Teaching Tip
Active Learning via a Sample Database: The Case of Microsoft's Adventure Works

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ABSTRACT

This paper describes the use and benefits of Microsoft's Adventure Works (AW) database to teach advanced database skills in a hands-on, realistic environment. Database management and querying skills are a key element of a robust information systems curriculum, and active learning is an important way to develop these skills. To facilitate active learning and produce a compelling narrative, the data structure and content of a useful pedagogically-oriented database should be realistic and lifelike. It should contain data that accurately depicts the business processes, functions, and entities of a realistic organization, structured in a way that demonstrates best practices in database design. Most database textbooks include sample databases, but these are often small and sparse of data. By contrast, Microsoft's AW database presents a robust, realistic, and comprehensive framework for many important educational objectives in an IS curriculum. This paper introduces the AW business case and database, and illustrates several pedagogical uses in an undergraduate CIS program.

Keywords: Business intelligence, Case study, Active learning, Problem based learning (PBL), Database management systems (DBMS), Data warehouse, Data mining, Extensible markup language (XML)

1. INTRODUCTION

This article presents Microsoft's Adventure Works (AW) business case and database as a pedagogical tool for providing many active learning opportunities to students in advanced database, business intelligence, and application development classes. The paper begins with a literature review of active learning (especially using cases) in IS pedagogy. It then argues that a case which includes an actual physical database (assuming the database is well designed and has a reasonably large volume of data) enhances the student experience with the case. After this, the Adventure Works case is described, followed by a description of the transaction database and the data warehouse of AW.

Next comes a set of advanced active learning exercises that make use of AW's case and databases. These exercises include:

1. reverse engineering to a conceptual model from analysis of the database,
2. implementing security techniques in application development,
3. combining advanced SQL queries with XML queries,
4. balanced scorecard dashboard construction,
5. data integration,
6. online analytical processing (OLAP),
7. data mining, and
8. e-commerce application development.

Finally, the paper discusses lessons learned using Adventure Works in two different advanced IS courses, and presents results from a student opinion survey of AW as a learning experience.

2. CAN DATABASES ENHANCE THE ACTIVE LEARNING CASE EXPERIENCE?

The term "active learning" is very broad and has been defined in many ways. These definitions characteristically focus on student engagement and typically involve problem solving, discussion, and/or writing. The active learning we focus on in this paper is often called problem-based learning (Savery and Duffy, 1995). In terms of Bloom's hierarchy of skills (Bloom et al., 1956), problem-based learning tends to focus on applying, analyzing, evaluating, and creating over recall and understanding. This paper argues that use of Microsoft's Adventure Works case and database facilitates active learning experiences and fosters these higher-level skills, thereby bringing value to a technical IS curriculum.

2.1 Active Learning for Information Systems Pedagogy

The importance and efficacy of active learning is well documented in the information systems pedagogy literature.

Teaching techniques and projects in IS education include problem-based active learning experiences in e-Commerce (Abrahams and Singh, 2010; Gricar, Pucihar, and Lenart 2005), computer programming (Zhang et al., 2013), system implementation capstone projects (Mitri, 2008), role play exercises (Kerr, Troth, and Pickering, 2003; Mitri and Cole, 2007), and information security projects (He et al., 2014). In addition to traditional face-to-face classroom settings, active learning methods have also been used and tested in online environments (Koohang and Paliszkiewicz, 2013; Paetzold and Melby, 2008). Various software technologies facilitate the richness of the active learning experience. For example, He et al. (2014) use workflow technologies, and Williams and Chinn (2009) use Web 2.0.. This paper argues that Microsoft's SQL Server database engine combined with their Adventure Works sample database provides another fruitful technology for active learning, and presents several examples.

Bonwell and Eisen (1991) cite a variety of active learning approaches, including cooperative learning, debates, drama, role playing, simulation, and peer teaching. They also cite methods of incorporating more student participation in lecture-format classes, including "feedback lectures" and "guided lectures." By contrast, Savery and Duffy (1995) focus on problem-based learning. Case studies (Christensen, 1981) and guided design (Wales and Stager, 1978) are two of the most popular instructional strategies for increasing problem solving skills in students. With the increased move toward "flipping the classroom" (Baker, 2000; Bergmann and Sams, 2012; Mok, 2014), largely enabled through the use of online educational technologies and learning management systems (LMS), there is a strong motivation to utilize a blended environment utilizing face-to-face class time for active learning and leaving the lecture material for online consumption by students in their study time.

The case study, problem-based learning, and guided design approaches to active learning are particularly amenable to information systems courses. Several examples apply case study to systems development projects, usually in a group setting (Mitri, 2008; Ramiller, 2003; Taneja, 2014). Different authors provide diverse and interesting approaches to case study applications in information systems courses.

For example, Ramiller (2003) approaches the case study approach as a narrative process, involving layers of mini-narratives. The case study is really a story, complete with characters and conversation. And, in order to be an active learning experience, a good case study provides the student with the capacity to take part in actually crafting the narrative by becoming characters in the story. Ramiller applies this concept to a systems development term project.

As another example, Mitri (2008) presents four case studies along with guided design phases for capstone group object oriented systems development projects. Each team is given a case description and tasked to develop a Java-based system. Projects are divided into phases: database design, requirements analysis, software development, and documentation/presentation. Each phase involves tasks linked to specific IS 2002 learning units. Students perform technical (programming, database design, querying) analytical (ER/UML modeling, documentation analysis) and interpersonal (interviewing, presentation) tasks throughout the project. Students are also required to keep a journal of their experiences during the entire duration of the project.

For a third example, Taneja (2014) structures a case exercise into three parts. First comes pre-class discussion, an individual task which involves reading the case study along with a warm-up writing exercise. Next comes in-class discussion with students clustering into two types of groupings. First they group according to organizational units of the case company. Then they reform into "expert groups", composed of people with similar knowledge who brainstorm on specific questions common to the group. Then they reform into the earlier (functional) groupings for further problem solving. Finally there is a post-class discussion by individuals as follow-up homework.

These and other examples illustrate the diversity and efficacy of applying case studies to facilitate active learning experiences in IS courses.

2.2 Databases as Case Study Instruments

Database management and querying skills are vital for any respectable information systems curriculum. The IS 2010 Curriculum Guidelines (Topi et al., 2010) repeatedly stress the importance of database management and database retrieval as foundational elements of an IS program. IS 2010 also cites the importance of robust database technology and realistic database samples: "Various courses and areas of study have their own specialized requirements, such as the large database with realistic sample data that are needed for effective work in the area of data management (Topi et al., 2010, p 389)." Database management and analysis is also an important criterion in ABET's information systems accreditation process (ABET, 2014).

Previously we discussed active learning and case studies in a variety of IS contexts. It is particularly beneficial if a case study includes, in addition to the description and narrative, an actual implemented database. A good database can provide information to explore in order to help students construct and discover the narrative of the case. Some current database textbooks provide sample databases as supplements, and tie these in with an on-going case description in the text. For example, the textbook Modern Database Management (Hoffer, Ramesh, and Topi, 2013) includes a running case throughout the book called "Pine Valley Furniture (PVF)." The authors provide sample databases for PVF (Oracle, SQL Server, and MS Access), as well as case descriptions and entity-relationship diagrams (ERDs) throughout the textbook.

A lifelike sample instructional database system should contain data and metadata of sufficient volume that accurately depicts the business processes, functions, and entities of a realistic organization, and organizes it in a way that demonstrates best practices in database design. When tied to a particular business case, the database should include elements for all business functions throughout the value chain (Porter, 1985). Intuitively, it makes sense that a database with sound structure, comprehensive organizational coverage, and reasonably high data volume can be the effective at demonstrating realistic scenarios for students in a business-oriented database class. Although textbook databases are structurally sound, their actual data content typically tends to be quite sparse. In addition, the data types are usually simple numeric or text values, and don't contain more advanced types for images, PDF documents, XML structures, etc. These limitations deprive students of many opportunities to explore valuable information and develop advanced skills.

This article suggests using a business case and corresponding sample database designed by Microsoft, called Adventure Works (Microsoft, 2014a). The sample database and business model provide a comprehensive and genuine environment for studying database design and use in a realistic (albeit fictional) company narrative. Adventure Works includes a rich set of features that can be used to reinforce students' understanding of data modeling, security, analytics, specialized data type processing, and a host of other useful educational objectives, and to do this in an active learning environment.

The remaining sections of this paper describe the Adventure Works (AW) business model and database, and discuss several pedagogically relevant opportunities utilizing AW in a variety of classroom settings involving active learning exercises. These exercises are based on a combination of case study and guided design activities. Based on surveys from students in a business intelligence course during two semesters, AW was found to be a very useful database with a variety of pedagogical benefits; these results will also be discussed.

3. THE ADVENTURE WORKS BUSINESS CASE

Adventure Works (AW) is a fictional company that specializes in manufacturing bicycles (Microsoft, 2014a). The company's product line includes 97 different brands of bikes, grouped into three categories: mountain bikes, road bikes, and touring bikes. In addition to manufacturing bicycles, AW also manufactures some of its own components. Other components are purchased from outside vendors, as well as all accessories and clothing.

Obviously, AW is primarily in the business of selling bicycles, but it also sells accessories (such as bottles, bike racks, brakes, etc.), clothing (such as caps, gloves, jerseys, etc.), and components (such as brakes, chains, derailleurs, etc.). Many of these are made by outside vendors, so in this capacity AW serves as a reseller. AW has a global presence, selling to customers throughout the United States, Canada, Australia, the United Kingdom, France, and Germany. The AW business model divides customers into two categories: retail stores that sell bikes, and individual customers. Although AW does not have any brick-and-mortar stores itself, the manufacturer does sell products directly to individuals via an Internet presence. Otherwise AW sells in bulk to retail stores, which act as resellers for its products.

AW has a total of 290 employees, serving various functions such as sales, production, purchasing, engineering, finance, information services, marketing, shipping and receiving, and R&D. Its customer base includes over 700 stores and over 19,000 individuals worldwide. AW utilizes the services of over 100 vendor companies that serve as suppliers of components, accessories, clothing, and raw materials.

Thus, the Adventure Works business case, although fictional, is a highly realistic case study for students in an information systems course. As described below, its database and data warehouse provide tremendous opportunities for students to learn about various aspects of information systems in a business context.

4. THE ADVENTURE WORKS DATABASE AND DATA WAREHOUSE

Adventure Works includes two Microsoft SQL Server databases (http://msftdbprodsamples.codeplex.com/). The first is an online transaction processing (OLTP) database, which is rich in structure, content, and variety. The second is a data warehouse, which is useful for online analytical processing (OLAP) and data mining, as well as teaching data warehouse concepts and structures.

The OLTP database consists of 71 tables grouped into five schemas related to AW's business model: Sales, Purchasing, Production, Human Resources, and Person. The database (in its raw state) contains data of almost 20,000 people (employees, customers, store contacts, vendor contacts, and general contacts). It also contains data of over 31,000 sales transactions to customers and over 4000 purchasing transactions from suppliers. The data in AW's 2014 version of the database pertains to the years 2010-2014, but this can easily be modified by updating the date fields and making the database appear more current. The data in AW's OLTP database is very comprehensive compared with data volume in a typical textbook's sample database. There are also several advanced data types that are demonstrated in AW's OLTP database, including bitmapped product photographs, XML documents, and hierarchy id fields for representing hierarchical data relationships. The wealth of data in AW's OLTP database provides a rich set of pedagogical opportunities.

The AW data warehouse is a centralized warehouse architecture consisting of Fact tables and Dimension tables and containing data obtained from the OLTP database and other data sources via a traditional extract/transform/load (ELT) process. There are a total of 10 fact tables, with subject areas ranging from Internet and reseller sales to financials to product inventory. These Fact tables are surrounded by 16 dimension tables, representing customers, product lines, accounts, employees, departments, geographic regions, and time. Thus, AW's data warehouse is a useful venue for discussing many key data warehousing topics, and serves as a springboard for OLAP cube building and data mining.

5. PEDAGOGICAL OPPORTUNITIES OF ADVENTURE WORKS

This section describes Adventure Works use in two classes of a CIS curriculum: (1) a 400-level system development and implementation class (our capstone), and (2) a 400-level business intelligence elective. Although it could also be used in introductory database courses, AW is probably better suited for more advanced classes.

Both of these classes are held in the computer lab, so much in-class time focuses on hands-on exercises, mostly using Microsoft SQL Server and Visual Studio. Both classes emphasize and elaborate on the Adventure Works business model throughout the semester. By the time students complete the course, they experience a realistic technical and business immersion, and develop key design skills along the way. The following are a set of active learning exercises centered on AW data.

5.1 Reverse Engineering to a Business Entity

The AW OLTP database has an interesting organization in many respects. One of these involves the concept of a *business entity*. Within the Person schema (which contains 13 tables related to people, their contact information, geographical information, etc.), there is a table called *BusinessEntity*. This table is directly related, via a one-to-one relationship, to three other tables in the AW database: *Person*, *Store*, and *Vendor*. *Person* is further related, also in a one-to-one fashion, to *Employee*, which is further related one-to-one with *SalesPerson*. For all of these tables, the primary key is the same, called *BusinessEntityID*. This provides students with an opportunity to "discover" an implicit supertype-subtype hierarchy, as shown below. Database students will often experience data modeling of enhanced (or extended) ER modeling involving supertype-subtype relationships (Hoffer, Ramesh, and Topi, 2013, chapter 3) when constructing data models and designing relational databases. But they may not get much opportunity to reverse engineer the supertype-subtype business model by analyzing a company's relational database structure. AW provides an opportunity to do this. A resulting ER diagram may look like Figure 1.

This type of reverse engineering is common practice in IT consulting, where a consultant may come into an environment with inadequate and outdated documentation (Briand, Labiche, and Lebuc 2006; Van Geet and Demeyer, 2010). This requires the consultant to work backward from the data in order to glean the underlying business model by analyzing both the structure and the content of the database. Reverse engineering is a useful educational technique (Ozkul, 2012), and the AW database structure gives a realistic reverse-engineering learning experience to IS students.

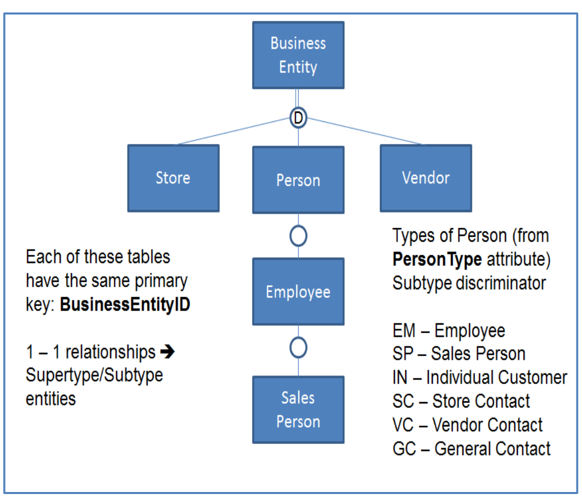

Figure 1. Supertype-subtype relationships in Adventure Works data model

5.2 Hashed Passwords Fields and Best Security Practices

The AW database includes a *Password* table, with a field for a 128-bit hashed password and a corresponding salt value. This provides opportunities to teach about cryptographic hashing (Azad and Pathan, 2014), and in particular to implement login features in applications that use Adventure Works. Our capstone class involves web application development in ASP, .NET, and C#, makes use of the .NET login web components and apply hashing algorithms for creating passwords and validating logins of AW users. Students could do this directly using .NET libraries; alternatively there are also many sample simplifying code snippets on the Web, which are used in the capstone for implementing applications of MD5, SHA1, and other hashing algorithms.

The capstone project involves development of a web application for Adventure Works. One of the system requirements is to provide user login and profile setting purposes, and enforce security requirements. Students are required to use cryptographic hashing, using the *Password* table, and in general abide by the AW rules for creating and managing users. They are also required to follow other best practices (OWASP, 2014), such as preventing SQL injection by using parameterized queries.

5.3 Incorporating XML into SQL Processing

The Adventure Works database includes several data fields with the XML data type. Examples are the *Resume* column of the *HumanResources.JobCandidate* table, the *CatalogDescription* and *Instructions* columns of the *Production.ProductModel* table, and the *Demographics* column of the *Sales.Store* table.

XML data querying is an important skill for processing semi-structured data, which outstrips structured, relational data in volume. Traditionally, database classes have focused on relational, SQL-based database structures, but increasingly there is a need to address other structures, especially those accessed via Web services. Many of these are in XML or JSON format. Database textbooks increasingly include content regarding XML and the use of Web services (Hoffer, Ramesh, and Topi, 2013, chapter 8). So, a database that includes XML content provides valuable educational opportunities in a technical IS curriculum.

Mastering this skill requires instruction and practice in XPath and XQuery, and also an understanding of how to incorporate XPath and XQuery with SQL in the Microsoft environment. An effective query for extracting relevant data from an XML field requires considerably more specialized skills than those learned in a typical database class. For example, Figure 2 shows a query involving the *Production.ProductModel.Instructions* column.

```
ITH XMLNAMESPACES (
  'http://schemas.microsoft.com/sqlserver/2004/07/adventure-works/ProductModelManuInstructions' AS AW)
ELECT ProductModelID, Name, tools.value('.','nvarchar(100)') as "Tool Needed"
ROM Production.ProductModel
ROSS APPLY Instructions.nodes('//AW:tool') as T1(tools)
HERE ProductModelID=7
```

Figure 2. T-SQL query returning the tools needed for manufacturing a particular product

This query involves reference to an XML namespace, use of XQuery functions *value* and *nodes*, and use of the CROSS APPLY T-SQL clause. CROSS APPLY is used to "shred" the results of the XPath path expression *//AW:tool*, so that the different tool elements from the XML document in a single row are returned in individual rows of the result set. This nuance of XML/SQL combinations makes a nice experiential bridge for students as they contrast XML and relational data structures and learn more advanced query skills.

5.4 Dashboards and Balanced Scorecard

Because the AW database is so comprehensive in scope and volume, it offers a good opportunity for students to practice data visualization skills. Also, since the database includes data pertaining to all functional areas of the business, it contains a wealth of information that would be useful business process management (BPM) (Sharda, Delen, and Truban, 2014), and in particular balanced scorecard (BSC) techniques for performance assessment (Kaplan and Norton, 1992). For the BI course, BPM/BSC is an important conceptual learning objective, and use of data visualization tools is an important technical learning objective. So, one key project for students is to create a dashboard based on Adventure Works data that addresses the four main perspectives of the balanced scorecard: financial, customer, internal process, and learning and growth.

In the BSC approach, measures are done for all four perspectives. Financial balance sheets are a traditional measure of corporate health. BSC suggests that just as important are (a) customer satisfaction and relationships, (b) the efficiency and effectiveness of the internal processes (such as manufacturing in AW's case), and (c) various "intangibles" that facilitate the corporate culture, employee morale, and knowledge base (learning and growth). The AW data has relevant data for all of these perspectives.

There are many ways to incorporate data visualization in a BI class. One is to use Google Charts JavaScript APIs (https://developers.google.com/chart/interactive/docs/index).

Other possibilities include linking SQL Server data to Excel charts, using products like Tableau or SAS Visual Analytics, developing ASP .NET applications with charting capabilities, or providing customized tools for mapping queries to visualizations (Mitri, 2012). Our BI class's dashboard project requires students to build a data visualization for each of the four BSC perspectives, and the ability to drill down from each data visualization for more detailed information. The four perspectives can easily be found in the AW database and data warehouse. Sales data and customer information are found in the *Sales* schema of the OLTP database. Relevant tables include Customer, Store, SalesPerson, SalesOrderHeader, SalesOrderDetail, SpecialOfferProduct, SalesTaxRate, and others. In addition, sales data is broken into Internet and Reseller sales subject areas of the data warehouse. Internal process information can be readily found in the *Production* schema, which includes much useful data on AW's manufacturing process. Relevant tables for internal process include BillOfMaterials, WorkOrder, WorkOrderRouting, ProductInventory, and others. Financial data is found in all schemas; the OLTP includes financial data in sales orders, purchase orders, salaries, product prices and costs, and a variety of other items. In addition, there is a financial subject area in the data warehouse. Learning and growth can be found by linking together elements from different schemas, or by going to the more subject-oriented data warehouse. A sample dashboard focusing on sales of product categories/subcategories is shown in Figure 3.

5.5 Data Integration

The Adventure Works data warehouse brings opportunities for BI students to gain practice in a variety of tasks related to data integration via Microsoft's SQL Server Integration Services (SSIS). In order to use these features, students must have access to SQL Server's Business Intelligence data tools which can be obtained for free in universities that are members of Microsoft's Developer Network Academic Alliance (MSDNAA).

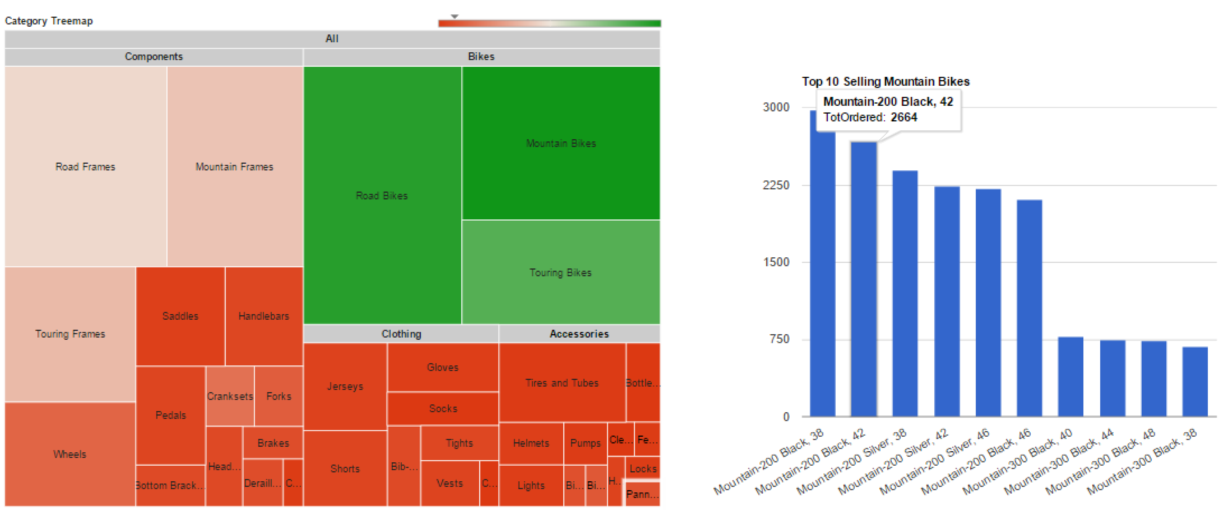

Figure 3. BSC Interactive Dashboard using AW Data and Google Visualization API

Microsoft provides tutorials for integrating data from Excel spreadsheets, folders containing text files, and the AW OLTP database itself. However, rather than have students just follow the step-by-step instructions in the tutorials (Microsoft, 2014b), it is more effective to condense the steps of the tutorials and incorporate these into a hands-on classroom exercise in which the instructor guides the students through the integration process while relating these steps to the conceptual elements of data integration theory and practice. Using SSIS in this way gives students hands-on experience with the entire ETL process. SSIS data source connection managers are used to link with a variety of data sources (containing structured, semi-structured, or unstructured data) for *extraction* purposes. The data flow tasks in SSIS allow students to create data flow linkages between data sources and data destinations. Data flow tasks also allow for a wide variety of techniques for implementing data *transformations*. Using SSIS, student gain a practical, active learning experience that helps to cement their conceptual understanding of data integration. Figure 4 shows SSIS screenshots for one of the Microsoft SSIS tutorials. This one takes currency data from a folder of text files, performs some data transformations, and updates a table in the AW data warehouse.

5.6 OLAP and Multidimensional Databases

The Adventure Works data warehouse brings opportunities for BI students to gain practice in a variety of tasks related to online analytical processing (OLAP) via Microsoft's SQL Server Analysis Services (SSAS). Another term for OLAP is cube building, and another word for cube is multidimensional database. Thus, the SSAS tool is typically used to create multidimensional databases by extracting and restructuring data from a database or data warehouse. Microsoft provides several SSAS tutorials that focus on the AW data warehouse as the source data.

For our BI class, the SSAS tutorials are condensed and presented as a collective class exercise, similar to the SSIS presentation described earlier. The instructor guides the students through the cube-building and deployment process while relating these steps to the conceptual elements of online analytical processing and multidimensional databases. The Microsoft tutorials include practice in dimension member hierarchies, discretization, pivot tables, and slicing and dicing operations. During the exercises, students also get experience working with Multidimensional Expressions (MDX) for cube querying. MDX is also a useful querying language for cubes, and advanced work can include using this language.

5.7 Data Mining

Microsoft's SSAS includes data mining features. Users can apply a set of supervised and unsupervised learning algorithms to a variety of data sets. Microsoft includes tutorials for applying decision trees, Naïve Bayes, clustering, and association rules for a variety of Adventure Works mining tasks. These include use of demographic data to predict bike buyer likelihood, market basket analysis based on AW's transaction history, and identifying "natural" groupings of AW's customer base. In our BI class, students learn the theory and concept of several data mining algorithms (e.g. ID3 decision trees, backpropagation neural networks, K-means clustering, and Apriori association rules), and for each one, we apply a simple example using SSAS on Adventure Works data. In this way, students get a basic understanding of different approaches to data mining and some hands-on experience working with Microsoft data mining.

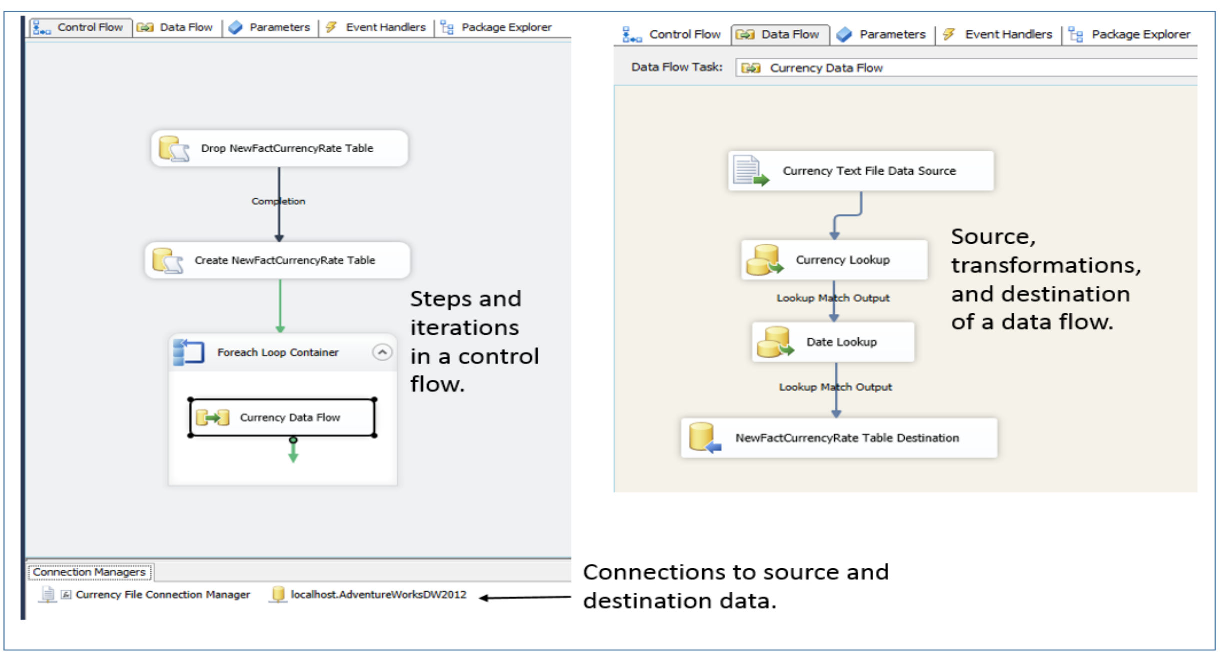

Figure 4. Solution to a Microsoft SSIS Tutorial

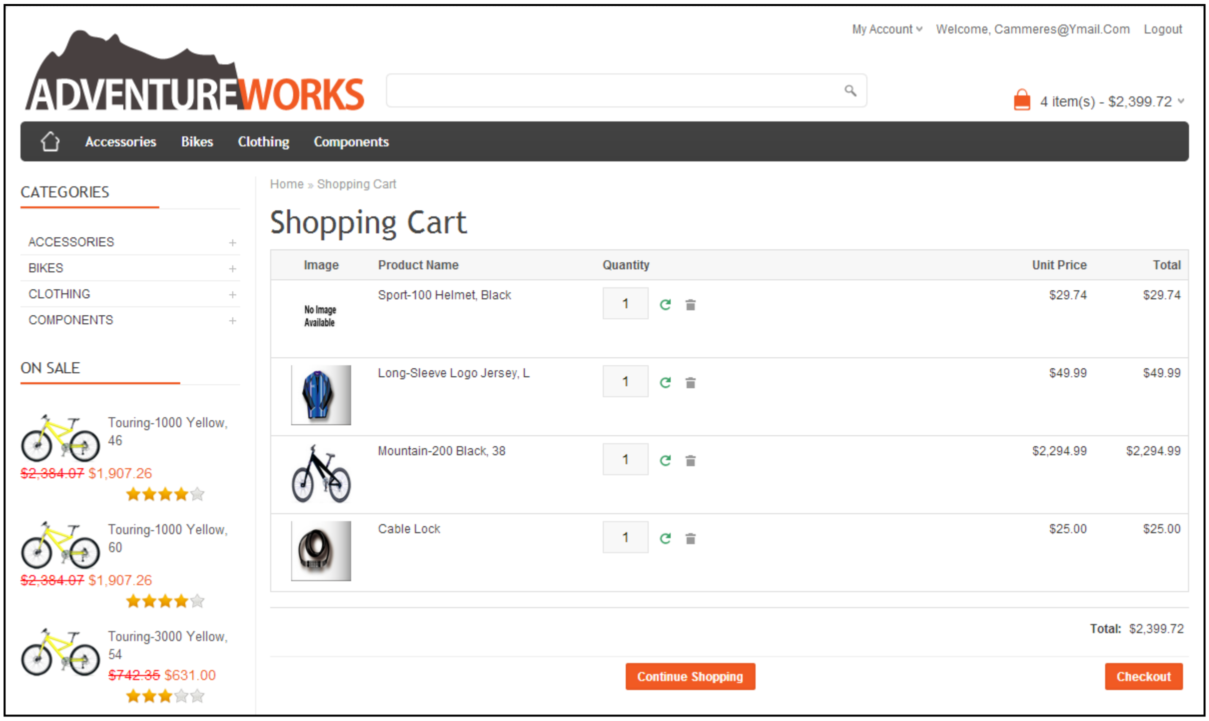

Figure 5. ASP .NET e-commerce application based on Adventure Works database (capstone project)

5.8 E-Commerce

Adventure Work's OLTP database has a wealth of structured and unstructured data to create data-rich Web-based e-commerce applications. Our capstone course provides students an opportunity to create ASP .NET applications for AW in e-commerce or a wide variety of other application areas. A typical B2C e-commerce application caters to three types of users: (1) an Internet-based customer, (2) a customer service representative (or salesperson), and (3) a decision-maker or knowledge worker. For customers, the application includes a product catalog and order processing system, along with customer profiling and secure login (as described earlier). For salespeople, the application provides the capability to track customers and monitor inventory levels, making purchasing requests when needed. For managers, it includes decision support capabilities including charts for dashboard functionality (also described earlier). Because of the rich amount of data found in AW's database, including multimedia data, some very impressive student projects have been accomplished by students working with AW data, as shown in Figure 5.

6. STUDENT PERCEPTIONS AND LESSONS LEARNED

6.1 Student Perceptions

In order to evaluate the effectiveness of Adventure Works as a case and database example, an online survey was presented to students in our BI class during fall 2014 and spring 2015 semesters. Out of 44 students who took the course during these two semesters, 26 students completed the survey. Questions were asked about a variety of student experiences and opinions regarding technical areas including advanced database querying, data integration, multidimensional databases, data mining, and data visualization. Questions were also asked about the effectiveness of the Adventure Works database for student learning.

The results indicate that students strongly appreciate the efficacy of AW in an active learning environment. One survey question was: "How useful was the Adventure Works database for helping you to gain a deeper understanding of database technology and querying skills?" The possible answers were very useful, useful, neutral, useless, and very useless. Of the 26 students, 22 rated AW as very useful and four rated it as useful. When asked "Please write a brief description of how the Adventure Works database either contributed to or hindered (or both) your understanding and skill level in database querying?" students gave several answers that pointed to AW's real-world relevance and practical usefulness. Example statements are listed below:

- It was a good practical business model to use to design queries and other exercises around. It brought relevance.
- I feel that the Adventure Works database helped in that it was like a real world example of how a real company would be set up.
- It really helped me to visualize how OLTP and OLAP databases are laid out visually. Also, since it is a widely used database, it was helpful to be able to find tutorials when I got stuck.
- It was helpful because it applied database and SQL query concepts we were learning in class with practical business concepts; it interwove the two in what was a realistic representation of what I thought

an enterprise-wide business database would look like.

- I think it is a very helpful sample database. It has many relationships and a lot of data which enables execution of complex queries as well as in depth analysis.
- Adventure Works was great because it allowed us to practice database/data warehouse techniques in a real-life environment. It also served as an excellent tool is understanding how larger relational databases are designed.
- I believe the adventure works database was very useful in understanding the concepts taught in Business Intelligence.
- The AW database was very helpful to my understanding of course content. Having one continuous project or database that was used across multiple assignments facilitated a better understanding of the content.

6.2 Lessons Learned

Adventure Works has been used for several semesters in BI and advanced capstone systems development courses, resulting in a few "lessons learned" for the instructor. First, it takes time to learn all the details of the AW database and data warehouse, so the instructor needs to prepare. An instructor should go through all the Microsoft tutorials for SSIS and SSAS; the vast majority of these involve AW. Perhaps more importantly, the instructor should become very familiar with the AW database and data warehouse content and structure. The pedagogical power of AW depends largely on the instructor's familiarity with it. This familiarity will grow over time; don't expect to know all of it the first semester.

Second, many of the exercises discussed in this article involve advanced skills and concepts. To effectively use a tool like SSAS in the classroom, instructors should be familiar with OLAP and data mining techniques. Understanding the structure and purpose of the AW data warehouse implies knowledge of how data warehouses work and what they are used for in general. Integrating the database with application environments and/or visualization tools requires comfort using these other tools and software libraries. And, of course, a lot of the really useful information to be gleaned from the database requires expertise with complex SQL querying.

Third, setting up the environment for SQL Server and the SSAS/SSIS tools may be tricky in a lab environment; care should be taken that the needed functionality isn't prevented by security constraints. For example, in our lab environment we had a glitch where a student's incorrect log-in locked the student out from using SSAS features and had to be unlocked by the system administrator. Depending on the school's infrastructure, they may want to use cloud-based services for the database, data warehouse, and analysis functions.

Fourth, students really prefer hands-on activity in the classroom (i.e. active learning) over passively listening to lectures; this is a comment that comes up very frequently at our school. There is much discussion these days of "flipping the classroom" and AW exercises are a good way to make the classroom experience an active one when it comes to building technical (and business) skills of advanced IS majors. For example.in our BI class, a large part of conceptual/business/governance/ethical material is presented and evaluated online, and most face-to-face class time is spent going through AW exercises along with conversations of how the technical work relates to these "softer skill" ideas.

7. CONCLUSION

This article presents Microsoft's Adventure Works business model and database as a pedagogical tool for gaining practical insight into the data model of a realistic business case. The data in AW's database and data warehouse is comprehensive enough to present many useful pedagogical opportunities for a technically oriented information systems curriculum. Several of these are described in the paper, including reverse engineering to an implied conceptual model, working with hashed passwords for information security, combining SQL and XML queries, building interactive balanced scorecard dashboards, and applications of OLAP, data mining, and E-Commerce.

All of these exercises provide active learning experiences for students, and thereby enhance higher-level problem-solving skill development. The AW database is quite robust, and the exercises described in this paper are probably more complex than appropriate for an introductory database audience. But for more advanced courses, AW is a rich teaching tool. With creativity, imagination, business acumen, and technical discipline, students can leverage AW's data to implement many practical, realistic, and rewarding information systems. In this way, the AW business case and database offers many benefits to IS instructors who wish to provide an active learning experience to their students.

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