Journal of Statistics Education

Preparing Teachers of Statistics: A Graduate Course for Future Teachers

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Journal of Statistics Education Volume 17, Number 2 (2009), www.amstat.org/publications/jse/v17n2/garfield.html

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Key Words: Teacher development; Statistics education; GAISE.

Abstract

This paper describes a unique graduate-level course that prepares teachers of introductory statistics at the college and high school levels. The course was developed as part of a graduate degree program in statistics education. Although originally taught in a face-to-face setting, the class has been converted to an online course to be accessible to more students. The course serves students who are pursuing graduate degrees in a variety of disciplines but who want to teach statistics as part of their careers. It also serves current teachers in high school who are teaching the Advanced Placement Statistics course as well as teachers at two-year and four-year colleges. The curriculum for the course is based on the theory that good teachers of statistics need to be *developed*, as opposed to being *trained*. Building on recent teacher preparation theory, we describe a course that models and builds specific knowledge about teaching and learning statistics. In addition, this course is organized around the six recommendations of the ASA-endorsed Guidelines for Assessment and Instruction in Statistics Education (GAISE).

1. The Challenges Involved in Preparing Teachers to Teach Statistics

Preparing graduate students to teach, as teaching assistants or because some will follow academic careers, is a major concern for mathematics and statistics departments (Moore 2005). Moore writes, "Changing our understanding of what constitutes effective pedagogy, improving the use of technology, and placing an emphasis on working with data in elementary courses raise the standard that teaching assistants must meet. … Training programs should themselves be models of good pedagogy" (2005, p. 1). Moore also writes that competent teaching depends on the learned craft of teaching and he raises the issue of how to help graduate students learn the craft of teaching. A series of articles follow Moore's introduction that describe "the training programs" in place at several major statistics departments (e.g., Harkness and Rosenberg 2005; Froelich, Duckworth, and Stephenson 2005).

There are currently very few courses that are focused on the preparation of teachers of statistics, at any educational level (Garfield and Ben-Zvi 2008). Most of these courses are offered in graduate programs in statistics, and focus on preparing graduate students in these departments to be good teaching assistants and future teachers (e.g., Gelman 2005). The focus of these courses is on teaching methods, which seem to primarily rely on giving good lectures. There are currently three books available that are focused on the teaching of introductory statistics at the college level

(Gelman and Nolan 2002; Garfield 2005; Moore 2000) and sometimes, one of these books is recommended to graduate students as they prepare to become teachers of statistics. There are also many good articles both in print and online versions, but few graduate students are aware of these many resources to improve the teaching of statistics.

At our university, we have created a unique graduate course that has been offered yearly since 2002 called "Becoming a Teacher of Statistics." Although originally a face-to-face course, it has recently been offered as an online course to make it accessible to a wider variety of teachers and graduate students. In our course, we strive to help preservice and in-service teachers become aware of the field of statistics education and its many resources, and to guide them to develop into knowledgeable, reflective, and effective teachers of this subject.

2. What is Needed to be an Effective Teacher of Statistics

While most people agree that a good teacher needs to know his or her subject matter at a deep level, and needs to have good teaching skills, there is also another type of knowledge and related skills that have been defined: pedagogical content knowledge (PCK). This type of knowledge is more specific, as it involves knowledge about teaching of a particular content area. For statistics teachers, this is knowledge about ways to effectively teach important statistical ideas and skills, ways to help students use statistical software and technology tools, and ways to help prevent or overcome typical misunderstandings and misconnections about statistical concepts. Originally described by Shulman (1986), pedagogical content knowledge has been viewed as an important factor in good teaching and promoting student learning. A recent study by Hill, Ball and Schilling (2008) conceptualized and developed measures to assess mathematics teachers' PCK.

In their volume, *Preparing Teachers for a Changing World*, Darling-Hammond and Bransford (2005) discuss the importance of preparing teachers to go beyond "covering the curriculum." Therefore, those who prepare teachers are encouraged to build on the growing knowledge base on learning and teaching to support teachers in meeting these demands. Their book provides a model of professional practice that includes as major components: Knowledge of subject matter and curriculum goals, knowledge of learners, and knowledge of teaching (the subject matter).

In thinking about preparing college level and high school level teachers of statistics, these components are also important to consider. While it is assumed that most graduate students preparing to teach introductory statistics have knowledge of the subject matter, they may be lacking the knowledge of curriculum, learners, and knowledge of teaching (both in general and specifically, of teaching statistics). Our course is designed to help prepare future teachers of statistics to become knowledgeable about each of these areas.

3. Alignment with the Current Guidelines

Any program to prepare teachers of statistics should include and be aligned with current guidelines for teaching statistics at the K-12 and college level that have been approved by the American Statistical Association (see The Guidelines for Assessment and Instruction in Statistics Education – GAISE; amstat.org and Franklin and Garfield 2006). The guidelines pose challenges for novice or even experienced teachers and need to be carefully examined and used as a basis for instruction. That is why our course to prepare teachers of statistics is based on the GAISE guidelines.

These six recommendations are:

1. Emphasize statistical literacy and develop statistical thinking;
2. Use real data;
3. Stress conceptual understanding rather than mere knowledge of procedures;
4. Foster active learning in the classroom;
5. Use technology for developing conceptual understanding and analyzing data;
6. Use assessments to improve and evaluate student learning;

Our course was designed to both help students understand and align their teaching with the GAISE recommendations,

and we therefore organize the course around these recommendations and at the same time address the three important types of knowledge: of curriculum, of learners, and of statistics.

Our broad goals for students who take the course are to:

- Become knowledgeable about current recommendations for teaching introductory statistics
- Learn about different types of first courses in statistics
- Experience and learn about many activities that help students develop understanding of important statistical ideas
- Read articles by leaders in the national and international statistics community
- Gain experience using state of the art technological tools including statistical software, web applets, and simulation/re-sampling methods to help students learn statistics
- Learn about appropriate ways to assess student learning via performance assessment, student projects, and other assessment formats
- Receive many materials and resources for teaching statistics
- Complete a group project that integrates and builds on what is learned in the course.

A three-credit graduate level semester-long course was designed that met once a week--for three hours--to attract both fulltime graduate students as well as in-service teachers at the secondary and postsecondary levels. Each offering of the course has enrolled a variety of students representing different disciplinary backgrounds and teaching experience. Students have been required to read chapters in one or two textbooks (e.g., Moore 2000; Gelman and Nolan 2002) as well as weekly assigned readings.

Each class focuses on a different topic, and students are expected to prepare for class by having read the assigned readings. We discuss readings, watch demonstrations, and participate in various activities during class, many of which involve using technology. Students are expected to attend class and to actively participate in discussions and activities and make assigned presentations. Students are also encouraged to bring in materials, articles, and readings to share with the class.

Table 1 shows a list of some of the weekly topics, along with sample activities covered each week. Appendix A lists several assigned readings for students.

Table 1. Weekly Topics and Sample Activities

Topic	Sample Activities
Introductions and Overview	• Personal experiences learning and teaching statistics • Activities for a first day of class • Types of first and second courses • Introduction to the new and emerging field of statistics education • Introduction to GAISE recommendations
Use real data	• What statistics is and what data analysis is. • EDA in introductory statistics courses • Importance of data, good data sets, how to use them and how to obtain them (from students, from research, from the internet, etc.) • Exploring data using statistical software
Stress conceptual understanding rather than mere	• Discussion of research on teaching and

knowledge of procedures	learning statistics • Examination of research on a particular concept and activities and software built on that research
Emphasize statistical literacy and develop statistical thinking	• Definitions by leading statisticians, educators and researchers • How to teach and assess statistical literacy, reasoning and thinking • Focus on learning outcomes
Foster active learning in the classroom	• Different teaching methods that actively engage students • A focus on cooperative learning • What makes a good activity; critiquing and improving different activities
Technology	• Role of technology in teaching statistics • Different types of tools and their uses • Abstract concepts that technology can help students visualize • Exploration of websites, web software, applets, and more
Assessment	• Ways to develop tests for different learning outcomes and concepts • Exploration of the ARTIST website (Assessment Resource Tools for Improving Statistical Thinking, see (https://app.gen.umn.edu/artist/) • Focus on student projects, project guidelines and scoring rubrics • Review of sample project ideas and sample student projects
A Statistical Reasoning Learning Environment (SRLE) that builds on and integrates the GAISE guidelines.	• Discussion of the SRLE as an alternative to traditional lecture methods • Crafting lesson plans and activities for the SRLE
Innovative courses and curriculum development projects	• Workshop Statistics, AP statistics , CHANCE course, AIMS, interactive, online courses
The Statistics Educational Community	• Where the statistics education field has been and where it is going • Publications, journals, organizations,

conferences, websites
- Some important organizations: Consortium for the Advancement of Undergraduate Statistics Education (CAUSE), American Statistical Association (ASA), International Association for Statistical Education (IASE)
- Discussion of ways to get involved in the statistics education community

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We now elaborate on how our course is built on the six GAISE recommendations.

3.1 Emphasize statistical literacy and develop statistical thinking

This guideline challenges us to carefully examine intended outcomes of a first course in statistics. We do this in two ways. Students are assigned to read and reflect on writings by key statistics educators (e.g., Cobb and Moore 1997; Utts 2003; Wild and Pfannkuch 1999). We distinguish between definitions of statistical literacy, reasoning and thinking (see Garfield and Ben-Zvi 2008) and examine ways to help students develop these outcomes. For example, we look at articles and graphs in the media and ways to have students discuss and critique them (statistical literacy) and ways to engage students in statistical thinking by considering the full process of statistical investigations and the use of student projects.

3.2 Use real data

Data are at the heart of statistical work, and we try to make data the focus for statistical learning as well. In our classes, we examine many data sets as well as ideas for collecting data and consider how data may be used to motivate and engage students. Our teachers are challenged to explore and learn from data in ways we would like them to then have their own students explore data. We discuss the merits of data that can be gathered on a first day of class survey or body measurements (e.g., arm span, hand span, head circumference) that can easily be gathered in class using a measuring tape. We also discuss good types of data that can be gathered on the Internet (e.g., the accessible databases of the CensusAtSchool project at http://www.censusatschool.org/; and the datasets section of the Consortium for the Advancement of Undergraduate Statistics Education (CAUSE) at http://www.causeweb.org/). We even ask students to find and share datasets with their peers as part of a required class assignment.

3.3 Stress conceptual understanding rather than mere knowledge of procedures

The students read some articles from the research literature on some of the difficulties students have understanding important statistical ideas and reasoning about statistical concepts. They participate in activities and discussions where they present their ideas of the important learning goals and have to come to consensus in pairs and then groups of four students.

We focus on several key statistical ideas that we would like our students to understand at a deep conceptual level. Theses ideas have been studied in the research literature and our students investigate what has been learned about developing these ideas as we have them read a sample of the scholarly literature and experience activities that develop these concepts. Some of these big ideas include distribution, variability, model, sample, and inference.

3.4 Foster active learning in the classroom

An important part of our course is the use of and discussion about carefully designed activities that promote student learning through collaboration, interaction, discussion, data, and interesting problems. We discuss with our students the

positive effects of active learning such as short-term mastery, long-term retention, depth of understanding of course material, acquisition of critical thinking or creative problem-posing and problem-solving skills, formation of positive attitudes toward the subject being taught, and level of confidence in knowledge or skills.

We draw our students' attention to two different models of class activities. The first engages students in making conjectures about a problem or a data set, as introduced in the preceding section on using real data. This method involves discussing conjectures, gathering or accessing the relevant data, using technology to test their conjectures, discussing the results, and then reflecting on their own actions and thoughts. Our students experience such activities and then discuss their implementation in class, in addition to benefits and possible obstacles to using such activities. An activity like this that we use involves setting up a blind taste test to determine if students can correctly identify Coke and Pepsi.

The second type of activity is based on cooperative learning, where two or more students are given questions to discuss or an open problem to solve as a group. For example, students could be given an activity involving a Web applet for bivariate data where they are asked to figure out a rule describing how individual points that seem to be outliers may affect the correlation and fitting of a regression line for set of bivariate data (e.g., the *Least Squares Regression* and *Guess the Correlation* applets in http://www.rossmanchance.com/applets/). They try different locations of a point and consider the resulting effect on the correlation coefficient and regression line.

We try to help our future teachers understand that when using cooperative learning activities, it is important that students work together as a group (and often in pairs using technology), not just compare their answers (Johnson, Johnson, and Smith 1998; Roseth, Garfield, and Ben-Zvi 2008).

3.5 Use technology for developing conceptual understanding and analyzing data

An important aspect of our course is exposing our students to innovative technology tools that can be used to explore and simulate data, test conjectures by analyzing data, and develop abstract concepts. Our students experience analyzing data sets using a variety of popular software tools (e.g. , Minitab, StatCrunch) which they then compare and discuss. They also examine *TinkerPlots* (Konold and Miller 2005; http://www.keypress.com/tinkerplots), a tool that allows students to build their own graphs and analyze data in ways that match their own intuitions. *TinkerPlots* is also introduced as a tool that can help them "see" the data hidden by graphs such as histograms and boxplots. They are also given experience using the Fathom software (Key Curriculum Press 2006; http://www.keypress.com/fathom), a flexible tool that allows them to easily explore data, as well as graphing calculators, simulation software, and Web applets.

Students in the course are provided with readings and resources on technology (e.g., Chance, Ben-Zvi, Garfield, and Medina 2007) and are challenged to discuss the important ways technology may be incorporated into activities to enhance students' learning.

3.6 Use assessments to improve and evaluate student learning

An important goal of the course to help our students become knowledgeable about alternative methods of assessment that provide formative information gathered during the process of learning (as opposed to summative information gathered primarily to provide a judgment of how well the student perfumed) should be to utilize that information to guide students' learning. They learn about student projects as a form of authentic assessment that allow students to pose or select a problem, gather or access appropriate data to answer the problem, analyze the data, and write up the results in a technical report and/or presentation. In many cases, projects allow students to collaborate with peers and professionals. Other forms of alternative assessment introduced and examined are assessments of students' statistical literacy (e.g., critique a graph in a newspaper), assessments of reasoning (e.g., write a meaningful short essay), or assessments that provide feedback to the instructor (e.g. , minute papers). We point our students to good assessment resources for creating quizzes and exams such as the ARTIST website (https://app.gen.umn.edu/artist), and consider ways to assess deeper levels of understanding, encouraging our students to move beyond items that focus on definitions, formulas, and computations.

We make the case that students will value what the teacher assesses. Therefore assessments need to be aligned with learning goals. We encourage our students to focus assessments on understanding key ideas and not just on skills, procedures, and computed answers. This should be done with formative assessments used during a course (e.g., quizzes, small projects, or observing and listening to students in class) as well as with summative evaluations (course grades). We attempt to model alternative assessment methods in the course by assessing our students in a variety of ways. For example, students are asked to work in a collaborative group to develop a class lesson plan, find and analyze a good data set, and present and explain a web resource to the class that they think would be a good resource to promote student learning.

4. Promoting Classroom Discourse

Another important goal for the teachers in our courses is to develop an appreciation for the value of classroom statistical discourse. This is different from teachers asking questions and students responding. The kind of discourse we promote is dialogue where students learn to question each other, respond to each other's questions as well as defend their answers and data-based arguments. The use of good activities and technology allows for a new form of classroom discourse. Cobb and McClain (2004) describe the characteristics of effective classroom discourse in which statistical arguments explain why the way in which the data have been organized gives rise to insights into the phenomenon under investigation; students engage in sustained exchanges that focus on significant statistical ideas. We try to model ways to create a classroom climate where our students feel safe expressing their views, even if they are tentative. We encourage them to express their conjectures, and ask other students to comment on these conjectures. Allowing questions that begin with "what do you think" or "what would happen if" can lead to good class discussions.

The final weeks of the course are devoted to student presentations of group and individual projects and assignments. The following section provides details on the required assignments and assessments.

5. Assignments and Assessment

Students are asked to complete one group project and two individual projects, all of which are presented in class. In addition, students write and submit four reflection papers throughout the semester. The following tables (2 and 3) provide details on the assignments and assessments. Points allocated to each assessment are listed below:

- 4 Reflection papers: 25 points each (100 points total)
- 1 write up and presentation on a favorite web resource: 25 points
- 1 write up and presentation of a good data set to use in a statistics course: 25 points
- 1 Group Project and Presentation: Designing a lesson plan (with accompanying materials): 50 points

Total points for student assessments: 200

Table 2. Assignments for Presentation to the Class

Assignment/Assessment	Description
Presentation of a web resource	Students find and share a favorite web resource that can be uses to support student learning in a unique way in a statistics course.
Presentation of a data set	Students find a multivariate data set that interests them and spend time exploring it and learning as much as they can about it. The data set is then shared with the class and discussion revolves around how the data set can be used in an introductory course.
Group Lesson Plan Project	Students work in small groups to develop a detailed lesson plan for one day in an

introductory statistics course.

Table 3: Focus of Assigned Reflection Papers

1. Experiences as a student of statistics and possibly as a teaching assistant or teacher of statistics
2. Description of one class observation of a first course of statistics in light of the GAISE recommendations
3. Summary and critique of three student-selected articles about teaching and/or learning statistics
4. Reflection on the "Becoming a Teacher of Statistics" course experience and the kind of statistics teacher they would like to become

6. Online Version of the Course

After several years of teaching this course exclusively in a face-to-face setting, we decided to adapt it to an online environment, in order to allow students outside of our local area to participate. The first online section of this course was offered during the spring of 2008, and a total of 15 students were enrolled in the online course. Although most of these students were graduate students from our university, three individuals from outside the campus (two community college instructors and one local high school teacher) were also enrolled in the course. A second offering of the online course enrolled 10 students, which is comparable to the number of students in the face-to-face version of the course.

When the online course was designed, efforts were made to preserve the format and content of the face-to-face version of the course. Our initial focus was on creating an online course where students would have many opportunities to collaborate and discuss course material, and to apply what they were learning about. Each week, students in the online course were asked to engage in small-group or whole-class discussion by posting messages in designated discussion areas and responding to messages posted by their peers or by the instructor.

Discussions typically focused around the kinds of topics students would discuss in small or large groups in the classroom. Students posted reflections about the weekly readings, shared and critiqued ideas for classroom activities, discussed ways to implement the GAISE recommendations in the introductory statistics classroom (and talked about the challenges they might face in implementing these recommendations), and evaluated different types of assessment tools and statistical software packages. Other discussions were geared more toward producing products that could be shared with the whole class. For example, in one discussion assignment, students were asked to talk about their understanding of the terms *statistical literacy*, *statistical reasoning*, and *statistical thinking*, and to come up with a list of what they felt were the big ideas students should learn in the introductory statistics course. In a later discussion assignment, students were asked to revisit their list of big ideas and to create activities they might use in their own classrooms in order to help students better understand each of these big ideas.

The assignments students were asked to complete in the online course mirrored the types of assignments students completed in the classroom-based course, but in some cases, the way in which the assignments were submitted or shared with classmates had to be altered. In the classroom, for instance, students typically give short oral presentations when they share web resources or data sets with the class. In the online course, special discussion rooms were set up for students to post and discuss the web resources and data sets they had found. Students were assigned to small

groups to complete the group lesson plan project, and this too was shared by means of posting the project and accompanying materials in a special discussion area. When presenting their projects in the online course, students were asked to create Powerpoint presentations with detailed notes to share with their peers — much like the kinds of presentations they might give were they sharing their lessons at a conference.

In sum, the online version of "Becoming a Teacher of Statistics" retains most of the elements of the classroom version of the course but has a few differences. The main difference is that discussions among students and between students and the instructor are written, rather than oral. This both requires students to be more diligent about expressing themselves in a way that others will be able to read and understand, but at the same time allows students (and the instructor) to read comments and responses that would most likely not been "heard" in a face to face classroom. For example, if a teacher is talking with students who are working together on a group activity, she cannot hear what students in other groups are saying. Second, although almost all of the assignments from the classroom version of the course have been implemented in the online environment, some minor changes have been made to particular assignments. For example, some of the reflection papers have been turned into discussion assignments.

7. Evaluation of the Course

We use several different methods in both versions of the course to evaluate the impact of our course. For example, a midterm feedback form is used as well as an end-of-course evaluation to find out how students are perceiving the course and what they find to be the most valuable. Students in the course typically report on how amazed they are at the vast set of resources available for teachers of statistics and how appreciative they are of the course and what it offers them as future teachers. Most informative are the reflection papers the teachers write throughout the course and, particularly, their end of course teaching philosophy statement that usually documents their integrations of course learning goals. Here are a few comments from students' final reflection papers:

- I can honestly say that this is by far the best education course I have taken. I have seen and heard many excellent ideas for use in my classroom. In fact, I have already implemented ideas into my statistics class. I enjoyed listening to the other students in class give their insights and ideas in to the teaching of statistics…. Thanks for a great class!
- I think the discussions have impacted me the most…. Being able to bounce thoughts and ideas off other educators in the profession is invaluable.
- Many aspects of this course had an impact on me as a teacher of statistics… The presentation of various resources in teaching statistics was a revelation! …Learning about the debates in the field e.g., when to teach what, was very helpful. In addition, the literature on students' misconceptions reminded me that students do not always learn what we intend to teach them and this factor should always be taken into account in the design of any staiststics course.
- Having to design a class was one of the most helpful aspects of this class. It was the project that put everything that we learned together, including content, methods, activities, assessments, use of technology, rubrics, etc.
- The most valuable lesson from this class is was that it made me realize that it is not enough to be a good teacher to make a good teacher of statistics.
- I would strongly recommend this class as a requirement for anyone who is interested in teaching any level of statistics, but especially the introductory classes.
- I view the benefits of this class as threefold. First, I have gotten so many great ideas for activities, many of which I used immediately… Second, through the class discussions and readings I have gained an entirely new view of what statistics education is about. The third major benefit of this course is the collegiality (in working on the project together). . . I think this is how teaching statistics should be. I am a much better teacher of statistics because of it.

These reflection papers suggest that the students in the course take the teaching of statistics very seriously, have expanded their knowledge of statistics education, and have developed their awareness of good teaching and resources for teaching and learning statistics.

Despite the challenges in helping preservice and in-service teachers prepare to teach statistics, we have noticed many

successes. Some of the teachers who have enrolled in the course have joined a local network of college statistics teachers who meet monthly to share teaching ideas and resources, and discuss the teaching of statistics. Other teachers have reported great success in introducing activities into their classes and encouraging their colleagues to also enroll in this class. Graduate students who have taken this course have won teaching awards and have taken good jobs in academic settings where teaching is valued. In 2006, a group of six students from this course attended the US Conference on Teaching Statistics (USCOTS)--funded by an internal grant--where they were excited and inspired to meet and learn from many people in the growing statistical education community. In summary, the course appears to be succeeding in developing knowledgeable, competent, and enthusiastic teachers of statistics.

An additional evaluation concern is whether the online course is as successful as the face-to-face class, and if it is providing students with parallel experiences to those in the face-to-face course. To answer this question, we have looked carefully at student performance on assignments and assessments, and we have examined anonymous midterm and end-of-term feedback provided by the online students. Student engagement in discussion in the online course was high and students appeared to be taking the necessary time to reflect on assigned readings and think critically about their roles as teachers of statistics. Student performance on assignments and assessments in the online course was comparable to what we observe when teaching the course in a classroom setting, and feedback from students was equally positive. One student mentioned that not only did he/she learn more about teaching statistics, but he/she felt that the course served as a good model for teaching in the online environment. The one element of the online course that students felt could be improved related to the way in which discussion groups were configured. Four to six students were in a discussion group that worked together for the entire semester. Some students preferred to change groups during the semester. In the second offering of the online course, assigned discussion groups change at different points during the semester, and there are more opportunities for both small-group and whole-group discussion.

8. Summary

This paper has described the use of the GAISE recommendations to design and teach courses to preservice and in-service teachers in two different settings: face-to-face and online. Unlike some of the teaching assistant training courses or programs that focus primarily on administering large sections of introductory statistics, this course strives to prepare teachers to understand the challenges involved in helping students develop important learning outcomes, by developing both their pedagogical knowledge and their pedagogical content knowledge. We continue to evaluate and revise our classes as we teach them each year. We hope more faculty will explore ways to develop courses for pre-college and postsecondary teachers and we encourage them to consider the different types of knowledge needed by competent teachers of statistics.

As other faculty begin to think about developing a similar course, we offer a few suggestions.

1. Try assemble a team of faculty, or at least, one other colleague, to discuss goals and activities for the course. This will enable more than one faculty member in the department to be invested in the course and to help teach, as well as develop, a better course as result of the collaboration.
2. Look beyond the specific teaching needs of the department but think more broadly about preparing future teachers of statistics who can design their own courses and make good decisions about selecting materials, technology, and assessments.
3. Look for readings that come not just from the statistics education community but also from other disciplines such as mathematics education and psychology, to help students see the connections and implications of this literature for teaching and learning statistics.
4. Don't make assumptions about graduate students' knowledge of statistics or how well they will understand goals of specific activates. Instead, offer them many opportunities to "be the students" and participate in activities and discussions as a way to deepen their own understanding of important statistics concepts.
5. Follow the advice of David Moore listed below.

Moore (2005) offers four recommendations for preparing graduate students to teach statistics: Borrow from existing programs, model good instructional practices, provide students with written materials to study and carry away with them, and evaluate how well you are doing. We concur with these recommendations, and are happy to share our course

materials with others who want to develop such a course. This includes lists of required and recommended readings, assignments, assessments, and evaluation methods. We encourage faculty who have the opportunity to work with graduate students interested in teaching statistics to consider developing and offering a course that goes beyond *training* to developing excellent teachers of statistics.

Appendix A

Sample List of Assigned Readings

Ben-Zvi, D., & Garfield, J. (2008). Introducing the emerging discipline of statistics education. *School Science and Mathematics*, 108, 355-361.

Bryce, G. R. (2002). Undergraduate statistics education: An introduction and review of selected literature. *Journal of Statistics Education* [Online], 10(2) www.amstat.org/publications/jse/v10n2/bryce.html

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Fillebrown, S. (1994). Using projects in an elementary statistics course for non-science majors. *Journal of Statistics Education* [Online], 2(2) www.amstat.org/publications/jse/v2n2/fillebrown.html

GAISE report for the Introductory College course http://www.amstat.org/education/gaise/GAISECollege.htm

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