Preparing Secondary Teachers to Teach Statistics: A Distance Education Model

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1. Introduction

In the U.S., most secondary school teachers of statistics have backgrounds in mathematics with little or no training in statistics, and there is no specific certification in statistics. This is problematic because while statistics is a mathematical science, it differs from mathematics in fundamental ways. Workshops (ranging in length from one to five days) are currently the primary vehicle for professional development available to secondary school teachers, but they have several limitations, including the following: most focus on pedagogy over content; the short workshop format is not conducive to the development of full content understanding; and, short workshops lack a mechanism for support that could help sustain participants' continued learning and enthusiasm.

In order to meet this need, a yearlong course for secondary school teachers of statistics was designed in a joint effort by two universities (California Polytechnic State University and University of California, Los Angeles) and the American Statistical Association. The endeavor was funded by a grant from the National Science Foundation which supported course development and course delivery for the first two years of the project. The resulting course, called INSPIRE (Insight into Statistical Practice, Instruction and Reasoning) consisted of both a face-to-face component and a significant online component. The primary goal of the project was to create a unique professional development experience for secondary school teachers that would

- Provide teachers with the necessary background to teach introductory statistics
- Help teachers to incorporate real data, active learning and technology in teaching introductory statistics
- Provide access to a variety of resources for teaching statistics
- Create a community of learners who would advise and support each other in matters of classroom practices, pedagogy and understanding of statistical concepts

The target audience for the course was practicing secondary school teachers who were new to teaching statistics (although not necessarily new to teaching). Our “students” were themselves teaching full-time and were in the unenviable position of trying to learn a new subject while simultaneously teaching it. With this in mind, we attempted to design the course in a way that would be mindful of the fact that as our students were learning the material themselves, they would also be thinking “how can I teach this in my classroom?”

2. Course Overview

The course was designed to have both a face-to-face component and an online component. The course began with a five-day workshop that was intended to help participants recognize differences in mathematics and statistics and in the way these two disciplines are taught, to allow participants to gain a deeper understanding of some basic statistical concepts, and to prepare participants for the online component of the course. The workshop, as the only opportunity for participants to meet face-to-face before working cooperatively over great distances, also facilitates the distance learning component. Research has shown that the creation of a community of learners is vital to the success of a distance education (Hsi 1999).

The online component is the primary vehicle for teaching the statistical content of the course. This component is an introductory statistics course, enhanced with special attention to pedagogical concerns and paced so that the participants will have time to learn the content before presenting the material to their own students. Materials are delivered primarily online in a structured curriculum involving group work, self-study, exploration of concepts, exams, and small projects.

In accordance with the research literature on teaching statistics (Garfield 1995), the distance component is designed so that participants actively participate in constructing their own knowledge, practice what they are intended to learn, confront their misconceptions, work with real data in realistic contexts, and apply statistical analysis software to analyze and visualize data.

3. The Online Component

The statistical content of the course was divided into 15 units, each roughly corresponding to a chapter in a textbook or a "big" idea. For example, the first unit covered summarizing and displaying data and the last unit covered some of the fine points of experimental design. Each unit was scheduled for two to four weeks, depending on the complexity of the unit.

The units themselves were divided into seven sections. The Main Concepts section served as the unit's "homepage"; participants could go there directly by entering the unit's URL into their browser or through accessing the course schedule in the course management system (Blackboard). The other sections appear in the browser as "tabs" and participants could go to any section within the unit by clicking on the corresponding tab. The seven sections comprising each unit were

- **Main Concepts**—A list of ideas and concepts of particular importance. We hoped that this list would help direct the participants' reading of the topic in their textbook and we took care to point out concepts that were important but likely to be missed in a first reading of a textbook.
- **Demonstration**—Not a lecture, but instead an example showing how concepts are used to analyze data or solve problems. Sometimes trickier points were explained or worked out in more detail. The demonstrations were recorded and delivered via Caststream, commercially available software that streams and syncs audio and power-point slides.
- **Activity**—a hands-on activity illustrating concepts introduced in the unit.
- **Teaching Tips**—a list of helpful hints for how to teach the material and what to teach. This section offered advice on what topics were particularly difficult to teach, and provided some ideas for how to make this better.
- **Data Collection and Analysis**—a somewhat directed data analysis exercise using a real or realistic data set.
- **Practice Questions**—a series of short, "homework-like" problems designed to help participants assess whether they were developing basic skills.

- **Milestone**—the milestone was the only required section and the only section that was graded. The milestones were open-ended problems that covered important concepts of the unit.

Participants were encouraged to visit the sections in any order they preferred. Only the "Milestone" section was required. Still, there was an implicit order to the sections reinforced by the fact that the Main Concepts page is the first page visible and by the fact that most readers tend to scan the tabs from left to right.

4. First Year Evaluation and Course Revisions

From the course instructors' perspective, one of the greatest disappointments of the course was the lower than anticipated level of student-to-student interaction. Indeed, even the interaction between students and instructors was sometimes disappointingly low. Some of this can be accounted for by the sort of random occurrences that any actuary could predict would occur during a course as long as ours. During the year, two students had surgery, one moved away, another had the statistics program at her school cancelled. A major difficulty was the students' different work schedules. Some taught their own classes at different paces. Some studied a little each week, while others would try to cover several units in a weekend. This made the discussions disjointed. Another reason for this, though, is that it is perhaps even more difficult to lead a discussion of substance on a "discussion board" than it is in a real classroom. While multiple participants might respond to a question in multiple ways, it is difficult for the moderator to get them to examine each other's answers critically.

These observations were supported by the findings of the project evaluator. Participants were uniformly enthusiastic about the workshop component of the course, and were generally positive, although a bit more reserved, regarding the online portion of the course. Eleven of the thirty-two participants (34%) failed to complete the online course. The teachers who completed the online course generally found the course units to be of high quality (79%) and the content to be about right in difficulty (96%). About one-fifth of the teachers spent 2.5 hours or less on a unit, or more than 5 hours on a unit, with most (50%) spending 2.51 to 5 hours per unit. Most teachers (79%) spent four or fewer hours per week on the course. Only one teacher spent more then 6 hours per week. Ten of the teachers (43%) reported falling behind in the course, while 7 (29%) generally kept up, and the rest sometimes kept up and sometimes fell behind.

When asked to rate the value of the different course components, all rated the Main Concepts as valuable or very valuable, 19 (79%) found the demonstrations to be valuable or very valuable, 96% found the Teaching Tips to be valuable or very valuable, and 92% found the Unit Activity to be valuable or very valuable. Seventy-nine percent rated the Data Collection and Analysis component as valuable or very valuable, 96% rated the Practice Problems as valuable or very valuable, while 71% rated the Milestones as valuable or very valuable. When asked about the group work, only 25% felt it was helpful and should be a required competent of the course, while 42% were unsure.

The eleven participants who did not complete the online course were contacted by the project evaluator and seven responded to an email survey with questions about their experience in the program and their reasons for dropping out of the course. Most dropped out of the online course after two or three months. In spite of the fact that they had dropped out of the online course, all but one teacher felt they had gained important things from the program and all but one reported that their experience impacted their students. The one who reported no gains and no impact felt that he had not been in the program long enough for this to occur.

When asked what the INSPIRE team could have done to keep them from dropping out, most described problems they encountered. Some felt they were not going to do well in the course, some had too many technical difficulties, some reported difficulties with their own background, personal constraints, and keeping up with the schedule and discussions. Overall, time constraints, difficulties with technology, and frustration over being required to participate in online discussions were the biggest factors in these participants' decision to drop out.

In response to the evaluator's report and our assessment of the first offering of the course, several revisions have been made. Two notable changes in the second offering of the course are that more time during the workshop was devoted to helping participants become comfortable with the technology they would be using in the online course and that online instructors are being more intrusive in following up with individual participants and trying to keep participants from falling behind. In addition, less emphasis is being placed on the online discussions. At this time it is too early in the second year to tell if these revisions will improve student retention and satisfaction with the online course, but we are hopeful that this will be the case.

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