Polytechnic: Taking the Plunge

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Abstract

The Purdue Polytechnic Institute was created two years ago from the former College of Technology. This was more than a name change; it represented a transformation which will have an impact not only the curriculum, but on learning, and teaching methods. Students need technical skills but they must also be able to collaborate, be problem solvers, and develop communication skills that employers are looking for. In order to develop these skills, the emphasis is on employing active learning, with more student-centered experiences and integrating the humanities throughout the college experience using a team teaching based approach. At our statewide site in Columbus, last fall we took the plunge! In the Computer and Information Technology (CIT) curriculum the students take CNIT 255 Object Oriented Programming and CNIT 272 Database Fundamentals. In the past these classes have been taught independently. This past fall we developed an integrated team project that involved important components from the programming and database classes. In this paper we will discuss the goals of the Polytechnic and how we have incorporated those concepts into our class and how we plan to proceed from here in our future efforts.

Introduction

The last several years have seen dramatic changes at Purdue University. The Purdue Moves initiative and from that the introduction of the new Purdue Polytechnic Institute from the former College of Technology has led to dramatic change about how students should be prepared to enter the workforce. In this paper we will take a brief look at the Purdue Moves and Purdue Polytechnic Institute and how that influenced our collaboration in two of our Computer and Information Technology classes and what we have learned and plan to do in the future in these and other classes.

Background

Several years ago the leadership at Purdue University pushed an ambitious agenda to place Purdue as an elite academic institution in the world. The name of this is Purdue Moves. Purdue Moves not only involved economic incentives but changes in the culture at Purdue. This agenda focused on four areas. These areas included affordability and accessibility, STEM leadership, world-changing research and transformative education. Following is a brief summary of each of these areas:

Affordability and accessibility

The objective is to provide students with a good education that they can afford and have the doors open to all that meet Purdue's standards and requirements. Accomplishments have included frozen tuition for six straight years and housing and meal plans have not increased since 2014 and partnering with Amazon allowing students to save about 30% on textbooks. Purdue's most recent freshman class and students from Indiana are the largest in recent years and in the case of this year's class the most diverse class ever.

World-changing research

Purdue researchers make discoveries that impact the real world, and Purdue wants to speed up the pace for technology transfer and research commercialization. In this area the focus is on drug discovery, plant sciences and research commercialization. To accomplish this Purdue has pledged to invest $250 million to accelerate the rate of drug discovers, create innovative research and teaching environment to stimulate discovery increase funding and attract new researchers. In the area Plant Sciences has invested more than $20 million in the College of Agriculture for plant science research and education to develop new ways to help feed the growing world population.

Transformative Education

The goal is for Purdue to be at the forefront in delivering higher education, both in and out of the classroom and providing modern teaching and learning approaches that better prepare students for careers. This area focuses on year-round university, international experiences, living and learning and transforming teaching and learning. Accomplishments in this area include increasing summer school enrollment by almost 30% since 2012. With additional travel abroad scholarships and innovative programs like Host-A-Boiler the number of students traveling abroad has increased over 70% in the past three years. Finally, Purdue wants to transform teaching and learning. Purdue wants to abandon the status quo for a higher education that is driven by teaching methods and experiences that are proven to prepare students for successful careers after they have left the Purdue campus. Part of this is the Purdue Polytechnic Institute (that we will go into more detail on) and the soon to open Purdue Polytechnic High School in Indianapolis.

STEM leadership

In this area the focus is on expanding engineering, transforming technology and strengthening Computer Science. Initiatives in the area of expanding engineering and strengthening computer science have included increasing the number of engineering and computer science faculty, increasing the number of undergraduate and graduate level engineering and computer science students. Purdue is now the top

producer of female graduates in engineering technology and fourth-highest producer of women earning a bachelor's degree according to the ASEE.

The third area is transforming technology. The focus of this is creating the Purdue Polytechnic Institute as a pioneer in learn-by-doing and use-inspired research which we will go into in the next section.

Purdue Polytechnic Institute

Purdue Polytechnic Institute is part of the Purdue Moves under STEM leadership and the center piece for transforming technology component. The Purdue Polytechnic Institute, previously the College of Technology, is one of 10 colleges at Purdue University offering undergraduate and graduate degrees. The college includes seven academic schools, departments, and divisions including Computer and Information Technology. Following are goals from the Polytechnic Transformation on the Purdue Polytechnic Institute website.

Goals for the Polytechnic

- Make the Purdue Polytechnic Institute the University's hub for consumer-oriented technology research.

- Transform the curriculum to teach the science of demand-driven innovation and entrepreneurship.

- Purdue Polytechnic students will engage in transformational experiences that include:

  o Year-long, team-based senior design projects sponsored by industry and supervised by professors and industry representatives.

  o "Study-away" experience — opportunities for meaningful study overseas or in high-impact programs in the United States.

  o Semester/summer internships.

  o Design-lab courses every semester, starting in freshman year.

- Polytechnic students will be guaranteed a chance to earn:

  o An innovation certification through the development of a market-ready product or technology, or

  o An entrepreneurship certificate through the development of a business plan.

Polytechnic goals for the student in the classroom

We now live in a global economy with a world of data at the students fingertips every second of the day. This is not the students of fifty years ago and higher education has to adapt to accommodate those

changes. The skills required to get positions today require a technical expertise but also the ability to collaborate with others, solve problems and be innovative in their approach. What does the Purdue Polytechnic Institute mean for the student? The Institute:

- Provides a more student-centered experience using state of the art teaching techniques, with faculty mentoring and competency-based learning approaches that offer great flexibility.

- Integrates the humanities intentionally and repeatedly throughout a student's four years using a team-based teaching approach, in order to improve on skills such as creativity, critical thinking and problem solving.

- Ties research and global engagement more closely with the needs of industry and communities, infusing critical thinking, innovation, and entrepreneurship into the learning environment.

- Employs an expansive active learning approach that will allow students to solve social and technical problems during their first year. This real-world experience will help students to have a thorough understanding of the concepts and have a better knowledge of the subject (Bertoline, 2013).

Effort in Columbus

The efforts detailed previously were more than a name change, it represented a change in direction, a transformation which will have an impact not only on the curriculum, but on learning and teaching methods and much more. Our students still need the technical skills but they must also be able to collaborate, be innovative, problem solvers, and develop communication skills that employers are looking for. In order to accomplish this, the focus is on employing active learning, with more student-centered experiences and integrating the humanities throughout the college experience using a team teaching based approach. At our statewide site in Columbus we do have a few additional hurdles in our efforts to employ some of the new concepts of the Polytechnic. One goal is integrating the humanities throughout the college experience. At our statewide site this is more of a challenge. All of the classes at the main campus are Purdue classes however at the statewide locations like Columbus, the humanities classes our Purdue students take are Indiana University courses and taught by our partner Indiana University Purdue University Columbus (IUPUC). Logistically and politically this made the integration of the curriculum a challenge. Another issue at the statewide locations is the lack of funding with the Purdue Moves Polytechnic funds directed to the main campus in West Lafayette. Even with these challenges we decided it was time to make the effort and last fall we took the plunge!

Computer and Information Technology (CIT) offers a BS with classes in a variety of areas including: networking, systems analysis, programming and database. In the third semester of the CIT curriculum the students generally take a second semester of programming – CNIT 255 and database fundamentals – CNIT 272. In the past these classes have been taught independently. This past fall we developed an integrated team project that involved important components from the programming and database classes.

First we will start off with a description of the courses and then discuss the team project used. After that we will look at how the project worked and finally discuss what we intend to do in the future with these and other classes.

CNIT 272 Database Fundamentals course

CNIT 272 Database Fundamentals is a study of relational database concepts building on the knowledge gained in the *CNIT 180 Introduction to Systems Development*. Necessary concepts and practices are introduced in the assigned reading from (Pratt 2015). The concepts are then reinforced in lectures, while lab meetings provide the students with opportunities to practice in a supervised setting. The concepts discussed include database design, data modeling using Entity Relationship Diagrams (ERD) using the Barker notation, and data normalization. The programming language used is Structured Query Language (SQL). Using SQL students learn to define, manipulate, and test the database using Data Definition Language (DDL) and Data Manipulation Language (DML). Students use the enterprise level database Oracle 12c in the class.

CNIT 255 Object-Oriented Programming Introduction course

CNIT 255 Object-Oriented Programming Introduction is a fast-paced study of Object-Oriented Programming (OOP) concepts and practices, building on the knowledge gained in the prerequisite course. Throughout the course, the students use fundamental programming concepts learned in *CNIT 155 Introduction to Software Development Concepts*. Necessary concepts and practices are introduced in the assigned reading from (Sharp 2015) and (Boehm and Murach 2016). The concepts are then reinforced in lectures, while lab meetings provide the students with opportunities to practice in a supervised setting. All students are expected to use outside resources to expand their knowledge beyond the classroom and share some of these newly discovered ideas with the class. Programming exercises use the C# language. Initially, the programs that the students create are relatively simple. However, by the end of the semester the students are expected to create dynamic, data-driven programs capable of interacting with either file or database data stores.

Project in CNIT 272 and CNIT 255

Projects are major components in many of the CIT classes. Individual and team projects are an integral way to assess learning. In terms of knowledge, techniques and application, a project is used to assess the application level. Students can use projects to apply concepts and techniques to develop the solution of a highly unstructured business problem. In the past, projects have been developed solely for a specific class and typically very narrow in scope – database, programming, systems, networking. We decided a project was a good starting point to integrate the courses. Because it is an unstructured business problem we could effectively expand the scope and it would give students a more realistic experience, a project where they would design and build a database and develop user interfaces using C# application that would search, insert, delete and modify the tables developed. Following are the details of the two projects used in the CNIT 272 and CNIT 255 classes.

Project used in CNIT 272

The project used in *CNIT 272 Database Fundamentals* class is based off of a health club scenario used previously in the class and modified to add the C# component. Students were initially given basic data requirements for the system along with user interface requirements for forms and reports. Students were required to use Oracle Data Modeler to develop the logical data model and Oracle 12c database for the implementation of the database. The project was to be developed in the following three phases:

1. Phase 1 deliverables included:

   a. Create the logical design database. The Entity Relationship Diagram (ERD) could initially be created in Oracle Data Modeler or Microsoft Word using a template provided.

   b. Meet with the instructor and discuss.

2. Phase 2 deliverables included:

   a. Update and correct any issues from the Phase 1 logical design.

   b. Create the physical design for the database using Table Instance Charts and develop sample data.

   c. Meet with the instructor and discuss.

3. After Phase 2 was turned in and before Phase 3 was finished each team was given a required modification to the initial system requirements.

4. Phase 3 deliverables included:

   a. Update any issues from Phase 1 and Phase 2.

   b. Use Oracle Data Modeler for the final version of the ERD.

   c. Implement the database design by creating a script to create and populate the database.

   d. Develop a professional presentation demonstrating the system and discuss the development of the system.

   e. Develop system documentation.

   f. Develop a C# application that would search, insert, delete and modify information from a table in the database.

Students had to submit a hardcopy of the project documentation. ERDs, scripts to create and populate the database and C# program code were to be provided on a flash drive submitted at the project presentation see Figure 1 and 2.
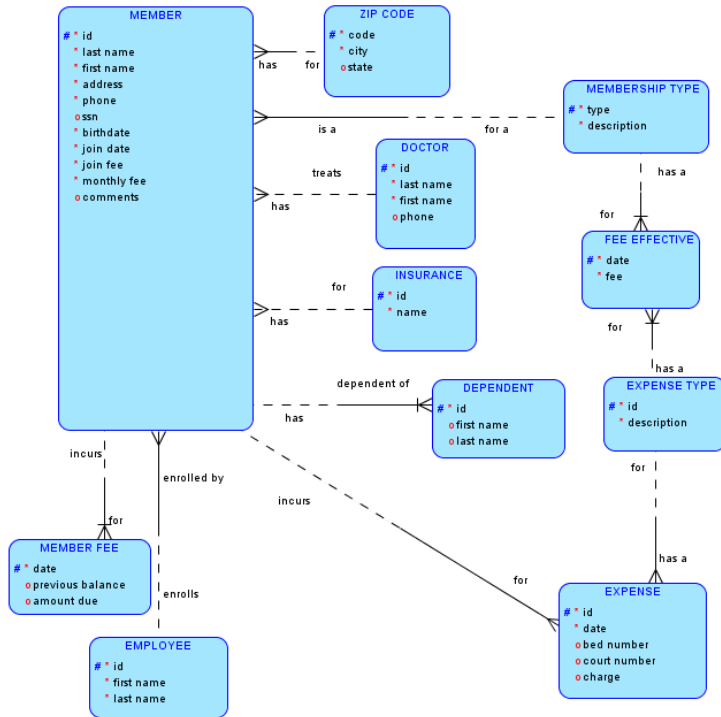
Figure 1. Entity Relationship Diagram for the team project in CNIT 272.

Figure 2. SQL to build tables for the team project in CNIT 272.

Project used in CNIT 255

The student team in the *CNIT 255 Object-Oriented Programming Introduction* class was given an assignment that required them to use Microsoft Visual Studio 2015 in order to develop a C# Windows Forms application that would communicate with the Oracle databases developed by the teams in the *CNIT 272 Database Fundamentals* class and provide the capability to:

1. Search for a specific row in the database.

2. Add a new row to the database.

3. Delete an existing row from the database.

4. Modify any column of an existing row except the columns participating in the primary key.

The students were directed to make sure that each CNIT 272 team would select a unique table for this project. Instead of the deprecated Oracle data provider found in the current .NET network, the students had to acquire and use the up-to-date .NET data provider available from Oracle!

The students were told to prepare a project report featuring and discussing the results. They were expected to include information on how the project work was divided among the team members.

Even though the database programming material would be covered in class, the students were strongly encouraged to read Chapters 17-20 of (Boehm and Murach 2016) early and be prepared to supplement the textbook material with results of online searches as needed.

The students submitted a ZIP file with their complete C# project via Blackboard by the due date. Along with the ZIP files, they submitted a copy of the report of their results in the Word document format. One submission per team was required. The students demonstrated their application in action, presented and discussed the results in class on the due date see Figure 3 and Figure 4.

Figure 3. Screenshot of the first form of the C# application communicating with Oracle databases.
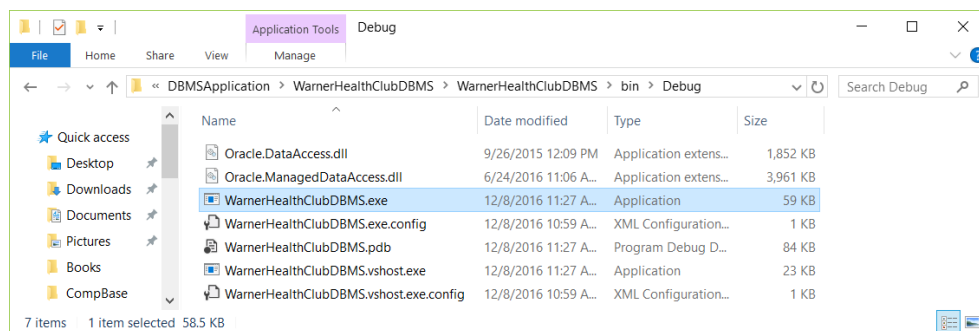
Figure 4. Executables, DLLs, configuration files, and the PDB file for the C# application communicating with Oracle databases.
Results and lessons learned from CNIT 272 and CNIT 255 project

The class content for CNIT 272 was reorganized. The database design portion was placed at the beginning of the semester and SQL programming was moved after the design portion was covered. In previous semesters the database design and SQL were both covered throughout the semester. The goal was to get a better designed database by covering design early and including plenty of practice after the topic was covered. This proved helpful in that the quality of the database design seemed better than in some of the more recent semesters. The downside was that with the programming labs were pushed back in the semester. Lab 7 that creates the database (DDL lab) was moved later in the semester and members of the teams wanted to create tables before we covered the material in lab 7. Some students were seeking help on how to create the tables for the project and some were testing with the tables that were used for SQL SELECT statements in labs 1-6. Both teams in the class were able to develop an application that provided a front end interface developed in C# that provided functionality to at least one table.

In CNIT 255 the Data Grid View plugin for Visual Studio proved very helpful. The most challenging part of the assignment proved to be developing the search function for the database. The students implemented two functional searches:

1.   The "Quick Search" function. This simple search bar lets the user enter a simple point of data when they wish to highlight all rows that include that data.

2.   The SQL Query View, which exists as a separate form in the application. It allows the user to enter a SQL query statement and receive a result. This view allows returning of information instead of just finding information in the database.

The application was able to add, delete, and modify any row in the database through simple inputs. The application's GUI included the necessary buttons for these operations.
Contrary to the original intention expressed in the assignment, two different versions of the program were created, each for communication with one of two separate databases developed by two teams in CNIT 272. Both versions were successfully demonstrated to be fully functional.

What is next?

The CNIT 272 Database Fundamentals and CNIT 255 Object-Oriented Programming Introduction are part of the CIT program core curriculum and are offered once a year in the fall semester. This past year the number of students in both classes was very small (six or less in each class). The next two years look at this point to have larger numbers that will be enrolled in both classes (at this point fifteen to twenty students). With a larger class it would be beneficial to plan the team members to match in each class. Also, there will possibly be several students that are enrolled in one class and not the other so those students should be distributed among the teams evenly and not concentrated on one team and cause a team to be at a disadvantage. It would also be helpful to coordinate the project dates in each class and have combined class meetings on occasion for project questions and a final presentation on the project that would be for both classes and possibly a combined project grade instead of separate project grade for each class. Finally, we have another class in our curriculum that is offered in the sophomore year, CNIT 280 Systems Analysis and Design. It is exciting to think of being able to integrate the analysis and design and implementation of the application and database in a combined project.

This would be a really great experience in that it would be a very comprehensive experience in terms of information technology functions covered and developed by the students. Also, students would have one project they would be become familiar with instead of three, and possibly let them go into more depth in a solution. At this time the CNIT 280 is offered in the spring semester each year so that would be a challenge. One option would be to move the CNIT 280 to the fall semester and use and Agile approach with incremental development of the application and database. With the current faculty loads this might be difficult at this time. Another less desirable option would be to have students in the CNIT 280 class in the spring of their sophomore year do the analysis and design for a project that would then be turned over to a another group of students in the CNIT 272 and CNIT 255 the following fall semester.

Conclusion

The Polytechnic Institute will involve a changing educational environment for our students in the coming years, one that should be exciting but also very rewarding for the students as it prepares them for the careers of the 21st century. Without funding and with constraints of being on a regional campus we were able to take two of our Computer and Information Technology courses and provide a learning component that complemented the goals of the Polytechnic. Although a relatively small step, we took the plunge and hope to expand our efforts in the coming semesters.

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