapters covered in each week except reporting weeks. The primary method of teaching the content were PowerPoint slides, short videos, and discussions. It is important to note that all the key concepts were demonstrated through linking real business cases, new events, or things in students' life. While introducing the concepts, students were sometimes asked to engage in the discussion of the concepts and cases with the instructor. Additionally, to facilitate students to prepare the evaluative reports, students were advised that the discussion materials in the class were highly related to the tasks in the reports. This approach not only promoted students' motivation to join in the discussion but also help them readily comprehend the concepts. Following the lecture of each topic/chapter, students were required to take a short quiz to assess the learning outcomes of the topic/chapter.

Hands-on Projects and Software Tools
The hands-on projects are the critical components for students connecting the textbook contents and real applications. Prior to assigning a hands-on project to students, a similar project was taught in the course with applying software tools. To address the problems in the hands-on projects, multiple software tools were used (see Table 1 and Appendix A). Microsoft office suite and Visio were primarily used for creating graph, charts, or tables. WEKA (https://www.cs.waikato.ac.nz/ml/weka/) is a popular open-source software developed at the University of Waikato, New Zealand. It is a collection of machine learning algorithms for data mining. WEKA was used in the hands-on projects of classification analysis, cluster analysis, market basket analysis, and sentiment analysis. Google analytics is a web analytics service offered by Google that tracks and reports website traffic. It was used for the hands-on project of writing a website traffic report for Google Merchandise Store.

The focus of hands-on projects was not only the technical skills but also the skills of well organizing and presenting the outcomes and findings. To achieve this goal, students were required to clearly demonstrate the project outcomes in the submission. More importantly, they were also asked to present their projects in the corresponding reports so that they could demonstrate both the findings from the projects and the process of thinking (e.g., how they conducted the project to address the question and why they chose the method). This requirement was similar to teaching basic concepts.

Module No.	Hands-On Projects	Tools
1	Defining Business Problems	Word/Visio
2	Creating a Database	Access
3	Pivot Table & Chart; Excel Charts & Dashboards	Excel
5	Regression	Excel
6	Classification Analysis; Cluster Analysis; Market Basket Analysis	WEKA
8	Sentiment Analysis	WEKA
8	Google Analytics	Google Analytics
10	Optimization & Simulation	Excel

Table 1. Hands-On Projects and Software Tools

Reports and Formats
The reports were designed as a mutual learning and evaluating method for benefiting both instructor and students. For the instructor, reports included the keys concepts and hands-on projects taught in the modules. For students, the reports evaluated the learning outcomes the students had done from the concepts study and hands-on projects. Each report covered corresponding modules (see Table 2) and designed with unique tasks associated with concepts and their hands-on projects for each student/group.

As the course design, the primary formats of the reports were presentation with three different formats: individual presentation, group presentation, and individual pre-recorded presentation (see Table 2). All the report formats had the similar task structure (i.e., demonstrating basic concepts, exhibiting outcomes and findings of hands-on project, and responding questions). Appendix B exhibits the detailed instructions for report 1 offered in the class. Unlike individual

presentation and group presentation, individual pre-recorded presentation required students to record their presentation and posted to Flipgrid (https://flipgrid.com), which is a video discussion platform owned by Microsoft. Students were required to post their pre-recorded videos and at least two questions on the Flipgrid before the report day. On the report day, presenters were responsible to respond to the questions raised by students or instructor after playing the video in the class.

Report	Tasks	Format
1	Module 1-3	Individual Presentation
2	Module 5-6	Group Presentation
3	Module 8	Individual Pre-Recorded Presentation
4	Module 10-11	Individual Pre-Recorded Presentation

Table 2. Reports and Formats

After presentation, each presenter was required to answer questions from other students and instructor. Through this approach, all the key concepts and outcomes of the students' hands-on projects were reviewed by the students themselves while any mistakes or incorrect illustrations in the presentation could be found and corrected by the instructor and the students.

5. DISCUSSION OF TEACHING RESULTS

This course was a new elective course offering for upper-level undergraduate students. 9 students enrolled the course who were in the major of business analytics, management information system, or information technology. 3 students responded the survey which was collected through the university's official course evaluation during the semester. For all score items on the survey, average student ratings ranged between 4.7 and 4.8 out of 5 (1 indicating "very poor" and 5 indicating "very good"). For the qualitative items, many positive comments were received and most of students appreciated the hands-on projects with using WEKA and report sections.

Comments examples were:

- "I definitely recommend this class. I struggle with confidence issues when presenting, but this class helped me excel in this area. I feel prepared to be part of a team and lead any reports in my career path!"
- "The reports helped me learn more in my opinion rather than taking a standard exam."
- "I would keep using the Flipgrid individual reports in place of the exams. Very helpful!"
- "One of the topics we covered in this course that were helpful to me was working with WEKA."
- "The excel and WEKA analysis homework assignments were very helpful to build my knowledge and skills."

In general, the course was well-received, especially in the hands-on projects and reports, which were perceived as the highlights of the course.

6. TEACHING SUGGESTIONS

Following the delivery of the course, the instructor did a self-evaluation and offers the following suggestions.

Cohere Concepts, Hands-on Projects, and Report Tasks

Integrating the basic concepts in the textbook, the techniques applied in hands-on projects, and report tasks in a whole is critical. Additional, report tasks should continue to be emphasized and drive the entire learning process. This approach could enhance students' comprehension as the key concepts and technique skills used in the hands-on projects are taught by instructor and also reviewed by students themselves through a series of report.

Engage Students in Discussion Cases Happing in Their Life

Although Sharda et al.'s textbook (2018) incorporates many business cases to facilitating teaching, it is recommended to introduce more current cases, events, or items close to students' everyday life and couple with the basic concepts in the textbook. For example, news about Tesla autonomous vehicle or Facebook. Those materials could help students understand the BI applications and implications in the business. More importantly, when demonstrating the basic concepts in the report sessions, students could use those fresh materials to enrich their presentation and raise the students' interest to join in discussing and share their viewpoints.

Maintain Open and Inclusive Criteria

Although each hands-on project has a fixed solution, it is recommended that the instructor consider open and inclusive criteria for grading students' performance. This is similar to the principle of problem-based pedagogical approach. If students used some approaches different from the solution or the techniques taught in the class, instructor would be better to investigate the alternative approach for the submission and identify if it was unsatisfied work or an attempt in exploring a new solution. Positive and constructive comments should be given to the exploratory submission even though some mistakes were found.

Furthermore, in the report-oriented BI course, students were required to present their methods and findings from hands-on projects in the report sessions. From the teaching experience, open and inclusive criteria could tremendously inspire students solving the projects with their own ideas, raise their learning interests, and prevent them from only focusing on grade points as their works match up the instructor' solution.

7. CONCLUSION

This paper introduces the report-oriented pedagogical method which has been implemented in a BI course. The paper reviews the curriculum structure and pedagogical experience of the course and provides teaching suggestions. The report-oriented BI course was taught as an elective course at a university for the upper-level undergraduate students in the majors of business analytics, information systems, and information technology. The report-oriented BI course was well received and perceived by students as having improved their thinking and skills in identifying business problems, applying BI techniques, and professional presenting their findings. The report-oriented pedagogical method also has limitations. This method is difficult to be applied in a very large size course. Given the report design, time frame of the course (90 minutes/course meeting, twice per week), and the experience of teaching this course, about 10-15 students is the ideal size for a course with report-oriented design.

Future research is called for additional adoption at both the undergraduate and graduate level. Continued delivery and modification of the report-oriented pedagogy techniques show promise to increase students' skill set in BI.

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Appendix A

Curriculum Modules

Module	Topics	Readings	Assignments
1	Overview of Business Intelligence	Textbook Ch. 1	Quiz Ch.1
	Defining Business Problems	Lecture Slides	Hands-On Project: Defining Business Problems
2	Business Intelligence and Data Warehousing	Textbook Ch. 3	Quiz Ch.3
	Creating a Database	Lecture Slides	Hands-On Project: Creating a Database
3	Nature of Data, Statistical Modeling, and Visualization	Textbook Ch. 2	Quiz Ch.2
	Pivot Table & Chart; Excel Charts & Dashboards	Lecture Slides	Hands-On Project: Pivot Table & Chart; Excel Charts & Dashboards
4	Report 1	Review Module 1-3	Individual Presentation
5	Data Mining Process, Methods, and Algorithms	Textbook Ch. 4	Quiz Ch.4
	Regression with Excel	Lecture Slides	Hands-On Project: Regression with Excel
6	Classification Analysis with WEKA	Lecture Slides	Hands-On Project: Classification with WEKA
	Cluster Analysis with WEKA	Lecture Slides	Hands-On Project: Cluster Analysis with WEKA
	Market Basket Analysis with WEKA	Lecture Slides	Hands-On Project: Market Basket Analysis with WEKA
7	Report 2	Review Module 5-6	Group Presentation
8	Text, Web, and Social Media Analytics	Textbook Ch. 5	Quiz Ch.5
	Sentiment Analysis with WEKA	Lecture Slides	Hands-On Project: Sentiment Analysis
	Google Analytics	Lecture Slides	Hands-On Project: Google Analytics
9	Report 3	Review Module 8	Individual Pre-Recorded Presentation
10	Optimization and Simulation	Textbook Ch. 6	Quiz Ch.6
	Optimization with Excel	Lecture Slides	Hands-On Project: Optimization with Excel
11	Big Data Concepts and Tools	Textbook Ch. 7	Quiz Ch.7
	Future Trends, Privacy and Managerial Considerations in Analytics	Textbook Ch. 8	Quiz Ch.8
12	Report 4	Review Module 10-11	Individual Pre-Recorded Presentation

Appendix B

Report 1 Instruction

Goal
Instead of the traditional test/exam, the report is an approach to evaluate students' knowledge learned from the course and capability utilizing the knowledge to practical applications/cases.

Content
- In the report 1 (individual presentation), your slides and presentation shall focus on addressing the questions listed in the template.
- You are encouraged to use materials from textbook and cases discussed in the class to answer the questions.

Slides
- Slides shall no more than 20 pages, including the cover page and Q&A page.
- The template provides an example of the report. You can use your own design such as background, color combination, animation, etc.
- You are required to use the same outline of content in the template. Specifically, your slides must include cover page, each chapter/assignment page, and Q&A page. The sequence of the slides must be the same as the template.
- You can add 1-3 pages for each chapter as needed.
- Slides designed in a professional style is strongly encouraged. For instance, diagram, chart, neat layout, etc.
- Slides must be submitted to Canvas by due date. Missing slides submission will incur points deduction (50% of total points).

Presentation
- You are required to present your work individually in the classroom.
- Each presentation is restricted to about 8 minutes (i.e., 6 minutes presentation, 2 minutes Q&A).
- Students in the class are encouraged to interact with presenter during the Q&A session, such as asking questions, making comments, applause etc.
- Too short (less than 3 minutes) or too long (more than 12 minutes) presentation may incur negative evaluation.
- Missing presentation on report day will incur points deduction (50% of total points) or presenting in a designated class day.
- Presentation conducted in a professional style is strongly encouraged.

Grading Rubric

Items		Criteria	Points
Slide	Concept questions	The key elements (e.g., definitions, relationships, graphs) are included in the answer and demonstrated correctly.	25
	Hands-on Projects questions	The key elements of output (e.g., graphs, tables) are included and interpreted correctly.	25
Presentation	Concept questions	The key elements (e.g., definitions, relationships, graphs) in the answer are interpreted clearly and correctly.	20
	Hands-on Projects questions	The key elements of output (e.g., graphs, tables) are interpreted clearly and correctly. The main steps of software operation are demonstrated clearly.	20
	Q & A	Respond questions correctly and clearly.	10
			100

Template Structure with Report Tasks

- Chapter 1 Overview of BI
  What is business intelligence and its purpose? What are the key components of BI? Which one do you think is the most important part for an international company to build BI?

- Hands-On Project: Defining Business Problems
  Post your fishbone diagram. Explain your thought. Why did you consider the five causes impact the sales decline? Explain your research questions.

- Chapter 3 Data Warehousing
  What is date warehouse? How does data warehouse interact with other components of BI? What are the differences among data warehouse, data mart, data lake?

- Hands-On Project: Creating a Database
  Based on the database you generated, explain what's the pattern of relational database? What type of data relational database usually cannot process? Why?