SUPPORTING STATISTICAL CONSULTANT DECISION-MAKING WITHIN A CASE-BASED LEARNING ENVIRONMENT

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Ensuring that students are provided, from the very beginning, with opportunities to engage in activities and decision-making that will be expected of them at the conclusion of their program of study is rarely practiced in higher education. Instead, instructor directed, method specific examples predominate course instruction. One reason for this gap may be too few instructional systems that adequately support a structured presentation of, engagement in, or management of the necessary scenario oriented content. This session will share the development of a case-based learning environment that enables faculty to challenge students to demonstrate their ability to successfully engage in open-ended analysis, evaluation, and application of content-specific knowledge within real-world statistical consulting contexts. Providing students with access to indicators of how well they are developing as new professionals throughout their program of study will be discussed.

INTRODUCTION

How Well Do We Provide Opportunities for Higher Order Learning?

Most programs of study provide students with a range of preparatory courses that build on one another and lead up to a final capstone experience. Such preparatory courses typically focus on course-specific learning objectives. In addition, most programs of study articulate program-wide learning objectives that cut across the curriculum. Often, these program-wide learning objectives are broadly focused and involve higher-order learning. For example, in Bloom's taxonomy, factual, conceptual, and procedural knowledge learning objectives are more easily identified within individual preparatory courses where students are asked to remember, understand, and apply. Too often it is only at the end of the program of study where courses that require analysis, evaluation, and synthesis are found. Razzouk & Razzouk (2011) report that while analysis and synthesis are the core of what students should be able to do as a graduate of a business program, these are "probably one of the least understood and most misrepresented learning activities" (p. 49). Typically, such higher-order learning objectives are infused in capstone experiences because they are difficult to intentionally address in most preparatory courses.

The Challenge

Wiggins and McTighe (1998) clearly articulate this supposition and provide instructional designers and faculty with a strategy for addressing this challenge in their book *Understanding by Design*.

> ...the student brings a naive epistemology to the work, namely, that there is a neat and clean knowledge out there and it is my job to learn, (i.e., memorize) and use it as directed. The key challenge in teaching for understanding is to make student's view of knowledge and coming-to-know more sophisticated by revealing problems, controversies and assumptions that lie behind much given and seemingly unproblematic knowledge" (p. 26).

Case-based instruction is one popular method that presents students with situations that require analytic thinking and promote synthesis within a particular professional field of study. Case-based instruction centers on the description of complex events that typically occur in real-world contexts where students review, in increasing complexity, instructional scenarios. For example, teachers examine classroom situations, lawyers review legal cases, and medical doctors analyze patients' histories, etc.

While case-based instruction is an instructional approach found in many professions and academic capstone classes, it is not commonly used as an integrated tool to support student learning from the beginning of the academic curriculum. Our project work, in conjunction with other academic areas with similar interests in case-based instruction, outlines the instructional

specifications for a case-based learning environment that will facilitate higher order learning among students throughout their entire curriculum in applied statistics. And, from this we have developed a prototype that enables students to engage in open-ended analysis, evaluation, and synthesis of concepts within real-world contexts. At the same time, this interface will also provide faculty and students with indicators measuring student performance as new professionals throughout their program of study.

Access to Case Materials
        The Department of Statistics is unique among academic departments across the country in that a Statistical Consulting Center (SCC) is an educational service unit with a rich tradition of fostering:

- Research Participation - to provide high quality statistical support for research projects for Penn State faculty, graduate students and non-university affiliated research organizations.
- Collaboration - to encourage collaborative research between statisticians and investigators from other disciplines.
- Education - to train statisticians to interact effectively with investigators from other disciplines.

        The Department of Statistics has ready access to a wealth of case-based materials that literally walk in to the SCC on a daily basis with real world problems. In a typical semester, the SCC responds to 50 - 60 client requests that range from 'STAT On Call' that provide simple statistical advice to long-term contracts with external research organizations that involve extensive reporting. Students in the Masters in Applied Statistics program, as a part of their capstone practicum experience (STAT 580 - STAT 581 sequence) become involved in working with these clients through the SCC. The SCC retains records of all consulting sessions and occasionally these records are 'sanitized' and re-purposed as instructional materials for introducing students in STAT 580 - STAT 581 to working with a range of clients and the unique requests they bring to the SCC. Currently, however, the department does not have a mechanism in place to systematically harvest, manage, or re-purpose these cases into other instructional contexts, (such as preparatory classes), prior to the practicum experience.

Overview of Development
        In order to develop an application that could serve this instructional need we first, in conjunction with designers and subject matter experts from a variety of programs: 1) defined a framework for how case-based scenarios can be purposefully structured to support student learning, 2) identified opportunities for collaborative engagement between students and faculty within this framework, and used this information to 3) develop a prototype interface that facilitates the presentation of a database of cases so that students can review, analyze, report on, and receive substantive feedback from faculty.

Partner Academic Areas with Parallel Challenges
        While this project work relies on the readily available materials from the SCC, our collaborative approach to design has enabled use to develop a framework that can be easily adapted to suit the needs of different types of content, scenarios, or academic disciplines.
        For instance, Forensic Science is a very applied domain that requires new professionals to be creative and apply lateral thinking when examining evidence recovered from a crime scene. While preparatory courses in chemistry, physics, biology and statistics give students the necessary scientific foundations to succeed in advanced forensic classes, it is currently very difficult for students to relate preparatory course material to real life situations during the early stages of their curriculum. Indeed, this may serve to lessen the motivation of students to learn this foundational material. Furthermore, it is unrealistic to prepare students for the infinite number of crime scene situations that they may encounter during their careers. A case-based learning environment would allow for harvesting the unique casework experience of the faculty of the Penn State's Forensic Science Program, engaging students during the early stages of their curriculum and developing their creative and lateral thinking for the more advanced classes and their career.

In addition, geospatial analysis and problem solving commonly involves situations where analysts are required to choose from multiple potential solutions and to predict the impacts of their decisions. The use of scenarios, complex problem situations for which there are no simple answers, and collaborative analytical tasks makes case-based learning a preferred approach for new and revised geospatial educational offerings such as those currently offered in the GIS/MGIS and GeoIntel programs. Similarly, in the related field of GeoDesign students analyze and assess building and development impacts on natural environment planning, design and model green infrastructure systems and evaluate ecological services, all problem spaces that are equally ill-structured.

Finally, Energy and Sustainability Policy Program case studies generally involve multiple stakeholders with a wide range of interests and valuations. Many different non-market strategies are possible to drive the outcome of policy issues and students can benefit from opportunities for scenario-based coalition building and strategy development to test and understand the effectiveness of different non-market approaches to reaching the desired policy outcome.

As much as possible we have striven to engage in design discussions that will enable other programs to take advantage of our work, leveraging this application to support the same type of instructional needs in a variety of academic programs of study.

Promise for Future Project Growth

Applications that capture and manage case-based materials are either built for a specific institution or purpose, or are unreasonably expensive and proprietary. Academic programs in higher education would benefit immensely from an open-source, locally managed, and easily maintained system for managing case-based instructional materials. With such a system in place, programs of study would be able to present practicum-like experiences with increasing levels of complexity to students prior to the capstone experience. When case-based learning is integrated throughout a program of study, it not only prepares students for success in their practicum experience it also allows academic programs to fulfill higher order learning objectives by providing students with ill-structured problem spaces into which the 'neat and clean knowledge' they obtain in their course work can be applied.

Furthermore, case-based instructional materials can be deployed in a variety of ways.

1. As a stand-alone resource that students can use to self-assess their abilities as they progress through prerequisite courses, and/or
2. Certain cases can be set aside for use in various prerequisite courses, and/or,
3. Certain cases can be reserved exclusively for the practicum experience.

Regardless of how case-based materials are deployed, the overall purpose is to provide students, at the start of their program of study, with opportunities to develop the ability to confidently and successfully apply what they are learning to real world contexts. At the same time, case-based materials establish a sense of relevance for what students are expected to learn in their coursework.

Drupal as Content Management System

Drupal is an open-source content management system that provides a powerful yet flexible framework for sharing content and has become a standard in many colleges at Penn State. In addition, it is well suited for sharing enhancements that are developed for this system. While in many colleges the use of Drupal is extensive, its dynamic features, such as using selective views to manage what information is presented or applying taxonomies to identify specific information, are more complex and less commonly used instructionally. In addition, Drupal's social media features allow groups to interact around specific content which, to date, have been instructionally under-employed. Both the capacity for manipulating the presentation of content and its ability to engage users are important aspects of presenting case-based instruction.

Initiation of Research and Replication in other Content Areas

Evaluating research questions that focus on whether the use of case-based instructional materials prior to the capstone experience has a positive impact on a students' ability to make decisions in the presence of uncertainty is the next step that we would like to take. In addition, examining the level of confidence students bring to the real-world problem solving that are presented in the capstone experience is also of interest.

In our applied statistics academic program the practicum experience requires students to gather client requests, recommend a course of action, and submit an initial draft report for evaluation by a faculty member. These draft reports are reviewed, graded and feedback is provided so that a full (and correct) report can be given to the client. These final reports are also graded. Evaluation and grades for these reports have been retained for the past seven years or more. With the implementation of case-based instructional materials, our hypothesis is that there would be a much narrower gap between the quality of the students' initial draft report and the faculty approved final submission.

Extending this, having designed this application under open source guidelines, it is anticipated that future research will emerge in the academic areas of our collaborative partners who, having access to this case-based framework, would adapt, enhance and expand upon our application to meet their own program's specific instructional needs. As a result, it is hoped that we have a platform from which to ask research questions that previously were not practically available.

REFERENCES

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