USING THE OPEN LEARNING INITIATIVE (OLI) TO SUPPORT TEACHING STATISTICS TO INTERNATIONAL POLITICS STUDENTS

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The School of Foreign Service at Georgetown University offers statistics courses for international politics students which include a lab component. The labs are supposed to support the lectures and enhance the courses' learning objectives. The TA-led lab structure, however, failed to achieve this goal. In an effort to use the lab time more effectively, the labs were replaced with web-based modules using Carnegie Mellon's Open Learning Initiative (OLI) platform. OLI is a scientifically-based, interactive online learning environment that has been shown to increase students' learning when used to support face-to-face instruction. Our paper will discuss the design process of the modules and the features of the OLI platform which lead to effective learning processes. We will also present preliminary assessments and how statistics instructors can take advantage of the OLI platform to create materials to support their teaching.

INTRODUCTION

The field of international politics, like most other fields, is becoming more data driven and reliant on large-scale databases for understanding past events, social phenomena, and making predictions about the future. As a result, the demand for statistics courses among students in this field is increasing.

The School of Foreign Service (SFS) at Georgetown University offers two required courses in statistics for students of international politics, one for undergraduates (IPOL 320) and one for graduate students (MSFS 527). The undergraduate course has 160 students a year and is growing (three sections in the fall and five sections in the spring) and the graduate course has 90 students a year (three sections in the fall).

A student who has successfully completed these courses should be able to:

1. Articulate an appreciation for the diverse application of statistics and its relevance to the field of political science and international politics.
2. Demonstrate conceptual understanding of fundamental statistical ideas, such as variability, distribution, association, causation, confidence, and significance.
3. Show introductory level ability to choose, generate, and properly interpret descriptive and inferential methods.
4. Exhibit critical thinking about statistics (e.g., demonstrate the ability to assess the 'validity' of statistical arguments in the popular press and scholarly publications).
5. Demonstrate the ability to effectively communicate statistical ideas and thus be able to participate in social debates in an intelligent way.
6. Demonstrate introductory level experience with using Stata, a statistical software widely used in the social sciences, for data management and analysis.

Each course meets for one lecture per week and one smaller recitation-type lab session taught by a teaching assistant (TA). Due to the SFS curricular requirements, lectures need to cover an extensive amount of material (30% more than the typical introductory statistics course) in one semester. In the fast paced lectures, students learn the different statistical methods, when to use them, and some of the mathematical rationale behind each method. It is therefore the role of the labs to enhance the course objectives by giving the students a chance to apply the information learned during lecture using a statistical software (Stata) to analyze real data. In their current structure and environment the TA-led labs do not achieve this. The students follow the TA's instructions but do not get a chance to "get their hands dirty" with data. Students' misconceptions are not revealed and therefore not addressed, and the course evaluations show that students have a hard time understanding how the lab materials fit into the overall course objectives. In addition, students come to lecture with varying levels of preparedness, which is largely due to large

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variability in the TAs' pedagogical abilities. As a result, valuable lecture time is spent on ensuring uniformity.

Clearly, a more engaging, interactive, and uniform lab experience designed to address the individual needs of students is needed so that it can more efficiently support the lectures and enhance the course objectives. In this paper, we discuss an ongoing effort to create this type of lab experience using Carnegie Mellon University's Open Learning Initiative platform.

THE OPEN LEARNING INITIATIVE (OLI) PLATFORM

Carnegie Mellon University's Open Learning Initiative (OLI) platform is a scientifically-based, classroom tested learning environment that presents the students with content and provides multiple opportunities for practice and self-assessment in the form of pedagogically-scaffolded activities (For more information, please visit the OLI website at http://oli.cmu.edu/). From the students' perspective, these activities share some of the features of studying with a human tutor, so we call these activities "mini-tutors." They provide assistance (in the form of hints) to the students when they get stuck, give immediate and tailored feedback on their answers, and prompts them to try again. Studies have shown that immediate feedback leads to significant reductions in time taken by students to achieve a desired level of performance (Anderson, Conrad, & Corbett, 1989). At the same time, the platform provides timely feedback to the instructor about the students' progress. This feedback highlights concepts that the students are struggling with, and reveals common misconceptions. Equipped with this feedback, the instructor can use lecture time more efficiently. Meyer and Thille (2006) discuss in more detail the process of designing the course and key features of the OLI platform.

The OLI platform has been shown to significantly increase learning gains and retention when used in conjunction with face-to-face instruction (Lovett, Meyer, & Thille, 2008). More specifically, carefully controlled studies have shown that students who used the OLI Statistics course demonstrated learning outcomes equal to or better than the traditional class, and in some cases in half the time (Wessel, 2012 and Lovett, Meyer, & Thille, 2010). The study that has drawn the most national recognition to OLI was conducted by independent researchers, Bowen, Chingos, Lack, and Nygren (2012, 2014). Six public university campuses participated in a randomized trial, comparing the OLI Statistics course, taught in hybrid mode, to a traditional Statistics course. The study found that even though the students who used OLI had less face-to-face time with an instructor and spent 25% less time on the course compared to students in the traditional class, they performed slightly better (but not significantly so).

The pedagogical features of the OLI platform, as well as its proven pedagogical effectiveness, made it uniquely fitting to address the current challenges of the SFS statistics courses. The proposed, interactive, self-paced OLI lab modules will reinforce the lecture material and fundamental statistical ideas in the context of real political science data. Additionally, it will engage students in hands-on activities where they will reflect on and test their own knowledge.

IMPLEMENTATION

In the first phase of this project we created six modules to be used in three labs (two modules in each lab). The first lab of the semester is more technical and includes a module on the World Bank's "DataBank" and a module on using the software Stata. The second lab of the semester covers exploratory data analysis and includes a module on categorical data (including cross tabulations) and a module on exploring the distribution of a quantitative variable. The next OLI lab is the fifth lab of the semester and covers interval estimation; a module on confidence interval for the population mean and one on confidence intervals for the population proportion. We chose these three particular labs for two mains reasons. First, we wanted the labs to include different aspects of statistics (producing data, use of statistical software, descriptive, inferential). In addition, we wanted to have some TA-led labs in-between two OLI labs so that we could ask students to compare the two learning experiences.

The design and development of each of the modules followed a similar process. We started by carefully outlining the student-centered measurable learning objectives, which are the underpinnings of each module. The OLI platform makes these objectives visible to the students on the top of each page (Figure 1).

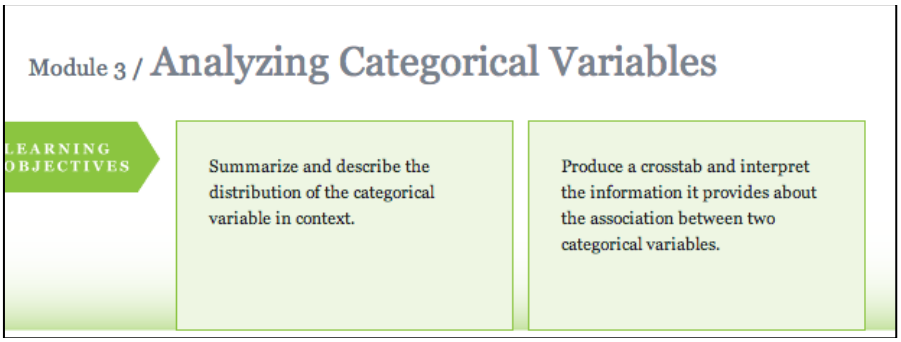

Figure 1. Learning Objective for Module 3

Next, we created the content, bearing in mind that the modules were not intended to teach the material (lectures do that) but rather support the lecture by showing the students how the material is applied in practice in the context of international politics. We also wanted to help students make the connection between the different topics, since "novices' conceptual knowledge is often fragmented and needs to be integrated over the course of learning" (Rittle-Johnson & Schneider in press). Figure 2 shows an example of content related to confidence intervals for the population proportion. We emphasize the "Big Picture" of statistics so that students see how the isolated topics fit together in a meaningful way.

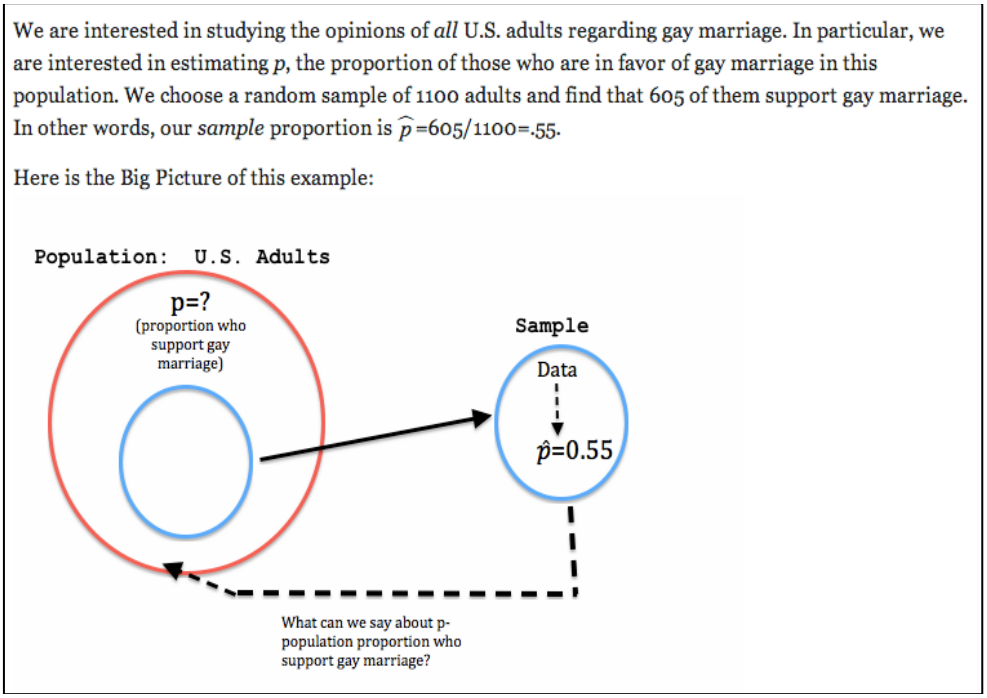

Figure 2. Content from the Module on Confidence Intervals for the Population Proportion

Our next step was to decide on the places within the module where activities are needed in order to support students' learning. Each activity was then carefully created by including common misconceptions as distractors as well as tailored feedback and hints. The left side of Figure 3 shows one such activity that was designed to exercise specific skills related to measures of center. The figure shows that when the student answers the question incorrectly, the system provides tailored feedback. Note that the right side of Figure 3 is part of the feedback (when the student clicks on "following figure").

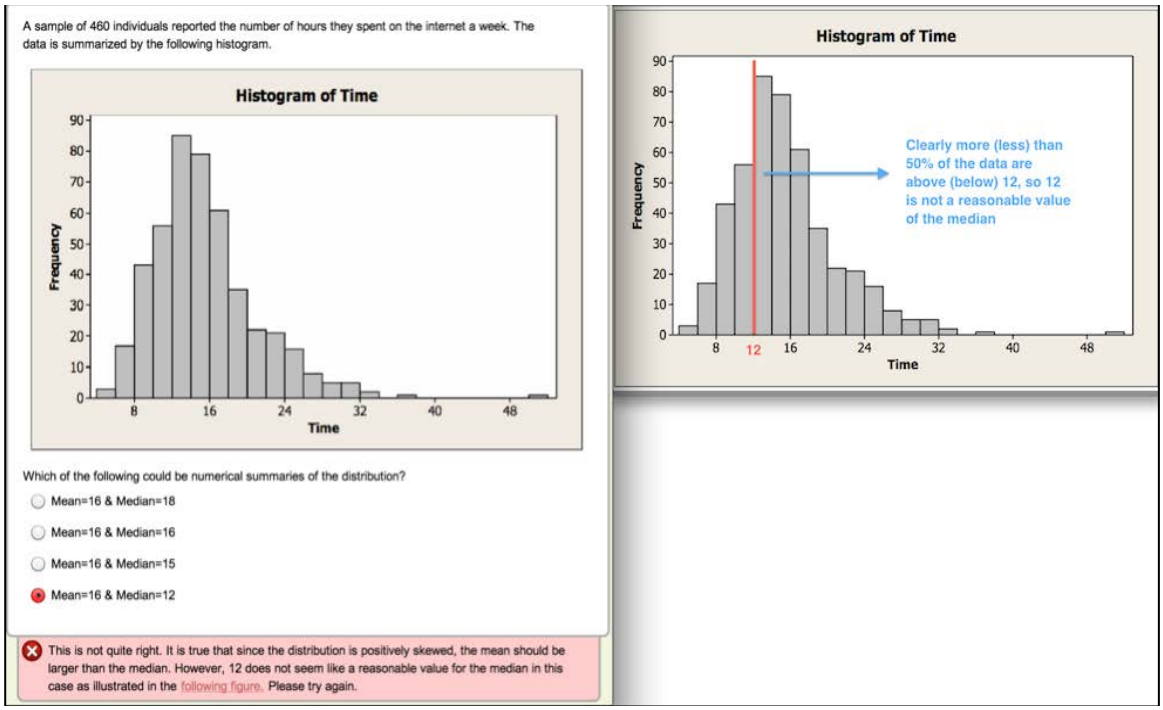

Figure 3. Activity with Immediate and Targeted Feedback

As we mentioned earlier, the OLI system also provides feedback to the instructor, which can be seen in Figure 4. The instructor sees the distribution of the students' answers and can assess what specific skills the students are struggling with and what misconceptions are the source of their confusion.

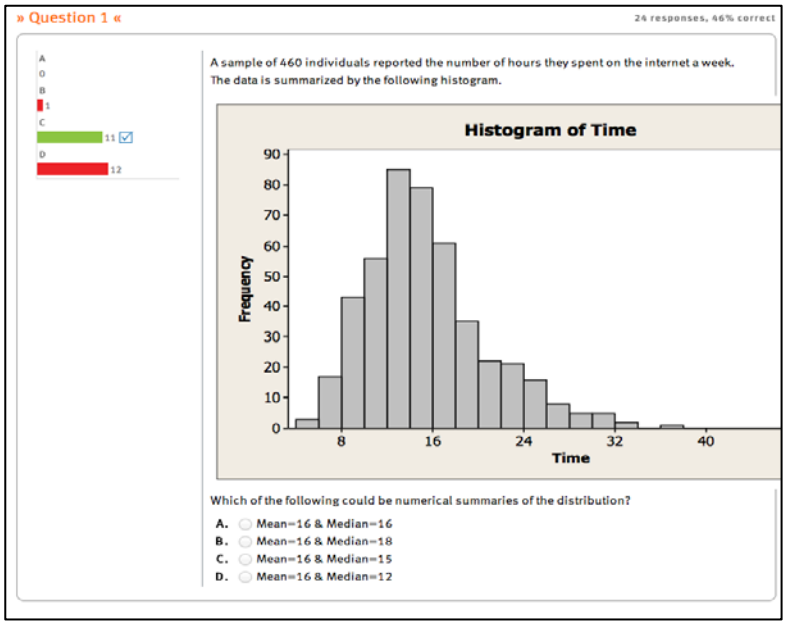

Figure 4. Feedback to the Instructor

After the completed modules were repeatedly tested for any technological glitches they were incorporated into the Fall 2013 courses. In each of the three OLI labs, the students worked through the material at their own pace in a guided environment where the TAs were present to answer any questions. On the fifth week of the course, after experiencing three OLI labs (weeks 1, 2, and 5) and two TA-led labs (weeks 3 and 4), feedback was collected from the students.

ASSESSMENT

Evaluation Design

Our plan for assessing the pedagogical effectiveness of the six OLI modules has two stages. The first stage was implemented in the Fall 2013 semester and focused on assessing the students' attitudes of the online modules themselves and in comparison to the TA-led labs. The second stage is currently being implemented in the form of a controlled study in order to compare the learning gains of students who used the OLI labs to students who experienced only TA-led labs.

During the fifth week of the fall 2013 semester, after students completed the OLI labs and also experienced two TA-led labs, we gathered attitudinal feedback using a Likert style survey that also included some open-ended questions. The survey was designed to collect information about what features of the modules the students liked/disliked and suggestions for improvements. Students were also asked to gauge their perceived advantages and disadvantages of the OLI platform and compare them to the TA-led labs. Most importantly, we asked students to identify the features of the modules that they found most beneficial to their learning experience and retention of the material.

Results

Overall, both the graduate and undergraduate students expressed very positive opinions about the presentation of the material through OLI, the activities, and the general features of the OLI platform. (Percentages below represent the proportion of students who either agreed or strongly agreed with the statement.) More specifically, students felt that the material was written in a way that was easy to understand (95% undergraduate, and 97% graduate) and helpful for learning Stata (84% undergraduate, and 100% graduate). Students almost unanimously agreed that the activities enhanced their understanding of the material (100% undergraduate and 92% graduate). In addition, students felt that being able to work at their own pace and go back to previous material were useful for their learning processes (89% undergraduate and 95% graduate). Finally, a majority of respondents also said they would recommend OLI labs to a friend (84% undergraduate and 79% graduate). The only feature of the OLI system that the students did not find useful at all is having the course objective listed and visible at the top of each page.

The open-ended questions were quite insightful. When we asked students which of the two types of labs they prefer, over 50% of the students suggested a hybrid model. In particular, we found that most students do not want to let go of the human component and instead favor a system that integrates the OLI platform with a TA presence. One student stated, "I think the OLI self-paced labs are very helpful, but only in conjunction with a TA to help out members of the class. Being self-paced helps individuals who are feeling confident, or conversely, feeling lost to go through the material in their own time." We found it quite interesting that most students suggested a blend between the TA and the OLI, which is exactly the model that has been shown to lead to significant increase in learning gains (Lovett, Meyer, & Thille 2008).

SUMMARY AND FUTURE WORK

With all the materials to support statistics courses that are available online, it is tempting to choose an adequate "off the shelf" product and let the 'technology drive the pedagogy'. Choosing the OLI learning environment as the platform on which to create materials that address the *specific needs* of our courses is a wonderful example of how the 'pedagogy drives the technology', as we believe it should be. Lovett and Meyer (2014) present other creative ways in which academic programs have used OLI materials to support their curricular needs. The experiences and qualitative assessments that we've conducted so far suggest that letting students work through OLI modules instead of the TA-led labs leads to an overall better learning experiences for the students. The next step is to formally test this hypothesis. We are currently conducting a controlled study to compare learning gains of students who use the OLI modules during labs to students in the traditional TA-led labs. The results of this study will be presented in future papers.

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