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MOVING BEYOND CHALK AND TALK: USING PROBLEM-BASED-LEARNING IN A RESEARCH METHODS COURSE SEQUENCE

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Abstract: The average adult can concentrate for only about eight to ten minutes during an hour-long lecture. Thus, students' ability to absorb information may be seriously impeded if we college professors talk nonstop. One alternative to the traditional "chalk and talk" instructional method is problem-based learning (PBL) – an instructional approach using real world problems as a format for students to acquire critical thinking, problem solving and group interaction skills. We describe how we transformed a two-course sequence in research methods into a problem-based-learning format. Student-reported benefits of the PBL approach include the need for higher-order thinking, improved group interaction skills, relevance of course material to real world situations, higher motivation and an overall higher level of class enjoyment.

INTRODUCTION

The average adult can concentrate for only about 8 to 10 minutes during an hour-long lecture (Liebman, 1996). Many lectures span more than an hour; thus, students' ability to absorb information may be seriously impeded if we college professors talk nonstop. One alternative to the "chalk and talk" instructional method is problem-based-learning (PBL) – an instructional approach characterized by the use of real world problems as a format for students to learn critical thinking, problem solving skills and group interaction skills. The modern history of the PBL approach began in the 1970s at MacMaster University's Medical School (Rhem, 1998). The PBL approach originally thrived only in medical and professional education programs. The approach is now slowly integrating into the hard sciences; however, the integration of PBL in the humanities, social sciences and in business schools is slow.

The instructional process of pure PBL typically flows as follows: (1) students are presented with an ill structured, real-world problem, (2) through group discussion, students decide what information they know and what information they don't know with respect to solving the problem, (3) the group decides which items on the "don't know" list will be assigned to individual group members for investigation, (4) students assimilate all new information generated from individual group members to develop a solution to the problem. The role of the instructor is to guide, probe and support students' initiatives. The role of the faculty is not to lecture or provide easy solutions; the role of the student is not to be a passive listener.

PBL places students in the active role of problem solvers who are confronted with an ill-structured problem that mirrors real world problems. As a result, PBL offers students an obvious response to the question too many professors have heard: "Why do we need to learn this?" Students also learn there is often no single right answer to a problem. In searching for a problem solution, students are forced to organize their thought process by first defining the problem, then gathering information and data, followed by solution testing.

Consider for example, the following real world scenario presented to student groups when they studied sampling and survey questionnaire design: "In 1948, Harry Truman ran against John Dewey for the U.S. Presidency. In an attempt to forecast the election result, the *Chicago Tribune* conducted a national telephone survey to ask the American people for whom they intended to vote. Results of this survey indicated that Dewey was a strong favorite to win the election. Thus, the *Tribune* printed its now-infamous bold headline "Dewey Defeats Truman" before the official election results had been tallied and reported. Of course, Harry Truman won that election to become the 33rd president. What mistake(s) did *The Tribune* make (in addition to printing the erroneous headline)?"

Under PBL, the typical student group would begin to assemble a list of "don't knows". For example, some actual questions posed by student groups were: In the 1940s, what percentage of American households had telephones? Was Truman a Democrat or a Republican? In 1948, were wealthy people primarily Democrats, Republicans, or a mixture? What was the survey sample size? In 1948, what percentage of Americans were registered Democrats? Registered Republicans? In 1948, was the incumbent of the same party as Dewey or Truman? As one can see, finding answers to all these questions should shed light on the *Tribune's* mistake.

The slow integration of PBL instructional approaches into University disciplines is due in part to the fact that no "cookie cutter" recipe exists for implementing PBL. The degree to which PBL is implemented and the methods used to implement PBL depend upon a host of factors such as the discipline, the size of the class, the maturity level of the students, instructional goals of the course, availability of group facilitators for larger classes and instructor preferences. Some faculty may feel very uneasy about "giving up control" and allowing students to seek their own paths to learning. The biggest challenge to faculty, however, may be assuming the role of group facilitator. Faculty typically do not have training on how to work with groups or how to help groups work with each other (Rhem, 1998). (See Levasseur (1996) for an excellent resource on this topic.)

Despite these barriers to PBL, we decided to “go for it”! We describe how we transformed a two-course sequence in research methods, which was traditionally taught in a lecture-only format, into a problem-based-learning format. Given the size of our classes, the maturity level of the students and the instructional goals of the two courses, we decided to use a modified version of PBL – the use of “mini-lectures” combined with both in-class and out-of-class group work on ill-structured problems.

COURSE DESCRIPTIONS

Both Research Methods I and II had historically been taught with elements of problem solving and student projects; however, both were primarily lecture-based courses, driven by formulas and computer techniques. Instructional topics in the two-course sequence included elementary statistics from description of data through an introduction to regression, survey questionnaire design and time series analysis.

Research Methods I

Research Methods I is taught each Fall semester and enrolls between 40 to 50 junior/senior level students. The course has been offered twice using the PBL instructional format – during Fall 00 and Fall 01. The course is designed to give the students an appreciation and understanding of the use of descriptive and inferential statistics. The course is designed to be “hands on” which requires students to apply statistical techniques to real data. Emphasis is on examining univariate statistics, graphing and plotting data, and student interpretation of the results. The course uses Microsoft Excel for calculations, but also requires students to do hand calculations on small data sets. Specific objectives of the course include: (1) Understanding the use of statistics in analyzing data, (2) Differentiating the descriptive versus inferential nature of statistics, (3) Understanding how a set of data might be described and analyzed using various statistical techniques, (4) Gaining an appreciation for the use of statistics in the research process, (5) Critically looking at statistical analysis to objectively assess its validity.

Research Methods II

Research Methods II is taught each spring semester and typically enrolls 20-25 students. The current semester (Spring 02) marks the second time the course has been offered using the PBL instructional format. The course is a follow-up course to Research Methods I and is designed to present the fundamental concepts and techniques in two subject areas: time series forecasting and survey questionnaire design. The first portion of the course is designed to provide the student with basic and advanced skills in the art and science of designing survey questionnaires. Upon completion of the first portion of the course, the student should be able to identify “junk mail” questionnaires from valid questionnaires, be able to write good survey questions using a variety of basic guidelines and optimize the format of a survey questionnaire. Finally, as part of a group project, students develop a complete survey instrument from “beginning to end”, administer the survey to a target group and do statistical analysis on a collected data set. The purpose of this project was to expose the students to real world issues in survey design, sampling, data collection and statistical analysis.

The second portion of the course is devoted to forecasting specific types of time series data. Students learn methodological tools to forecast a wide variety of variables such as sales, economic indicators, environmental indicators and biological trends. At the end of the forecasting module, the student should be able to determine which forecasting techniques work best on specific types of data and to quantitatively assess several types of forecasting errors. All forecasting methods are implemented using MS Excel.

Specific objectives of the course include: (1) Understanding the meaning of a trend, seasonal and cyclical component of time series data, (2) Computing moving average forecasts and exponential smoothing forecasts, (3) Computing forecasts with trend and seasonal components, (4) Computing forecasts using linear regression techniques, (5) Understanding measures of forecast error, how to compute the measures and how to interpret the measures, (6) Decomposing a questionnaire into its five basic components, (7) Applying guidelines for writing survey questionnaires, (8) Implementing guidelines to optimize the aesthetic impression of a survey questionnaire, (9) Implementing the steps for pre-testing a survey questionnaire, (10) Applying the multi-step procedure for improving the response rate of questionnaires.

CONVERTING TO A PROBLEM-BASED-LEARNING FORMAT

Conversion of both courses to a PBL format entailed the following six tasks: (1) developing the PBL syllabi and policies concerning attendance, group work, group recordings of work, and evaluation; (2) modifying current lecture format to a mini-lecture/problem format; (3) developing ill-structured PBL problems for group work; (4) developing Web pages to enhance student learning; (5) modification of the statistical components in both courses to incorporate MS Excel as the exclusive statistical computing software package.

Conversion of Research Methods I

On the first day of class, students were randomly assigned to groups (four to five students per group). A group exercise -- the Learning Style Inventory -- was used to help group members get to know each other. This exercise was an icebreaker and discussion piece. Students remained with their group throughout the course. Groups also sat together during each class.

Dr. Ilvento revised the course to incorporate nine group assignments, collectively accounting for 13.5 points of the final grade. (Previously there were five assignments in the lecture-only format.) Each homework assignment included several group problems to be completed in-class. Each assignment was handed out during the second half of a Friday Class. This time was meant for group discussion and work. The instructor and a graduate student circulated amongst the groups to assist students as they worked through the problems. This format allowed for students to work through statistical applications with the support of their fellow group members. The group assignments were designed to push the students beyond the lecture material. Dr. Ilvento tried to use interesting examples that would demonstrate techniques and strategies of statistical analysis in an interesting problem-based format. Examples of the group problems appear in the appendix of this submission

Each group submitted a single assignment answer. Each student signed the in-class component and got partial credit for that assignment. All students who signed the in-class homework received the same credit for that portion of the homework.

The course was changed to a Monday, Wednesday, Friday 50 minute format to allow for more group work. Previously it was taught on a Tuesday/ Thursday schedule. Dr. Ilvento specifically requested a problem based learning room, which included group tables. Students were given five exams, which were tied to unique components of the course, rather than lump several components into an exam (previously there were three exams). Dr. Ilvento tried to build current issues into the course to increase awareness of the role of statistics in the world today. New topics included political opinion polls, surveys on the use and ethics of downloading music files on the web, the recent U.S. News and World Report Rankings of Universities in the US, state average SAT scores, election results by county in Florida, and use of the binomial distribution in communication lines. A web site was designed for the course. The site included Power Point handouts of mini-lecture notes, course handouts, Excel data files, links to statistical data sources and an anonymous suggestion box.

Conversion of Research Methods II

Both the structure and content of Research Methods II were revised beginning in Spring 2001. The course had been taught in Spring 1998, Spring 1999 and Spring 2000 using a traditional lecture-only format. While Dr. Hyde hesitated to completely eliminate the lecture component of the course, she felt that the course content was especially conducive to many aspects of problem-based learning. Thus, she chose to change the structure of the course from a "lecture-only" format to a "mini-lecture/group work" format.

The content of Research Methods II was changed for the Spring 2001 semester so as to facilitate the incorporation of PBL methods. Historically, the course was taught in three modules: time series forecasting, linear programming, and marketing research. Each of these modules occupied roughly 1/3 of the semester. When Dr. Hyde decided to incorporate PBL into the course, she opted to delete one of the three modules -- namely linear programming -- from the course content. She also decided to refine the marketing research module by focusing exclusively on survey questionnaires and expanding the coverage of this module from 1/3 to 1/2 of the course. Deletion of the linear programming module would then free up class time required for in-class group work and expansion of the marketing research module.

Students were randomly assigned to groups of 3 to 4 students. Group assignments were made randomly during the first week of class. Students remained with their group throughout the semester. Each group sat together for each class, in a "PBL" classroom. Three types of group work were required.

In-Class Group Work. The first type of group work required each student group to work on in-class problems either before or after a mini-lecture. Dr. Hyde circulated amongst the groups to assist students as they worked through the problems. This format allowed for students to work through applications with the support of their fellow group members. The group assignments were designed to push the students beyond the typical lecture material. She attempted to use interesting and timely examples that would

demonstrate techniques in an interesting problem-based format. Examples of the in-class group problems appear in the appendix of this submission. This type of group work was denoted as “in-class group work” and each group’s work was collected at the end of the group work time. Dr. Hyde discussed possible solutions to the problems during the next class meeting and also returned each group’s submitted work with suggestions and notes.

This type of group work was not graded, per se, for right/wrong answers but each student participating in this type of group work received 6.25 points toward their “in-class group work” grade. Throughout the semester, 16 of these “in-class group work” sessions were conducted. Thus, a student who attended each class and participated in each of the 16 “in-class group work” sessions earned a grade of 100 for the “in class group work” grade (which counted 15% of the final course grade). For each class a student missed, he/she essentially received a 6.25 - point deduction for their “in-class group work” grade.

Out-of-Class Group Work. The second type of group work involved out-of-class homework assignments. Each of the six homework assignments included one or two group problems. Each group submitted a SINGLE assignment answer for the designated group problems. Each student signed the group-work component of each homework assignment. Each student in a given group received the same credit for the group work portion of each assignment.

Project Group Work. The third type of group work focused on the survey questionnaire project case. Each group was required to design and administer a survey questionnaire on any topic of choice (subject to Dr. Hyde’s approval). Each group submitted a written report and gave an oral class presentation on their group’s survey results. This survey questionnaire project case was worth 25% of the final course grade. The purpose of this project was to expose the students to real world issues in survey design, sampling, data collection and statistical analysis.

Other Course Changes. Dr. Hyde specifically requested a problem-based-learning classroom that contained group tables, an overhead projector, and an internet connection. Students were randomly assigned to 6 groups (three to four students per group). Students were required to complete six assignments that included a group component and a take home component. When the course was previously taught in lecture-only format, only three assignments had been required.

FACULTY OBSERVATIONS

We were active participants in the group exercises and watched the students grapple with the problems. We found it to be effective and also gave us a sense of what material needed to be reviewed or emphasized. Dr. Ilvento experienced no problems with the make-up of groups, group dynamics, or in-fighting. Part of the reason for this was that he did not require students to meet and work outside of class. Managing assignments outside of class would have posed more group dynamic problems. Only one group in Research Methods II reported problems in group dynamics. The specific problem reported by the group was a conflict in the amount of work that various members of the group wanted to dedicate to a group portion of one particular assignment. Dr. Ilvento also avoided grading issues by giving each group all the points for the exercise provided that they were present and completed the work.

Initially, Dr. Ilvento was going to allow only 25 or 30 minutes for the group exercises. He soon realized that the students required the full 50 minutes of the class to complete the exercises. The group work required they be balanced and coordinated with the class lectures. At times the mini-lectures were out of sync with the scheduled group work and the students did not have all the tools they needed to complete the work. This aspect was not always negative because it forced students to think beyond the confines of the class. At these times the instructor was critical as a resource to the groups to help them conceptualize or formulate the solutions. It is important for the instructor and a graduate student to serve as a resource for the groups. Dr. Ilvento was fortunate to have TA assistance for the course, but he did not at first require the TA to be at the group exercises. However, with 11 groups he needed at least one other assistant to adequately cover student questions.

Dr. Hyde experienced absolutely no problems with keeping groups “on task” during the in-class group work. She could readily see that students were engaging in conversation related to the problem at hand. The most demanding element she faced was creating problems for the in-class group work. She wanted these group problems to satisfy three criteria: (1) be relevant to either past or future material presented in class, (2) be “doable” in 30 - 45 minutes, (3) be *fun and interesting*. Because the class met at 8:00am, she focused heavily on the third criterion of “fun and interesting”! As an added class feature, she offered daily trivia. This feature usually was an interesting trivia question whose answer was based on consumer surveys. For example, “The average American family loves this food product but spends only about \$2.20 on this product annually. What is this product?” The answer is “Catsup”!

We believe that PBL engages students in learning information in much the same way the student will be required to “learn” in a future employment situation. From our point of view, classes were anything but routine – we found that we never could exactly anticipate what was going to happen in class on any given day. But a common denominator did surface in all class meetings: students were interested, engaged and were not at all passive in their learning roles. Attendance was nearly 100% and it was clear to us that students were more motivated. As with other changes in teaching approaches, we found that many students at first resisted the approach. Later, they not only adapted but many flourished in a PBL environment. Make no mistake – our experience was that PBL is

not “easier” from the instructor’s point of view. We put much more effort in preparing for the course and being group facilitators than if we had used the standard “chalk-and-talk” instructional approach. Was it worth it? Oh yes! We won’t go back!

EFFECTIVENESS AND BENEFITS OF PROBLEM-BASED-LEARNING

We deemed our use of PBL to be a tremendous success. We observed a dramatic increase in student motivation and attendance throughout both courses. From our point of view, classes were anything but routine – we found that we never could exactly anticipate what was going to happen in class on any given day. But a common denominator did surface in all class meetings: students were interested, engaged and were not at all passive in their learning roles.

At the end of each semester, we asked students to voluntarily complete a short evaluation of the PBL methods used the course. Research Methods I students were very positive about the changes in the class. Based on evaluations from 80 students across two semesters, more than 80% indicated that group assignments, take-home group assignments, the web page, and the in-class examples were EACH “very useful” or “useful”. The strongest ratings (Very Useful) were given for the web page and for the availability of Power Point notes. About half rated the group assignments as “Very Useful”. A follow-up question focused on the effectiveness of the overall PBL group experience in helping the student understand the material. On a 10-point scale (with 10 being Very Effective), the average rating was 7.7. Only one student gave a rating of one, while nearly 2/3 (63.6%) gave a rating 8 or higher.

The most recent class of students – those taking Research Methods I in Fall 2001 – were also asked to rate their interest in statistics before taking the class and after taking the class. Using a 10-point scale with 10 representing highest possible interest, the mean “before-the-class” interest score was 3.78. The mean “after-the-class” interest score was 6.81 – an increase of more than 3 points! Not a single student indicated a decreased interest in statistics after taking the course.

In Research Methods II, more than 75% of the students rated the in-class group work as very useful. More than 80% of the students rated the out-of-class group assignments as either very useful or somewhat useful. As in Research Methods I, a follow-up question focused on the effectiveness of the overall PBL group experience in helping the student understand the material. More than 70% of the students gave a rating 8 or higher; the average rating was 8.11.

USING PROBLEM-BASED-LEARNING IN YOUR COURSE

The PBL instructional approach centers on an ill-structured problem that has no simple, fixed, formulaic solution. A starting point for faculty wishing to implement PBL is to take exam questions and word problems and “work backwards” by making complex, messy cases out of these problems. For larger classes of 100 or more students, PBL is possible! Typically, such larger classes consist of 20 or more groups of 5 students each. In this case, peer tutors or graduate assistants are required to direct groups and, if needed, to keep groups on task. Each instructor must set his/her own guidelines for how to handle group grading but these guidelines must be clearly conveyed on the first day of class. Consistency is essential!

The degree to which PBL is student-directed versus teacher-directed is a decision that the instructor must make based on required course coverage, size of the class and maturity level of the students. Many faculty start out PBL as we did – combining “mini-lectures” with various types of in-class and out-of-class group work. Out-of-class group work is feasible for groups of three or four. However, student feedback indicates that out-of-class scheduling becomes problematic with more than 5 people in a group.

One issue, which must be addressed by any faculty who attempts PBL, is course coverage. Unquestionably, when using PBL, course coverage decreases but student understanding of facts/topics covered increases. If problem solving, motivation and active questioning by students are desired results in education, then the “got-to-cover-the-material” instructional model becomes harder to defend.

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