Improving and contextualising statistics service teaching: An online module-based teaching and assessment tool for statistical laboratory sessions

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Abstract

The laboratory sessions of service-taught statistics courses are a critical component of achieving statistical capability. The laboratory sessions should challenge the students’ ability to apply their knowledge to contextualised data, and equip them with the necessary tools and skills to undertake data analysis in any future course or work-related context. Traditionally, statistics laboratory sessions are taught with a teaching/demonstration focus. Through feedback from courseware evaluations, a teaching via demonstration focus was replaced by a student self-guided learning approach with tutorial support. This approach improved interactive learning and feedback, however necessitated the expenditure of extra time and use of tutors in both supervision and assessment in the lab. In this paper we discuss the features of a completely online laboratory module system, encompassing both self-guided sessions and assessment, within a single framework. This moves the assessment process from the current subjective assessment to objective online assessment. Three years feedback from students indicates that the system provides a clearer teaching and grading process compared to classic lab systems. Results also indicate that the laboratory modules were completed faster than anticipated, with time saved leading to the ability to extend material beyond the current levels.

Keywords: teaching statistics, online learning, SPSS

1. Introduction

The statistics laboratory session is a critical component of all statistics courses. Statistics laboratory sessions bring together the theory components from lectures and challenge the students to apply their knowledge to contextualised data. In this paper we discuss the features of our online laboratory modules, encompassing both self-guided sessions (Interactive Phase), i.e. the ‘how-to-do-it’, including instantaneous feedback via assessing whether students are on the right track, and the assessment of understanding of key concepts used in the statistical analysis produced by the computer output. Each laboratory session contains a self-guided session (Interactive Phase) consisting of detailed instructions and formative assessment. Once the student completes this phase, they move on to the Assessment Phase which contains a number of randomised questions designed to test the student understanding of the objectives.

In moving to this interactive online approach, we looked to some references that helped guide our approach. As outlined in [1] we wanted to provide students with feedback on their learning as well as allow them the chance to assess and reflect on their learning. The self-guided sessions, ‘the interactive phase’, give students the chance to undertake the steps in statistical analysis, correct any errors made, reflect on the completed task, then apply the knowledge to a selected set of data analysis problems similar to those encountered earlier all in an online environment. This is an improvement on many existing systems in that feedback is instantaneous if an error is made (whereas in a classic lab setting the student would have to wait for a tutor); and it is simpler to identify at which step the error is made as the student cannot progress further. The online assessment phase (without Interactive responses) reflects the capabilities acquired in the Interactive Phase. Also, the online assessment phase cannot be undertaken until the Interactive phase is completed. Finally, the
process is objective in that it removes any potential bias in assessment between tutors. As outlined in the five considerations when Assessing Large Classes [2] (and as our students are all from large classes of 150) we meet the five distinct challenges involving the assessment of large student cohorts. Specifically, we “Avoid assessment that encourages shallow learning” by developing material to the highest level required for the course. We “Provide high quality, individual feedback” with instantaneous feedback on all incorrect choices in the Interaction phase, with direction to what went wrong. An introductory unit is also offered so the students develop the skill level required to undertake the labs. This will help a diverse mix of students reach a minimum level of skill prior to commencing any laboratory work.

As stated in the Work-Integrated Learning Paper [3], retention of learning is said to be much greater when it occurs in a real-life context. Firstly, we apply contextualised data, bringing to life the theory in future work environments. Secondly, we use a computer package (SPSS) that reflects use in industry. Finally, the modules provide feedback on which students have met target attributes and competencies required not only in later years of their program, but in the workplace, through recorded completion and grading. This assists the course co-ordinator and tutors in determining who may need additional assistance.

Course evaluations of the lab sessions conducted prior to this project indicated that students want a different approach that would motivate them to do their best. For some courses, the laboratory sessions are conducted immediately after a two-hour lecture. Course leaders have conveyed comment from students that this timing leads to some students not performing their best because they are too tired. This coupled with an inadequate number of tutors to look after a large lab class compounds the frustration of the students when they need assistance. Furthermore, the in-lab assessment via the tutors is extremely time-consuming as students patiently wait their turn to work for assessment.

Articles in the Journal of Statistical Education, Teaching Statistics and the Institute of Statistical Education revealed other projects undertaking online and long distance learning in some form. Keeler [4] discussed the use of statistics towards an e-portfolio - specifically of interest to us was the use of SPSS. The delivery of materials used by Keeler was to provide written laboratory notes to learn the use of the package, and a few data sets to build the students capabilities before attempting a project. Other work indicates the attractiveness of our approach to teaching. Kaput [5] notes that technology can facilitate reflection through ‘procedure capturing’ where students replay problem solving processes to help learners focus on the process they used to solve the problem. Galmacci and Milito [6] and Laio [7] use a multimedia approach for the delivery of statistics. Galmacci and Milito [6] note the difficulties in teaching large statistics classes using online materials, and states that data and lab orientated teaching “gave generally the best results: students seem to reach a better level of knowledge, ability and criticism”. An outstanding paper outlining a Module process similar to ours is Aydmh, Hardle and Roonz [8]: “This concept enables each teacher to compile his own statistics course of instruction (which is called view in e-stat) to match the different needs, interests and backgrounds of the audience. A view comprises a course, which can be either more general in statistical theory (without a specific target of application) or for statistics within a specified subject area. With this technology it is possible to address students of many different fields.” Trends suggest the move to online learning in statistics is worthwhile and valuable, with authors such as Haerdle proclaiming it a success from both introductory to advanced levels of statistics. The method of teaching and assessment in this project (tutorial face-face assistance with entire online materials in a module form) is a direction that builds upon successful existing principles of online statistical delivery.

2. Methodology

Prior to this project, the method used to teach our service students statistics utilised a number of packages. Currently, the largest course of undergraduate statistics students undertake six modules. Each module requires the use of four computer software packages: The PDF/word document containing the actual laboratory tasks; SPSS to conduct the analysis; Word to copy, paste and produce the report; and a web browser to distribute the lab, and any associated data sets. Then the tutor assessment through visual inspection. This is shown in Figure 1.

Figure 1 Application distribution prior to this project: interplay of programs and flow of exchange in labs

This method leads to a rather cluttered desktop. At times up to seven different windows are open. With this in mind, our method incorporated the instructional component (the word document) as part of the assessed
project component, thereby removing the need for a separate word document for assessment. Figure 2 shows the reduced amount of screen utilities.

Figure 2 The new approach

This project contained a number of developmental steps.

Step 1. Module identification: This involved the identification of common topics across disciplines that needed to be included in the modules. Inclusion of topics that reflect this commonality would enhance the portability of the tool across various service discipline areas. We began by looking at what laboratory topics were required across disciplines (say for example, linear regression). As we are initially dealing with the largest cohort first year large classes, these topics were a priority.

Step 2. Establishing the criteria for satisfactory completion of the Module: Within each Module, the specific capabilities required for satisfactory completion were identified. Each capability is evaluated within the online assessment module.

Step 3. Build the generic self-guided session (Interactive Phase): The self-guided session consists of a series of ‘how-to-do-it’ online pages with step-by-step instructions on performing the statistical analysis. Students are prompted on where they are, within the session, using multi-choice or short answer questions. For example:

Students are asked to produce an ANOVA table. They are shown ‘how to do it’, and then asked to do it themselves. They then compare their output to a variety of output shown on the module. If the students produce an incorrect table, they will select the incorrect response. Feedback is then given on how they made the error providing formative feedback, and they are asked to try again. The self-guided session is generic – the data and questions are uniform in structure with contextualisation added when imported into the specific course.

Step 4. Build the generic online assessment module (Assessment Phase): The capabilities acquired in the Interactive Phase are tested in the assessment component of the module. This is delivered using the Test procedure in Weblearn (weblearn.rmit.edu.au). Again, the format is generic. Multiple sets of data are used so that randomised questions are delivered.

Figure 3 gives an overview of how a module is structured. Note how the Interactive Phase allows students to take a quiz multiple times allowing them to move to the assessment phase when they are comfortable with their progress. While the interactive phase can be accessed multiple times, the assessment phase can only be taken once. This is because the assessment phase is summative in nature and is used to evaluate the students’ level of progress.

Step 5. Contextualising steps 3 and 4: With the generic self-guided session and assessment built, the completed module is uploaded to the specific course where the questions are contextualised. The course coordinator simply rewords questions to suit the context. Of course, added flexibility of online delivery allows the coordinator to eliminate any questions which are not appropriate (such as not covered, or not applicable to the discipline), or adds questions and data that may be more specific.

Step 6. Evaluating the system: Students who have undertaken the statistics modules under the old system were asked to undertake one of the modules “Custom tables and the Chi-squared test”. Students filled out anonymous questionnaires and were asked to volunteer any comments that might assist in creating a better teaching experience. Questions were designed to obtain the students’ opinions on the complexity, clarity, and applicability of each phase of the module. Also, there were questions on their overall impressions of the system. Once it had been decided how best to address the comments, we moved back to Steps 3 and 4 and modified the modules. After implementation, systematic evaluation through student surveys was carefully assessed.

3. Analysis

Some examples of the questions contained in a module are given in Figures 4 and 5. Figure 4 shows how the interactive phase is used to give the student feedback. In this case, the student has picked an incorrect answer and
pointers are given as to how the correct answer may be obtained.

Figure 5 shows another question from one of the modules. In this case, the student has to load a dataset into SPSS prior to performing any statistical analyses.

This system has recently completed its third semester of implementation. Overall impressions has been positive, “It is a fantastic method of education and I could not speak more highly of it in terms of both teaching and assessment.” Internal course surveys have seen the percentage agreement for “The web-based (online) materials in this course are effective in assisting my learning.” improve from 46% (2006, n=91) to 81% (2007, n=91), and 89% (2008, n=108).

4. Recommendations

There are some important practical considerations in the construction of the modules. First, the modules are based on Weblearn. Being a specific system, we believe our approach is only directly useable within the Weblearn framework, however the generic structure is simple enough to apply to broader systems such as Flash. To create the interactive phase, Word documents that are currently being used for teaching are converted to HTML, and any images are converted to a jpeg format. If this is not in-place already then substantial time is needed in constructing the notes: the time required to construct the modules is substantial (however altered easily). On-going alterations and fine-tuning to the content of the modules is continually used based on feedback from the students and lab tutors. As such the project will continue to improve and evolve over time.

5. Conclusion

In summary, the improvements include: objective assessment to remove potential bias in grading between tutors; reduced time in grading assessment, thereby releasing more time for tutors to spend on assisting students with concepts; an efficient way of tracking student attendance in large classes; laboratory modules enabling greater inter-disciplinary usage of the central system; facilitation of off-campus, flexible learning, allowing students to receive lab grading and feedback at any time and place; access for students after-course completion as a resource they can use in later years; reduced feedback time to students; reduced plagiarism with randomised material; and management of the volume of marking and staff involved in marking.

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References