Title
Application of "Case Based Approach" Along with "Generative Model of Teaching" and "Technical Writing" to the Teaching of Applied Statistics

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APPLICATION OF "CASE BASED APPROACH" ALONG WITH "GENERATIVE MODEL OF TEACHING" AND "TECHNICAL WRITING" TO THE TEACHING OF APPLIED STATISTICS

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WHAT PROBLEM DO WE ASPIRE TO SOLVE?

We want to walk away from the traditional overview of statistics as a discipline that relies upon repetitive procedures with fictitious data sets and major emphasis on step-wise and structured procedures.

INSTEAD

We want to present applied statistics as an interdisciplinary approach that allows the students to use statistics to answer real world questions and communicate statistical results.

HOW ARE WE APPROCAHING THIS DILEMMA?

Implementation of case-based approach along with “generative model of teaching” and “technical writing”

WHAT IS CASE-BASED APPROACH?

Presenting applied statistics to the students within the context of a real case study emphasizing:

- An overview of the study and the questions to be answered,
- Variable of the study along with their operational definitions, and how they were measured,
- Design of the study, description of the sample, and data collection,
- Relevant exploratory data analysis and test of assumptions,
- Statistical methods and the relevant mathematical underpinnings,
- Relevant computer printouts,
- Interpretation of the printouts from a mathematical point of view,
- writing the answer to the research question and interpretation of results within the context of the case, and
- Discussion of papers and/or reports about the case.

WHAT IS GENERATIVE MODEL OF TEACHING?

The objective of the generative model of teaching is to minimize the role of the students as passive recipients of information and to maximize their role in the learning process through helping them:

- Understand the relationships between the different parts of the case,
- Generate links among the different parts of the case,
- Generate relationships between their own prior knowledge and experience with the new information, and
- Use the new information to solve real world problems and answer real world questions.

MAJOR FACTORS INVOLVED IN THE GENERATIVE PROCESS OF TEACHING AND LEARNING:

PRECONCEPTION: Learning about students' prior knowledge of statistics, beliefs about statistics, and their learning strategies.

MOTIVATION: Success in generating relations among old knowledge and the new knowledge motivates the students and helps them believe in their ability to do well in statistics.

ATTENTION: Expecting the students to be active participants and generate relationships helps to focus their attention

GENERATION: Generation of relations between the old and the new and the different parts of the new by the students

HOW DO I APPLY THE GENERATIVE MODEL TO THE TEACHING OF APPLIED STATISTICS?

- Assess students' pre-requisite knowledge and ascertain that they learn the missing concepts,
- Discuss in what ways learning and teaching applied statistics is different from mathematics,
- Discuss how the dominant models of learning mathematics (doing procedure, proofs, and solving problems) is not applicable to applied statistics,
- Communicate why it is important that they be active participants and generate their own knowledge,
- Model how they can create links between issues of design, exploratory data analysis, probability, sampling distributions, hypothesis testing,
- Collect anonymous data to monitor their level of attention, motivation, learning, and involvement in the course.

WHY IS USING WRITING IMPORTATN IN THE TEACHING OF APPLIED STATISTICS?

Through engaging in technical writing the student will learn how to:

- communicate statistical finding to a non-statistical and technical audience,
- Link statistical results to real world problems and issues, (An important component when implementing the generative model),
- Explain, clarify, interpret, convince, and publicize information,
- Answer questions that require them to interpret data, communicate, integrate, and synthesize information.

WHY DO STUDENTS FEEL UNCOMFORTABLE WITH WIRING?

- Based on their models of learning, students do not think writing should be a major part of statistics.

- Students in general and the math and engineering majors in particular are not trained how to write and thus feel uncomfortable to be judged on the basis of something they have not been trained for.

- Students generally provide facts and not conclusions defended by numbers and figures.

- Students generally write their opinions rather than arguments supported by numerical reasoning.

- Students have not learned that they need to write something a few times before they have a final draft.

HOW DO I APPLY TECHNICAL WRITING TO TEACHING OF APPLIED STATISTICS?

- Communicate the importance of writing in applied statistics to the students.
- Communicate to the students that writing will be an integral part of this course,
- Model writing results for a statistical and non-statistical audience in lecture notes and labs of which the students get a copy.
- Pose short questions in lecture notes and lab and have the students generate links between the design, statistical concepts, methods, and printout.
- Randomly call on a student to read his/her answer to the short question posed. I have other students add their comments until we have an acceptable response.
- Pair students up and have them read and analyze their responses to short questions.
- Make writing of results for a statistical and non-statistical audience a major part of homeworks, take-home exams and in-class exams, and
- Have students read and analyze journal articles that model how the results should be written.

An example of how I use case-based method combined with generative model and technical writing: Paired sample test of the mean

During lecture, I will:

- Introduce a case study with multiple pre and post continuous measures and various categorical measures such as gender, ethnic background,
- Present students with numerous research questions on the case regarding average gain or comparing the average of pre and post measures,
- Discuss design issue and data collection,
- Discuss sampling distribution, standard error, the role of correlation in standard error, t, and p value, (tie to CLT discussed).
- Present students with printouts for paired sample test on pre and post test and one-sample test of the mean on the difference between post and pre scores (gain scores),
- Discuss different parts of the resulting printouts,
- Model writing the results within context for a statistical audience with (t, p, CI), and
- Model writing the results within context and for a non-statistical audience discussing average change and confidence interval.

During lecture, the students will:

- Read the research questions in the handout on their own,
- Generate similar research questions using the variables in the case,
- Given the relevant printouts, discuss the major findings a pair,
- Answer questions regarding the major findings for each printout as well as similarities and differences between the two printouts,
- Answer questions regarding the sampling distribution of the paired and one-sample test of the mean,
- Answer questions regarding the role of sample size in creating statistical significance and how this is different from statistical significance.
- Write the results of the study within context and share it with their neighbor,
- When called upon, read their write up on the interpretation of the results to the rest of the class.

In teaching the lab on paired-sample test of the mean, I will:

- Present a few research questions that require the use of paired sample test of the mean on pre and post data or one sample test of the mean on gains scores or post-pre.
- Show the students how to run the paired sample the mean and one-sample test of the mean to answer a research question,
- Conduct exploratory data analysis and test of assumption,
- Discuss and demonstrate the role of outliers and sample size on the level of significance and standard error.
- Remind them of the different parts of the printout, and how each part can be calculated,
- Remind them of the mathematical underpinnings of the paired sample test of the mean, and
- Model how to write the results within context.

During lab, the students* will:

- Given a research question, identify the independent and the dependent variables and specify how they were measured,
- Run the relevant analyses to answer the research question(s) posed,
- Run the relevant test of assumptions and discuss the findings,
- Discuss how to calculate and interpret the components of the resulting printouts,
- Discuss the similarities and the differences between the resulting printouts from a conceptual and statistical point of view, and
- Write up the answer to the research question(s) posed within context.

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* The students are persuaded to work in teams of two.

How did the students react to teaching ofapplied statistics through case-based approach, generative teaching, and technical writing?

After the students took the final exam, they were asked to respond to a few questions about the teaching methodology. This survey was anonymous. The students were asked to rate each statement on a scale of 1-5 with 5 standing for the highest. A summary of the results are presented below:

1) I used real data sets and real context to make the learning and teaching more effective. How well did this work? 83.9% of the students rated this question as 4 and 5.

2) I enticed you to engage in writing the results to make learning of applied statistics more effective. How well did this work? 77.4% of the students rated this question as 4 and 5.

3) I tried to engage you in learning by asking you to participate than just listen, how well did this work? 58% of the students ranked this question as 4 and 5. 32.3% gave it a rating of 3.

4) As I was presenting the lecture, I tried to engage you by having you read selected parts of the handout, how well did this work? 51.6% gave this statement ratings of 4 or 5. 25.8% gave it a rating of 3.

5) I designed the lab around real data and tried to engage you in the interpretation of results within context, how well did this work? 57.7% gave this statement and rank of 4 or 5. 22.6% gave it a rank of 3.

What was the best feature of the class?

- The homework, the lab
- Good pace and lots of examples
- Your effort to make us participate, most math classes are not like that
- Learning to analyze data and what we saw
- I enjoyed the participation level. I was never afraid to ask a question because of it.
- The effective methods maximized learning in class and minimized extra work at home
- Ties to actual life cases
- Your concern with student learning
- The labs and learning to compute data
- The atmosphere of the class, easy to ask for help
- Using real data where we can actually have a real “feel” of statistics
- The real life application
- The fact that you do not give credit to only a single right answer on the exam

What was the best feature of this class?

- Hands on labs, real life examples, analysis of data
- The lively mode of the class made it interesting
- Learning practical stuff
- Atmosphere of the class and I can ask questions
- Open book and not exams
- Interesting and motivating
- Handouts
- Practical data sets and giving meaning into what we are learning
- Take home part of the exam was very helpful
- Learning a lot of real stuff and not just from the book
- The teacher was approachable

What helped you the most in learning about statistics?

- Conducting surveys and analyzing them.
- Previous experience in AP statistics
- Enthusiastic teacher and good interaction with Students
- Working with the real data was great
- Labs and handouts
- Learning about the real life cases
- Doing problems
- The examples and the direct applications
- Lecture and discussion
- Having example problems
- The labs helped a lot, more interaction with data
- Practice exams
- I can now interpret data on my own without being fooled by misleading statistical interpretations out there.
- The handouts
- Looking at data and what to expect from the data before trying to solve anything
- Enforcing ideas rather than computation
- The handouts clarified many vague points
- I learned the big picture instead of just calculation