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Teaching a Report-Oriented Business Intelligence Course: A Pedagogical Experience

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ABSTRACT

As the demand for business intelligence (BI) professionals continues to grow, educators need to calibrate their instruction to accommodate the demand of practitioners for specific technical skills while also providing college students with a broader foundation that includes a general understanding of BI concepts and problem-solving skills that are applicable across disciplines. This paper describes a pedagogical method called report-oriented learning which seeks to combine the established methods of problem-based learning and case-based learning. Report-oriented learning requires students to reflect on the knowledge gained during the conceptual parts of the course and use critical thinking and storytelling skills as they prepare and present several comprehensive reports in class. We applied the report-oriented method in a business intelligence course that consists of four instructional approaches: (1) section preview, (2) lectures and quizzes on basic concepts, (3) application of concepts and development of practical skills with hands-on projects, and (4) comprehensive reflection and inquiry in the form of reports. We surveyed students with anonymous questionnaires in the report-oriented BI courses from 2021-2023. The results indicate that the method was effective and perceived by students as having improved their critical thinking and practical skills related to the application of BI techniques and the professional presentation of their findings.

Keywords: Business intelligence, Report-oriented learning, IS curriculum, Teaching tip

1. INTRODUCTION

Business intelligence (BI) refers to "a broad category of applications, technologies, and processes for gathering, storing, accessing, and analyzing data to help business users make better decisions" (Watson, 2009, p. 491). The demand for BI professionals has been growing steadily in recent years, which has had implications for information systems (IS) and information technology (IT) education (Presthus & Bygstad, 2012; Wang, 2015; Watson, 2009; Wixom et al., 2014; Wixom et al., 2011). Across the U.S., over 130 academic programs offer undergraduate and graduate degrees in BI and related areas, such as business analytics and data science (Wixom et al., 2014).

Reflecting the broad nature of the topic, BI-specific courses tend to incorporate content from multiple disciplines, including statistics, database management, management information systems, computer science, and various areas in business.

The emphases applied by instructors of BI courses vary. Some educators focus on the utilization of computerized BI tools (e.g., Microsoft Power BI, Python, SAS Enterprise Miner, Tableau; Teradata SQL; WEKA) with the intent of helping students build technical skills (Jeyaraj, 2019; Mrdalj, 2007; Zhang et al., 2020). One group of educators put more emphasis on BI-related concepts to help students understand the broader role that BI plays in business (Wang & Wang, 2019). Others seek to convey how BI operates in real-life business settings by utilizing case studies (Mitri, 2015; Pomykalski, 2015; Presthus & Bygstad, 2012).

Regardless of teaching methods used, BI education still faces challenges. It is difficult for instructors to cover enough concepts (real-time data warehousing, data mining, automated anomaly and exception detection, data visualization, etc.) in reasonable depth during the timeframe of a typical college course (Negash, 2004). Industry practitioners expect that BI graduates possess a broad set of specific technical skills that can

be readily applied upon entering the workforce (Wixom et al., 2011), which is a daunting challenge by itself given the immense number of tools and methods that are available and used in practice (Sayer & Olavsrud, 2021). In addition, students are expected to build the skill sets of storytelling and critical thinking for effectively and creatively presenting a whole picture underneath the numbers and outputs from BI applications (Knaflic, 2015). In short, the requirements of BI education make it challenging for instructors to cover the material as broadly and deeply as expected by practitioners and students across concepts, disciplines, and tools.

Many educators choose between a primary focus on concepts versus tools or on breadth versus depth, application, and critical thinking (Albrecht et al., 2009; Mrdalj, 2007; Wang & Wang, 2008, 2019; Zhang et al., 2020; Zheng et al., 2014). This paper combines the established methods of problem-based learning and case-based learning to introduce report-oriented learning as a pedagogical method for teaching BI. Report-oriented learning balances the coverage of concepts and practical applications with critical thinking, problem-solving, and comprehensive reflection. We use the term "report" in two ways. On the one hand, we refer to reports as the typical output of BI applications, which summarizes and presents the results of an analysis in a format that is conducive to user needs. Instructions on how to use the reporting functions in BI tools are part of the skills-oriented parts of our course. On the other hand, we refer to reports as comprehensive syntheses of conceptual knowledge, the output derived from utilizing BI-related software applications, and summary reflections on the course content in the form of oral and written presentations. Students prepare a report at the end of each course section, in lieu of more traditional assessments in the form of midterms or final examinations. Our goal in this paper is to provide teaching tips (Lending & Vician, 2012) for applying the report-oriented learning method in BI courses. This paper shares a classroom experience that encourages student-led learning to foster the development of critical thinking skills while also allowing for the comprehensive coverage of BI-related concepts and the acquisition of specific technical skills.

In section 2, we review the literature on problem-based learning and case-based learning and introduce the concept of report-oriented learning. We then share our experience of designing and implementing a report-oriented BI course in section 3. We conclude the paper with reflections from students in section 4, suggestions for teaching a report-oriented BI course in section 5, and an outlook in section 6.

2. LITERATURE REVIEW

Problem-based learning (PBL) and case-based learning (CBL) have long been applied in BI courses, as well as to related courses such as business analytics, to complement traditional lecture-based teaching methods (Romanow et al., 2020; Wixom et al., 2014). Both methods have strengths and limitations identified from the review of PBL and CBL. To adopt the advantages of the two methods, we introduce report-oriented learning (ROL) and compare the three methods from the perspective of instructor and students.

2.1 Problem-Based Learning (PBL)

PBL is a learner-centered instructional approach that "empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem" (Savery, 2006, p. 12). The idea is that the experience of solving ill-structured problems will help students learn both discipline-specific content and thinking strategies at the same time (Hmelo-Silver, 2004). PBL first became popular in medical education in the middle of the 20th century when it was viewed as a way to address an explosion of medical information and emerging new technologies that rendered ineffective traditional teaching methods which usually combine science lectures with clinical teaching (i.e., application of the lecture-based content) (Barrows, 1980). The approach was expected to promote "student-centered, multidisciplinary education and lifelong learning in professional practice" (Boud & Feletti, 1997, p. 2) in a field that "relied on a combination of a hypothetical-deductive reasoning process and expert knowledge" (Savery, 2006, p. 10). PBL has since been adopted in a variety of content domains outside the medical field, including chemical engineering, architecture, teacher education, business administration, and economics (Savery, 2006).

In contrast to a traditional approach that conveys knowledge through lectures followed by specific problem applications and tests, PBL applies a "systematic and highly sequenced approach to simultaneously learning the knowledge of a domain and the skills and practices of a discipline through problem-solving activities" (Tawfik & Kolodner, 2016, p. 9). The steps to be followed (Barrows, 1980) include: (1) a problem (preferably ill-structured, possibly inter-disciplinary) is presented to students as the starting point of learning; (2) students work in small groups to develop an initial diagnosis with existing knowledge; (3) students collectively identify gaps in understanding then individually explore resources, skills, and knowledge necessary to fill the gaps; and (4) students reconvene to discuss what they learned, what questions are still open, and to generate viable solutions. The learning activities repeat until the students and instructor are satisfied with the results.

PBL applies open inquiry and focuses more on the process of student learning rather than on getting specific and pre-defined answers (Presthus & Bygstad, 2012; Woods, 2020). Students are encouraged to be active learners as they collaboratively and individually investigate and apply concepts and tools to solve real-world problems. Students take responsibility for leading and directing their research, analysis, and discussions. To develop viable solutions, students may need to think creatively, explore and apply methods learned in the current or other related courses, obtain additional data, and apply personal experience and concepts from outside of their coursework. PBL occurs in a low-control environment in which the instructor takes on the role of a tutor-facilitator who guides student learning with a focus on the "development of problem-solving skills, self-directed learning skills, and teamwork/collaboration skills" (Savery, 2006, p. 15). The instructor does not actively direct student work by providing knowledge that is specific to the problem at hand, outlining the steps needed to arrive at a pre-defined solution, or correcting incorrect steps (Table 1). An instructor-led closing analysis, as well as self- and peer-assessment at the conclusion of the assignment, is seen as critical, as is the assessment of student learning related to both discipline-specific knowledge and the problem-solving process (Savery, 2006). In addition to providing students with problem-solving skills, PBL can be an

effective method to prepare students for conventional tests of knowledge and engage students in learning (Savery, 2006). In addition to learning discipline, students are guided to recognize and value the contributions of others that enable them to perform their tasks effectively. This process also helps students develop skills in collaboration and communication (Tawfik & Kolodner, 2016).

However, PBL also faces challenges. Adoption in public education has been met with concerns because of the non-traditional setup that does not typically result in the "uniform product" that is developed in a more traditional, highly structured classroom (Savery, 2006). Moreover, PBL itself requires practice and is not always implemented competently, which can lead to ineffective results (Tawfik & Kolodner, 2016).

A basic assumption of PBL is that students will eventually learn from their errors and acquire discipline-related knowledge as well as problem-solving skills. It has been shown to be a good method to encourage students' lifelong learning, curiosity, and practice skills. However, it is not a particularly time- or resource-efficient approach and can be ill-suited for a course setting that is restricted by time limitations in combination with specific content expectations (Tawfik & Kolodner, 2016). To shorten the students' learning curve and the time needed to complete the entire set of PBL-related steps, instructors may choose to present specific example problems with practical solutions to the students after instruction (Tawfik & Kolodner, 2016). In this situation, the main emphasis is on problem-solving and content application. Comparatively less time is reserved for collaborative sensemaking and reflection built on several iterations of digesting and rethinking content, hypotheses, results, and the learning process, which are considered critical steps of PBL (Tawfik & Kolodner, 2016). Research has shown that the various shortcuts and a reduced variety of problem cases throughout a student's curriculum can undermine the results typically expected of PBL (Tawfik & Kolodner, 2016). Students might not fully acquire the motivation or skills to think deeply about the root of a problem, explore new knowledge areas, and apply learned insights to problems in different environments. The same is true for a reduction of individualized interaction between an instructor and their students in settings where resource constraints do not allow for the small class sizes typically associated with PBL. Students might become frustrated in large classes (e.g., more than 20 students) when instructors can no longer tailor their advice to the needs of individual learners and groups that each may apply different methods to address the problem at hand (Srinivasan et al., 2007).

2.2 Case-Based Learning (CBL)

CBL applies a more structured approach to learning in small groups than PBL. It uses guided inquiry and focuses on helping students develop critical thinking skills and synthesizing knowledge in a specific context that is provided and controlled by the instructor (Pomykalski, 2015; Srinivasan et al., 2007). Like PBL, CBL has been applied in health education (Srinivasan et al., 2007) and business intelligence education (Pomykalski, 2015), among other contexts. In CBL, students are provided with the specific content of an instructor-selected example case. Through the process of inquiry and solving the problems that are presented in the case, students are trained to label their experience in memory and subsequently apply the knowledge gained from solving previous problems to new situations that they are presented with (Tawfik & Kolodner, 2016).

	Problem-Based Learning (PBL)	Case-Based Learning (CBL)	Report-Oriented Learning (ROL)
Initial Topic	Instructor: full case disclosure	Instructor: full case disclosure	Instructor: full case disclosure
	Students: unknown	Students: general content disclosed	Students: general content disclosed
Preparation	Instructor: lots of advance preparation	Instructor: lots of advance preparation	Instructor: lots of advance preparation
	Students: no advance preparation	Students: some advance preparation	Students: some advance preparation
Control	Instructor: provides no direction	Instructor: provides some direction	Instructor: provides some direction
	Students: direct discussion	Students: provide some direction	Students: direct discussion
Data-seeking	Instructor: some additional data-seeking	Instructor: no additional data-seeking	Instructor: no additional data-seeking
	Students: lots of additional data-seeking	Students: some additional data-seeking	Students: lots of additional data-seeking

Table 1. Comparison of Teaching Methods (PBL vs. CBL vs. ROL) (Adapted from Srinivasan et al., 2007)

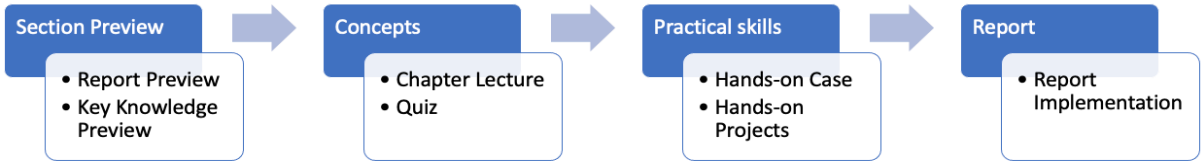

Figure 1. Report-Oriented Learning Process

The cases used in CBL are usually adapted from real-life events and entities and, in contrast to PBL, presented with a clear structure and specified teaching and learning goals. Case studies are typically assigned after students have been taught related concepts and can, thus, help deepen and assess student learning. As described by Pomykalski (2015) and Srinivasan et al. (2007), CBL is built on intensive preparation by both the instructor and the students. Instructors select cases with specific learning objectives in mind, while students are typically asked to read the case closely in order to identify key issues, major players, and important facts or scenarios, often in conjunction with various other pre-case assignments. The main part of CBL is the case discussion when students participate and listen, contribute ideas, and build on each other's comments and contributions. Prompted and guided by the instructor, the discussion continues until the key elements are integrated and solutions are developed. The learning experience concludes with a post-case analysis, e.g., a reflective report.

In contrast to PBL, where instructors play a minimal role during student discussions, CBL requires instructors to act more as coaches who provide both conceptual knowledge and guidance to help students solve the problems presented in the case and develop pre-defined solutions (Savery, 2006). Both the instructor and the students take responsibility to determine the direction and the path of the learning process (Srinivasan et al., 2007). When students get off track, the instructor uses guiding questions to redirect the focus and ensure that the main learning objectives are covered, which does not happen in PBL (Table 1). Compared to PBL, CBL tends to be more time-efficient and structured and keep students focused on key learning outcomes (Tawfik & Kolodner, 2016). According to Srinivasan et al. (2007, p. 75), it "still encourages debate discussion, and exploration of ambiguity while providing more structure for the learner in an efficient goal-directed manner." Instructors provide guidance by correcting incorrect assumptions of the learners and moderate participation of the students during the discussion and learning process. CBL is applicable for BI teaching as it can bring BI concepts to life and demonstrate the applicability of concepts more effectively than lecture-based instruction can (Pomykalski, 2015), while also allowing for skill-based learning and the integration of specific tools.

In practice, however, CBL also faces limitations. First, CBL depends much on the availability of well-developed cases and skilled instructors who guide students through the case questions and development of the predefined solutions. The risk is a heavy focus on lectures rather than the facilitation of student-led learning. Second, CBL does not offer an open environment like PBL to allow for student-led exploration and the development of individual case solutions. Even though CBL typically assumes guidance by the instructor to help students understand what happened in the case and analyze why it happened and how the problems were solved, the method might stifle curiosity and encourage a "spoon-feeding mentality of learners" (Srinivasan et al., 2007, p. 75).

2.3 Report-Oriented Learning (ROL)

We developed ROL with the intent to take advantage of the strengths of both PBL and CBL in a BI course while limiting the downsides. The method aims to provide students with BI-related conceptual knowledge as well as practical skills and have them apply both to solve real-world business problems in a self-directed manner. Reports are used to solidify and assess student learning of concepts and practical applications. The learning process consists of four parts: section preview, concepts, practical skills, and report (Figure 1).

Each section begins with a preview, during which the instructor provides a brief overview of the key concepts to be covered during the following weeks and puts the content into context by outlining the relationships between the concepts. To manage expectations, the instructor also provides information about the report and emphasizes its importance as the final deliverable to assess student learning. The report information may include but is not limited to report format, schedule, tasks, and evaluation rubric.

During the second part of each section, a traditional approach to teaching is applied with a focus on Bloom's taxonomy levels one and two (i.e., remember and understand) (Krathwohl, 2002). The fundamental concepts of the section are presented with lectures, followed by an assessment of student learning that is based on quizzes or tests. The goal of the second part is for students to establish a knowledge base of the key concepts and develop an understanding of the bigger picture and context that the concepts are a part of.

Hands-on cases and projects comprise the third component with a focus on Bloom's taxonomy levels three and four (i.e., apply and analyze) (Krathwohl, 2002). Building on the systematic knowledge that students acquired during the previous parts, we now emphasize practical skills and the application of concepts with the goal of developing students' ability to answer relevant business questions. When teaching hands-on cases, the instructor acts as a knowledge provider (similar to the role of the instructor in CBL) who explains the background of the case and guides the students in their application of specific tools to solve business problems. Following an initial example case, students are given similar hands-on projects as independent assignments. At this moment, the instructor starts acting more as a tutor (similar to the role of the instructor in PBL) who facilitates logical and creative thinking among the students. Guided by the instructor's feedback, students identify limitations and issues in their solutions and are encouraged to explore new tools and methods

to resolve the problems. At this stage, the instructor may or may not have a predefined solution for the hands-on projects.

Report is the last step of the ROL process. The students' case reflections and their solutions to the hands-on projects become the main parts of the report, which is subsequently developed and implemented as part of the final learning component. The format of the reports varies and includes individual presentations, group presentations, written reports, etc. Just like in PBL, the students take the lead when they review the hands-on case as necessary and control the direction of exploring new skills and methods to develop solutions for the hands-on projects. The reports provide a concentrated outlet for the material covered during the former steps and seek to apply levels five and six in Bloom's taxonomy (i.e., evaluate and create) (Krathwohl, 2002). Students are asked to summarize the knowledge they acquired in part two, reflect on the key takeaways and lessons learned from the hands-on case, and share the methods and solutions they developed for the hands-on projects (Table 1).

There are two important requirements to keep in mind when applying the ROL method. First, the assessment of student learning that is based on the reports should be comprehensive. This means that the key course content, including basic concepts, hands-on projects, and cases should be included and reflected in the various report assignments. To manage expectations early on, students are made aware of the fact that the learning activities in each course section conclude with a report as described above. Second, the instructor should make an effort to help students build analytical, critical thinking, and story-telling skills when applying a variety of approaches to developing the reports.

The ROL method is applicable to BI teaching because it allows students to develop solid skill sets that include rich BI-related knowledge and prepares them to solve various business problems. From the perspective of the instructor, it is impossible to cover the full spectrum of BI-related material and topics in a single course at a reasonable depth. So, instead of trying to include as many BI-related concepts and emerging software tools as possible, the ROL approach seeks to provide students with the ability to synthesize knowledge and practical applications of BI-related concepts and present the learning outcomes in the form of reports. Test-driven learning is replaced with report-driven learning, which is more practical and closer to real business environments.

2.4 Comparison of the Teaching Methods

To compare how the applied content of the course modules is handled in ROL versus PBL and CBL, we follow Srinivasan et al. (2007)'s approach and apply the four dimensions of initial topic, preparation, control, and data-seeking from the perspectives of the instructor and the students (Table 1).

Initial topic relates to how the content of a case is first disclosed during the course module. While in all three methods the instructor is expected to familiarize themselves with the content of the case, the expectations for the students vary. Given the nature of PBL (i.e., student-driven learning), students start without being provided with intensive background knowledge when first identifying the problems and exploring approaches and resources for problem-solving. In contrast, students in CBL and ROL settings are provided with some background knowledge by the instructor to help jumpstart the learning process.

The preparation stage is also similar across methods from the instructor's perspective. The instructor usually spends a significant amount of time upfront to prepare the case or problem together with the relevant material. The preparation requirements for students again differ between the three methods. In PBL, no advance preparation is required for the students. With all students starting at the same level of preparation, the students are given time to struggle, explore, and eventually solve the problem. In contrast, CBL and ROL both require students to prepare the case in advance, so that the teaching process can keep the focus on the main learning objectives and be conducted in a time-efficient way.

Control of the discussion and learning activities also distinguishes the learning methods. In PBL, students direct the discussion and their learning without direct control by the instructor. Even when students lose focus during the learning process, the instructor keeps a hands-off approach and maintains an open inquiry learning environment where students are free to explore any knowledge or techniques that can help them figure out their unique solutions to answer their questions. In contrast, instructors in CBL and ROL assert more control and guidance throughout the learning process to ensure that the key learning objectives are fully covered.

Differences between the methods are also reflected in relation to data-seeking. In both PBL and ROL, students are encouraged to seek additional data to extend their views and skills learned in the course to real-life scenarios. The goal is to help students gain experience in solving problems under self-guidance. In CBL, the main goal of the method is for students to develop a deep understanding of the specific case that can then be stored in memory and applied to similar situations in the future. Students are usually not expected to seek a large amount of extra resources during the process of a case study.

To further demonstrate the ROL, we share our experience of designing and implementing a ROL-based BI course in the following section.

3. COURSE DESIGN AND IMPLEMENTATION

3.1 Course Design

The course was designed for upper-level undergraduate students with a major or minor in IS, business analytics, or IT. Prerequisite courses include Introduction to IS and Database Management Systems.

3.1.1 Learning Objectives. The course focuses on BI concepts, processes, techniques, and the role of BI in enterprise decision-making. After completing the course, students are expected to understand basic concepts of BI and its role in an organization (LO1), be able to identify and address business problems by using BI concepts and tools (LO2), and professionally report the outcome and findings of hands-on projects using a variety of techniques (LO3).

The objectives are aligned with Bloom's taxonomy (Krathwohl, 2002), an approach that is widely used in education and that categorizes student learning according to two dimensions: types of knowledge and cognitive processes. The four types of knowledge include factual knowledge, conceptual knowledge, procedural knowledge, and meta-cognitive knowledge, while the six cognitive processes include (from low to high) remember, understand, apply, analyze, evaluate, and create. Each combination of the two dimensions indicates an

Sections	Modules	Objectives
1	1: Overview of BI and Problem Identification	Concepts: Describe the need for BI, BI evolution, and BI methodology; Describe the various types of analytics and the analytics ecosystem to identify various key career opportunities. Hands-on projects: Conduct a BI project using 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.); Identify business questions through Root Cause Analysis.
	2: Business Intelligence and Data Warehousing	Concepts: Describe the basic definitions and concepts of database management systems and data warehousing; Describe the processes used to develop and manage data warehouses; Explain data warehousing operations; Explain the role of data warehouses for decision support. Hands-on projects: Create a database with Access; Edit and link related tables; Create and run queries to merge relational tables; Export an Access database into Excel.
	3: Nature of Data, Statistical Modeling, and Visualization	Concepts: Describe the nature of data, statistical modeling, and its relationship to business analytics; Describe the importance of data/information visualization; Apply different types of visualization techniques. Hands-on projects: Know when to apply Pivot Table/Chart; Create a Pivot Table/Chart by using Excel and interpret the outcomes; Describe different types of charts and dashboards; Select the appropriate chart or dashboard to convey information; Create charts and dashboards with Excel.
	4: Report 1	Report: Make a report to synthesize modules 1 to 3.
2	5 to 6: Data Mining Process, Methods, and Algorithms	Concepts: Describe the objectives and benefits of data mining; Apply standardized data mining processes; Apply current methods and algorithms of data mining; Describe current data mining software tools; Describe privacy issues, pitfalls, and myths of data mining. Hands-on projects: Conduct simple and multiple regression with Excel and interpret the output; Explain classification analysis and the decision tree algorithm; Conduct classification analysis with WEKA and interpret the outcomes; Explain clustering analysis and the k-means algorithm; Conduct clustering analysis with WEKA and interpret the outcomes; Explain association rule analysis and market basket analysis; Conduct market basket analysis with WEKA and interpret the outcome.
	7: Report 2	Report: Make a report to synthesize modules 5 and 6.
3	8: Text, Web, and Social Media Analytics	Concepts: Differentiate text analytics, text mining, and data mining; Understand the application areas for text mining; Understand sentiment analysis and its popular applications. Hands-on projects: Understand the mechanism of sentiment analysis; Conduct sentiment analysis with WEKA and interpret the outcome; Explain Google Analytics, including its terminology and features; Analyze website traffic and write a professional report based on the data from Google Analytics.
	9: Report 3	Report: Make a report to synthesize module 8.
4	10: Optimization and Simulation	Concepts: Explain 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. Hands-on projects: Conduct optimization and Monte Carlo simulation with Excel.
	11: Big Data, Future Trends, and Privacy in BI	Concepts: Explain big data and be familiar with the technologies and services for big data analytics; Explain the need and applications of stream analytics; Explore emerging technologies in BI; Describe major ethical and legal issues of BI implementation; Identify key characteristics of a successful BI professional.
	12: Report 4	Report: Make a report to synthesize modules 10 and 11.

Table 2. Objectives of the Modules

educational goal with respect to the type of knowledge and how deeply the knowledge should be processed.

In our course design, LO1 and LO2 target factual knowledge, conceptual knowledge, and procedural knowledge, which need to be processed from the remember level to the analyze level and are reflected by quizzes and hands-on projects demonstrated in the following sections. LO3 mainly focuses on conceptual knowledge, procedural knowledge, and meta-cognitive knowledge. Based on LO1 and LO2, students synthesize (i.e., evaluate and create) the knowledge and reflect on their understanding with a series of reports.

3.1.2 Curricular Modules. The BI course covers twelve modules that are grouped into four sections. Each section consists of two or three modules of closely related topics. The topics include BI evolution, initiating BI projects, database management, data analysis, data visualization, and BI future trends. In alignment with these high-level learning objectives, each module has specific learning objectives related to the concepts that are adopted from the textbook (Sharda et al., 2018) and the practical cases (i.e., hands-on projects). Each section concludes with a report that serves as a comprehensive assessment (Table 2). Appendix A provides an outline of the modules with readings and assignments.

3.2 Course Implementation

The twelve modules of the ROL-based BI course were covered in one semester (i.e., about fifteen weeks). Most modules took

about one week, except for the modules that included the complex hands-on projects or reports, which needed extra days. Each section was implemented with the four steps shown in Figure 1.

3.2.1 Section Preview. On day 1 of each section, the instructor provided a brief overview of the key concepts to be covered during the following weeks, the relationships between the concepts, assignments, and reports, and outlined how to assess student learning at the end of the section. We found it to be important to provide students with clear information about what would happen during the following weeks. We observed that the students' study tended to be driven by the report and students allocated more time to the concepts and skills that are covered in the report.

3.2.2 Basic Concepts and Quizzes. The basic concepts and corresponding quizzes were primarily derived from Sharda et al. (2018)'s textbook. Teaching focused on basic BI concepts and followed eight chapters in the textbook. Each module covered one or two topics or chapters, which were taught using PowerPoint presentations, short videos, and discussions. All the key concepts were illustrated with links to real business cases, news, and relevant events in students' lives. During the introduction of the concepts and cases, students were asked to engage in the discussion. In addition to pointing out that the discussions helped students prepare for the development of the reports, students were also advised that the content of the in-class discussions might be part of the section report. This approach not only increased students' motivation to participate in the discussions but also helped them comprehend the concepts. Following the lecture of each topic/chapter, students took a short quiz to assess the learning outcomes of the topic/chapter.

3.2.3 Hands-on Projects and Software Tools. Hands-on projects followed the lectures and included a case that focused on one or two practical questions related to the module concepts. The hands-on projects included data and scenarios that were set up for the teaching of BI-related software applications. Students were expected to know how to handle the software as well as to understand the purpose and logic of each step of the operation. Prior to assigning a hands-on project, a similar project/case was taught in the course, which included the application of one or several software tools (Table 3). The Microsoft Office Suite and Visio were used to create graphs, charts, and tables. In addition, we introduced WEKA (https://www.cs.waikato.ac.nz/ml/weka/), a popular open-source software suite that was developed at the University of Waikato, New Zealand and includes a collection of machine learning algorithms for data mining. WEKA was used for classification analysis, cluster analysis, market basket analysis, and sentiment analysis. We also introduced Google Analytics, a web analytics service offered by Google that tracks, analyzes, and reports website traffic.

By working through given cases, students labeled and incorporated the experience into their memory. When facing a new, yet similar hands-on project, students could retrieve the experience from the cases and apply the experience to the new scenario. The focus of the hands-on projects was not only on the technical skills required to solve the problems but also on the skills required to organize the outcomes and present the findings. Subsequently, students were also asked to summarize the outcomes of the hands-on projects in the corresponding report at the end of the section.

Module Number	Hands-On Projects	Tools
1	Defining Business Problems	Word/Visio
2	Creating a Relational 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 3. Hands-on Projects and Software Tools

3.2.4 Reports. After working through the concepts and hands-on projects, students prepared a report in lieu of a traditional midterm or final examination (e.g., multiple-choice, open-ended questions) at the end of the section. As a comprehensive assessment of student learning, each report covered both the key concepts and the hands-on projects that were included in the section. To ensure comprehensive coverage of the concepts, students were assigned individual questions and problems that were derived from the lectures and the hands-on projects covered throughout the section.

We used four different formats for the reports: individual presentations, group presentations, individual pre-recorded presentations, and written reports (Table 4). The format of the reports could be adjusted, depending on the size of the class or the content being covered. All report assignments had a similar task structure that included summarizing basic concepts, describing outcomes and findings of hands-on projects, and answering questions. An example of the instructions for Report 1 is provided in Appendix B. For the pre-recorded presentations, students were asked to post their contributions to Flipgrid (https://flipgrid.com), a video discussion platform developed and maintained by Microsoft. In addition to their pre-recorded videos, students also posted at least two questions before the due date. When conducting the report, the presenters played videos in class then answered the questions raised by their classmates and the instructor.

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	Written Report/Presentation

Table 4. Reports and Formats

Question Statement Describe your progress on:	No Apparent Progress	Slight Progress	Moderate Progress	Substantial Progress	Exceptional Progress	N	Average Rating
Gaining a basic understanding of the subject (e.g., factual knowledge, methods, principles, generalizations, theories)	0	0	1	10	9	20	4.40
Learning to apply course material (to improve thinking, problem solving, and decisions)	0	0	2	10	8	20	4.30
Developing specific skills, competencies, and points of view needed by professionals in the field most closely related to this course	0	0	2	9	9	20	4.35
Acquiring skills in working with others as a member of a team	0	1	4	8	7	20	4.05
Developing creative capacities (inventing; designing; writing; performing in art, music, drama, etc.)	0	2	2	9	7	20	4.05
Developing skill in expressing myself orally or in writing	0	0	3	7	10	20	4.35
Learning how to find, evaluate, and use resources to explore a topic in depth	0	0	4	7	9	20	4.25
Developing ethical reasoning and/or ethical decision making	1	1	2	7	9	20	4.10
Learning to analyze and critically evaluate ideas, arguments, and points of view	2	0	1	6	11	20	4.20
Learning appropriate methods for collecting, analyzing, and interpreting numerical information	1	0	0	8	11	20	4.40

Scale: 1=No Apparent Progress; 2=Slight Progress; 3=Moderate Progress; 4=Substantial Progress; 5=Exceptional Progress

Table 5. Evaluation of Learning Skills (2021-2023)

The reports were designed to ensure a review of all key concepts and outcomes of the hands-on projects. The question-and-answer format was helpful to identify mistakes and incorrect interpretations in the presentations and offer corrections by the instructor and the students.

4. COURSE ASSESSMENT

The BI course with the ROL design was developed as an elective course for upper-level undergraduate students with majors or minors in IS, IT, or business analytics. To assess the overall effectiveness of the course, we followed Zadeh et al. (2021)'s method for course evaluation. We surveyed students with anonymous questionnaires that included 5-point Likert scale questions and qualitative open-ended questions.

Table 5 summarizes the progress on the primary skills that students reported between 2021 and 2023. Students expressed that the course helped them gain a basic understanding of BI concepts (4.40), learn to apply course materials to improve problem-solving (4.30), analyze and interpret data (4.40), and express viewpoints orally and in writing (4.35). Altogether, this implies that students benefit from the BI course.

The qualitative items in the survey asked students to comment on the topics (i.e., the modules listed in Table 2) and assignments (i.e., quizzes, hands-on projects listed in Table 3; reports listed in Table 4) that they felt were useful/not useful, as well as to provide suggestions for improvement related to the course or instructor. Many students' comments confirmed the results in Table 5. Most students appreciated the hands-on projects, in particular WEKA, and the reports. In contrast, the more traditional course components, including the lectures and readings were not favored by the students. Some students commented:

"*I learned 99% of the course material through reports and hands-on assignments, not lectures and reading. The work really took all the seemingly obscure concepts in the book and fit them into real-world situations. For instance, terms like 'Sentiment Analysis' initially appeared difficult but I've since realized just how common this is (e.g., keywords in Google reviews).*"

"*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!*"

Question Statement The Course: On the next two items, compare this course with others you have taken at this institution.	Much Less than Most Courses	Less than Most Courses	About Average	More than Most Courses	Much More than Most Courses	N	Average Rating
Amount of coursework	0	2	17	1	0	20	2.95
Difficulty of subject matter	0	2	17	1	0	20	2.95
For the following items, choose the option that best corresponds to your judgment.	Definitely False	More False than True	In Between	More True than False	Definitely True	N	Average Rating
As a rule, I put forth more effort than other students on academic work.	0	1	3	10	6	20	4.05
I really wanted to take this course regardless of who taught it.	0	1	5	8	6	20	3.95
When this course began I believed I could master its content.	0	0	5	7	8	20	4.15
My background prepared me well for this course's requirements.	0	1	6	5	8	20	4.00
Overall, I rate this instructor an excellent teacher.	0	0	0	5	15	20	4.75
Overall, I rate this course as excellent.	0	0	1	3	16	20	4.75

Scale: 1=Much Less than Most Courses/Definitely False; 2=Less than Most Courses/More False than True; 3=About Average/In Between; 4=More than Most Courses/More True than False; 5=Much More than Most Courses/Definitely True

Table 6. Evaluation of Course and Instructor (2021-2023)

"*Reports were definitely the most helpful because it requires the student to interpret the material and present it themselves. Rather than just memorize, the student is required to research and present class material to demonstrate their understanding of the topic. This along with the instructional assignments are helpful to help students fully grasp the course without the pressures of the usual basic memorization that comes with test taking.*"

"*The Excel and WEKA analysis homework assignments were very helpful to build my knowledge and skills.*"

Table 6 shows the results of several questions related to the level of difficulty and workload in relation to other courses at the university. Ideally, the responses to these questions stay close to the middle (i.e., 3.00) to avoid student bias that easy courses are labeled as low quality and hard courses are labeled as high quality or vice versa. Table 6 also provides the overall evaluation of the course and instructor (4.75).

The quantitative and qualitative feedback from the students indicated that the ROL-based BI course was effective and provided a good learning experience for the students regarding concept knowledge and practical skills.

5. TEACHING SUGGESTIONS

Based on the experience of teaching the course over the last three years, we share the following suggestions.

5.1 Integrate Concepts, Hands-on Projects, and Report Tasks

Integrating the basic concepts from the textbook with the techniques applied in the hands-on projects and the tasks assigned in the reports is critical. The specific tasks and questions included in the reports may need to be emphasized more than once during class and should drive the entire learning process. Ideally, student comprehension is initiated during the instruction of the key concepts and demonstration of the technical skills that are applied in the hands-on projects and later reviewed and deepened by the students themselves during the development and presentation of the reports.

5.2 Engage Students in Discussion Cases Happening in Their Life

Although Sharda et al.'s (2018) textbook incorporates many business cases that are helpful to facilitate teaching, we recommend complementing the textbook material with more current cases, events, and items that are immediately applicable to students' everyday lives. The added material will help students develop a deeper and more comprehensive understanding of BI applications and their implications for businesses. More importantly, when demonstrating the basic concepts in the report sessions, students can use the more current material to enrich their presentations and raise all students' interest to join in discussing and sharing their viewpoints.

5.3 Maintain Open and Inclusive Criteria

We recommend that the instructor consider open and inclusive criteria for grading students' performance. This approach corresponds with the principles underlying the PBL. If students use approaches that are different from the approaches used to derive the model solution or apply techniques that were not taught in class, the instructor should investigate the alternative approaches and assess not only the quality of the result but also the efforts made by the students to develop a new solution. Positive and constructive comments should be provided, even if some mistakes were found.

In our sections, students were required to present their methods and findings from the hands-on projects in the report sessions. From students' feedback, we found that open and inclusive grading criteria can tremendously inspire students to

solve hands-on projects with their own ideas, raise their learning interests, and prevent students from focusing solely on matching their work with the instructor's model solution.

6. CONCLUSION

This paper introduced a report-oriented pedagogical method that has been implemented in a BI course. It described the curriculum structure and pedagogical experience of the course and provided teaching suggestions. The report-oriented BI course was well received and perceived by students as having improved their critical thinking, technical skills, and storytelling skills in identifying business problems, applying BI techniques, and professionally presenting their findings.

The report-oriented method also has limitations. Most notably, it is difficult to apply the concept in a larger course. Based on the instructor's experience of teaching the course, the current approach with individualized report assignments and twice weekly course meetings of 75 minutes appears to be ideal for a class size of 10-15 students. Moreover, the group reports as one of the formats evaluating students' performance in the report section may enable free riders. We think continued review and adjustments of the report-oriented learning approach promise further improvements in students' BI skills.

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APPENDICES

Appendix A. Curriculum Modules

Sections	Modules	Topics	Readings	Assignments
1	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
2	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
3	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
4	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. Example: Report 1 Instruction

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

Content
- In Report 1 (individual presentation), your slides and presentation shall address the questions listed in the template.
- You are encouraged to use material from the textbook and cases discussed in class to answer the questions.

Slides
- Slides shall be 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, including background, color combination, animation, etc.
- You are required to follow the content outline that is provided in the template. Specifically, your slides must include a cover page, each chapter/assignment page, and Q&A page. The sequence of the slides should be consistent with the template.
- Add 1-3 pages for each chapter, as needed.
- Slides designed in a professional style are strongly encouraged. Add diagrams and charts and aim for a neat layout, etc.
- Slides must be submitted to Canvas by the due date. A missing slide submission will incur a deduction of points (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 the presenter during the Q&A session, such as asking questions, making comments, applause, etc.
- Presentations that are too short (less than 3 minutes) or too long (more than 12 minutes) may result in a negative evaluation.
- Missing presentation on report day will result in a deduction of points (50% of total points)

Grading Rubric

Items		Criteria	Points
Slides	Concept questions	The key elements (e.g., definitions, relationships, graphs) are included in the answer and demonstrated correctly.	25
	Hands-on project 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) that are included 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	Responses to questions are correct and clear.	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 a data warehouse? How does a data warehouse interact with other components of BI? What are the differences between a data warehouse, data mart, and data lake?
- Hands-On Project: Creating a Database
  Based on the database you generated, explain the pattern of a relational database. What kind of data is difficult to process with a relational database? Why?

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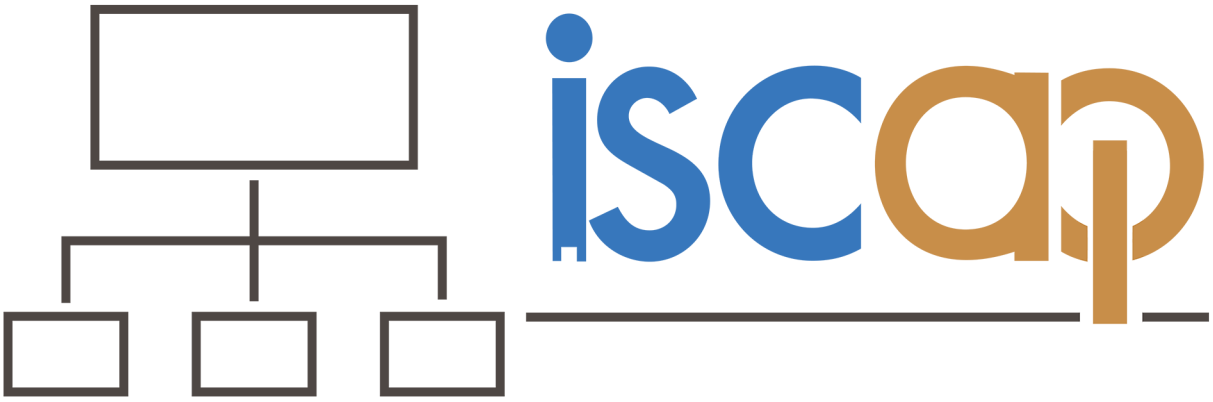

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