Effective Interactive Activities for Online Statistics Courses

Faith Chao
Department of Mathematics
Golden Gate University
536 Mission Street
San Francisco, CA 94105
fchao@ggu.edu

T. J. Tabara
Department of Mathematics
Golden Gate University
536 Mission Street
San Francisco, CA 94105
ttabara@ggu.edu

Abstract

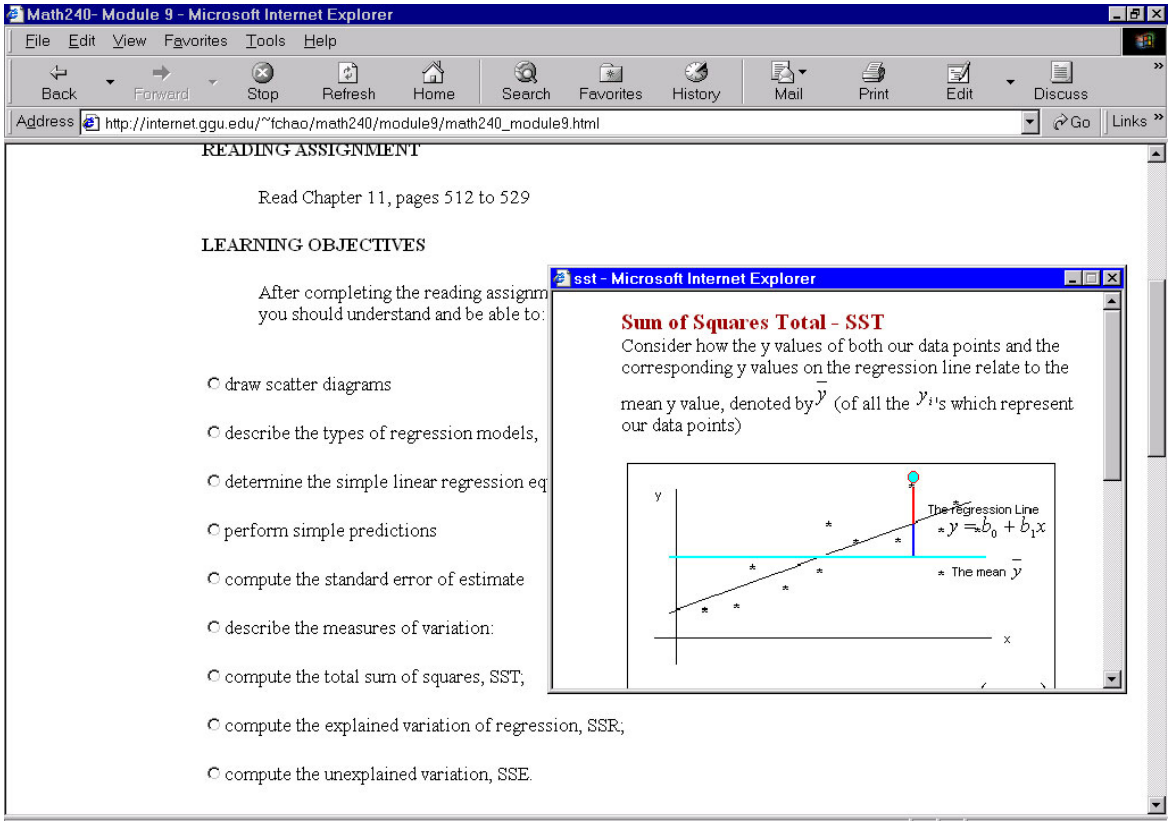
It is a challenge to design effective interactive activities for mathematics and statistics courses, especially when the modality of the course is online, and where students have different backgrounds in culture. We will present several different types of these activities that we have found to be effective, those that allow the students to interact only with programs and machines, and those that encourage students to interact with each other. We will also present statistics on the differences in behavior between undergraduate and graduate students in a first course in Statistics.

Design Considerations for Online Graphics Based Learning Environments

Our online students demanded more than textbook translations and supplemental lecture notes; they wanted a rich graphics source of interactive materials and activities necessary to keep them on track. It has been understood for some time that interaction is of major importance in the live classroom. (Flanders 1970; McCroskey and Anderson 1976.) We'd claim that it is clear that interaction in online courses is a definite requirement. Our online course designs incorporate a full and varied set of course materials and interactions to provide the student with a necessary lifeline to proceed through the course. As both graduate and undergraduate courses are the first course in statistics at Golden Gate University, they use the same design and have a great deal of common materials. The major differences are that the graduate course covers more materials in the same span of time of 15 weeks, approximately one third more materials, and in the manner the students are evaluated. The undergraduate course has 13 multiple-choice machine-graded homework quizzes, one take-home midterm and a proctored final. The Graduate Course also has 13 multiple choice machine-graded homework quizzes. It has a proctored midterm testing the skills students should have acquired, and a final project instead of a final exam. Both classes have weekly discussion sessions.

Examples of Interactive files and programs:

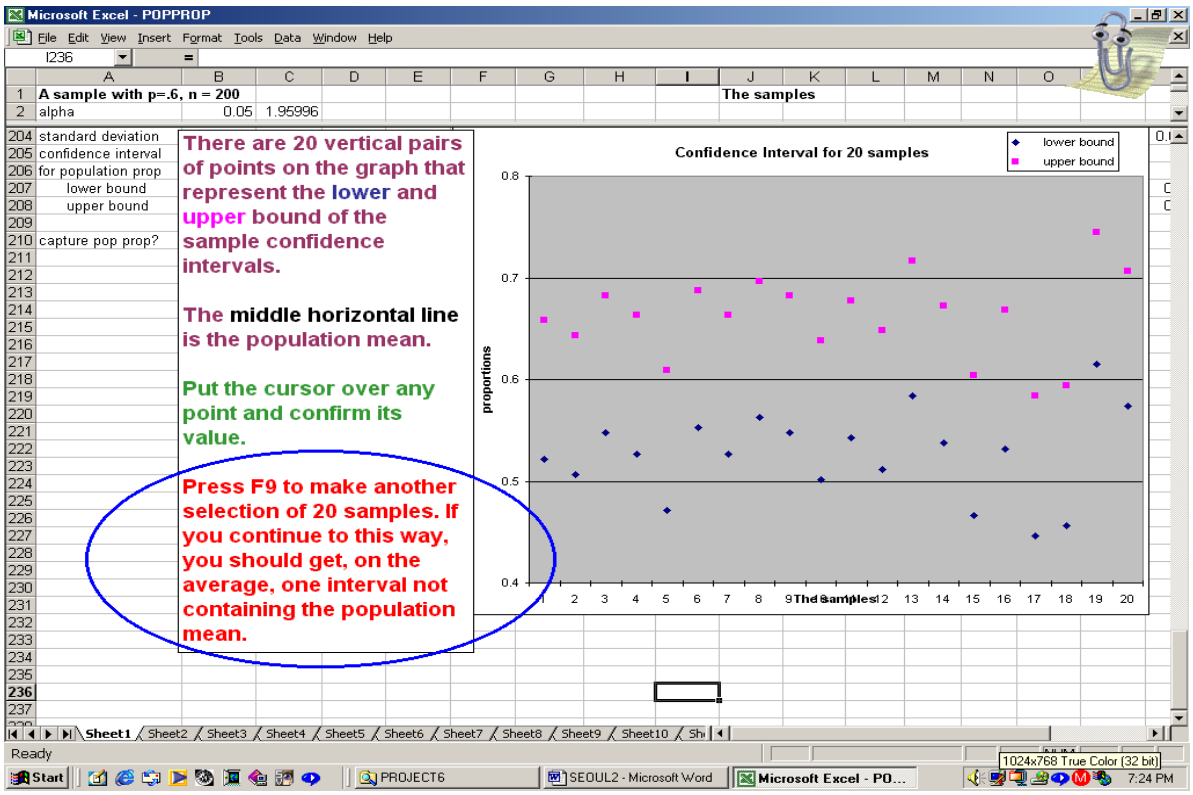
- **Learning Objectives**
  A full description and discussion of learning objectives can be assessed interactively by the students using radio buttons to view forth files, each addressing one single individual topic.



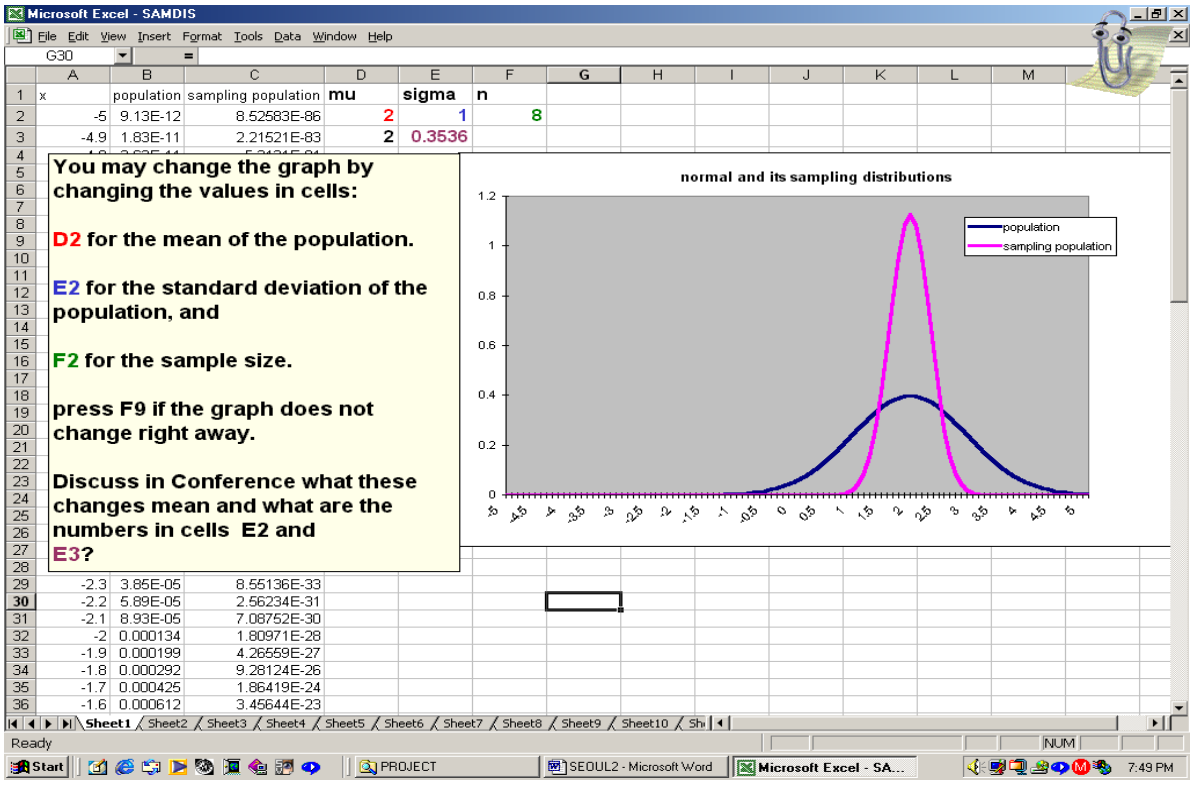
This feature allows the students to first obtain an idea of the material that they are expected to learn and understand, and later accessing the individual screens forms an efficient way to review.

- **Interactive Excel files**
  Excel has capabilities to construct graphs and table and to illustrate course concepts. It is also readily available to students and relatively easy to use. Prepared Excel files can be easily downloaded from web pages or e-mail attachments.

  Below is an example of an interactive prepared Excel file that allows the students to choose 20 samples randomly at a time.

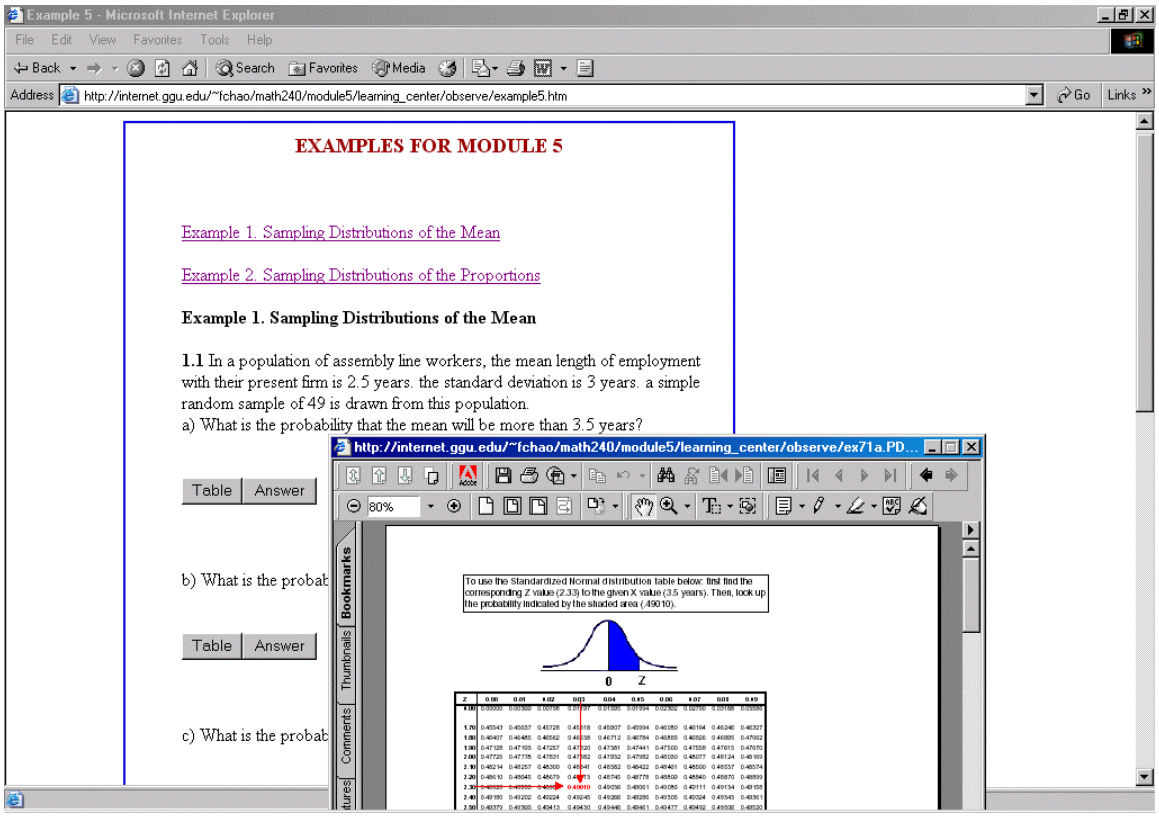


Another example illustrates the relationship between the population and its sampling distribution:



Students feel that learning Excel is something that will be of great benefit to them in their working career, far beyond their everyday use of Excel and classroom experience. As a result, there is little, if any, resistance to learn how to use this software. In fact, once students become familiar with interactive Excel files, the demand to provide more examples becomes a challenge.

- **Worked out examples**
  This is usually the lifeline of students taking an online course. Every week, step-by-step explanations of solutions to selected problems are provided with a button when student either are not able to do the problem or wishes to confirm an answer. The use of opening a small screen at the student's command also allows us to illustrate in a most effective way on how to use tables.



- **Computer-graded Homework Assignments**
  Computer-graded multiple choice homework assignments provide immediate feedback to both the instructor and the student.

- **Case Studies/Projects**
  Case studies/Projects are incorporated to give students the opportunity to use real data in discipline-specific situations. Relating the course material

to real situations in the student's discipline provides the framework for students to apply what they are learning and thus reinforcing that learning.

Redirecting the Learning Effort to the Student

Online course delivery creates an opportunity to move from a teacher-directed instruction to student-directed learning and experimentation. Mathematical and statistical software can encourage students to interactively experiment with course topics. The opened-ended study time frame of online courses stands in stark contrast to the traditional 55-minute class period. In fact, the online lab ends when students reach their limits in terms of curiosity and experimentation. Typically, our online students spend hundreds of hours logging onto the course, with the undergraduate students logging more time on average. It seems clear that the total commitment in time for online students far exceed that for the student on in-person classes or even web-enhanced classes. Typically a web-enhanced classes student will spend only around between 10 to 15 hours rather than hundreds of hours. (See Attachment)

Sustaining Student Interest and Commitment – Discussions Allows Personal Interaction

Contact with students is multi-faceted. Email, and fax communication (sometimes telephone) enable a personal, one-on-one interaction between the instructor and a student. It presents an opportunity for individualized attention, study suggestions and extensions of course topics to career interests. Hachman and Walker in 1990 claim that participation by a learner during class has a positive effect on the student's learning and satisfaction. The "discussion" feature of our online course is to insure that students can and are encouraged to participate. Each week we post a discussion topic with suggested activities, such as searching the web for an article or asking the students to respond to a question or scenario. Students will post their thoughts, questions or answers in "discussion" where all can see and comment. Although our interaction online is asynchronous, replies usually takes less than 24 hours. The advantages of asynchronous communications over synchronous communications seem to outweigh the disadvantages since it would give a student enough time to digest what is posted and how to respond to the discussion item. Many students will email us if they have a specific question or if they are experiencing some individual difficulties, either with the material or with technology.

Our system focuses on the public forum similar to the classroom environment. Instructors can provide feedback to students on their weekly assignments and build community through small group and student-to-student interactions.

It is curious that the undergraduate students spend more time in total in discussions and posting significantly more messages than the typical graduate student. The quality of the posting are even better on the whole until the graduate students reach multiple regression,

and time-series analysis beyond the scope of the undergraduate course. The graduate class seems to come alive at that time. Most of the postings after we reached these topics are thoughtful, insightful and thorough, sometimes well researched. Our speculation is that the graduate student is focused, knowing what they want to get out of the course and apportioned their time accordingly. When they reached a subject they feel is important and related to their jobs and career, they will spend more time and do more in-depth discussion. (See Attachment)

Comparing Outcomes

It is clear that although the undergraduate class was achieving higher scores all the way through 2/3 of the course, the graduate students caught up after reaching a subject they found useful and achieved, in our opinion, a deeper understanding of the concepts.

We performed hypothesis testing using the pooled-variance *t*-test for the difference between two means of the undergraduate and the graduate classes. Below is the summary table for each hypothesis test with the significance level of 5%.

Syllabus		**Outline**		**Online Testing**			**Files**	
Hits	Time	Hits	Time	Hits	Time	# of Tests	Hits	Time
Not Reject	Not Reject	Not Reject	Not Reject	Not Reject	Not Reject	**Reject (Positive)**	Not Reject	Not Reject

Message		**Discussions**			**Total Login Time**
Hits	Total #	Hits	Time	Total #	
Reject (Negative)	**Reject (Negative)**	**Reject (Positive)**	**Reject (Positive)**	**Reject (Positive)**	Not Reject

Note: "Not Reject" means that the mean from the undergraduate class is not different from the graduate class. "Reject" means that the mean of the undergraduate class is different from the graduate class.

Analysis:

- Online Testing – This is simply that with the undergraduate students we emphasize building skills rather than doing applications.
- Message – The Cyber has a feature that a student can e-mail a message privately to the instructor instead of posting questions in the Discussions area. Graduate students had more private messages than the undergraduates. Our graduate students are nearly all working full time and taking this course in addition. Some of the students think that their questions are unique to them so it will be embarrassing if posted "trivial" or "stupid" questions for everyone else to see. We encourage the students to post their questions in Discussions. So everyone

can share common problems. Most of the e-mails are not unique and almost always address similar kind of problems.

- Discussions – On the contrary to the above observation, the undergraduate students use the Discussions area (public posting) more often than the graduate students. The graduate students prefer sending e-mails to posting. The undergraduate students spent longer hours for posting questions than the graduate students.
- Login hours – As far as the total login hours are concerned, there is no difference between these two populations. However, among those who scored the lower end on the mid-term test, there tends to be two extreme efforts we could observe: one spent a large number of hours after the test (change of access habit), and the others gave up with this format of learning (no change of access habit).

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Undergraduate

		Syllabus		Outline		Online Testing			Projects		Files		Messages		Discussions			
	Test Score	Hits	Cumulative Time (min)	Hits	Cumulative Time (min)	Hits	Cumulative Time (min)	Total # of Tests taken	Hits	Cumulative Time (min)	Hits	Cumulative Time (min)	Hits	Total # of Messages	Hits	Cumulative Time (min)	# of Messages	Total Login Time (hr)
1	96	112	361	120	782	45	185	33	7	13	3	28	2	2	3154	18431	30	330.00
2	72	24	17	55	299	30	354	20	12	49	0	0	0	0	2437	13427	13	235.77
3	96	41	119	97	329	51	202	45	5	64	1	1	0	0	1064	5682	3	106.62
4	94	55	144	91	585	49	229	43	4	120	9	38	0	0	1059	9112	20	170.47
5	59	89	154	131	662	65	128	58	26	61	3	2	7	7	1816	15785	11	279.87
6	98	35	13	23	125	19	124	19	2	2	1	1	0	0	1531	8843	20	151.82
7	98	107	72	162	825	43	99	35	4	4	0	0	0	0	2546	9222	44	170.37
8	98	58	72	126	764	55	239	43	6	5	4	3	0	0	2978	13639	44	245.37
9	98	34	79	145	641	74	222	65	5	2	6	13	1	1	1619	17553	37	308.50
10	98	126	226	109	958	55	493	48	17	74	18	28	0	0	6196	36398	39	636.28
11	74	67	219	119	953	46	73	26	0	0	3	0	0	0	1803	17964	23	320.15
12	100	94	63	136	940	44	384	35	0	0	3	7	1	1	3488	27607	43	483.35
13	41	49	101	117	447	46	298	38	1	1	2	7	0	0	2222	33733	24	576.45
14	88	45	57	93	261	50	70	36	9	14	12	15	2	2	5631	26457	22	447.90
15	94	76	199	152	976	84	369	53	8	29	7	1	2	2	2300	14238	27	263.53
16	94	85	487	191	1357	55	255	41	12	67	14	187	5	5	5982	84978	47	1455.52
Av	87.38	68.56	148.94	116.69	681.50	50.69	232.75	39.88	7.38	31.56	5.38	20.69	1.25	1.25	2864.13	22066.81	27.94	386.37
SD	17.08	30.94	127.62	40.46	328.73	15.34	122.40	12.60	6.83	36.42	5.33	45.93	2.05	2.05	1673.91	19012.75	13.29	322.91

Graduate

		Syllabus		Outline		Online Testing			Projects		Files		Messages		Discussions			
	Test Score	Hits	Cumulative Time (min)	Hits	Cumulative Time (min)	Hits	Cumulative Time (min)	Total # of Tests taken	Hits	Cumulative Time (min)	Hits	Cumulative Time (min)	Hits	Total # of Messages	Hits	Cumulative Time (min)	# of Messages	Total Login Time (hr)
1	88	64	243	70	881	39	231	27	0	0	7	8	25	25	598	5420	20	113.05
2	69	63	78	100	640	32	27	17	0	0	17	4	6	6	2626	8387	25	152.27
3	85	61	11	108	1003	21	37	15	0	0	3	0	13	13	436	1069	10	35.33
4	76	24	249	27	122	20	238	15	0	0	0	0	0	0	182	2917	0	58.77
5	76	114	473	99	1791	61	326	43	0	0	0	0	4	4	1027	8830	26	190.33
6	26	46	54	49	607	35	108	24	0	0	5	14	3	3	1797	9506	29	171.48
7	61	23	21	104	729	58	94	43	0	0	1	0	0	0	2663	5341	26	103.08
8	90	73	303	73	779	61	624	30	0	0	1	0	1	1	1367	19664	31	356.17
9	95	48	136	46	436	36	263	31	0	0	5	3	7	7	503	1500	15	38.97
10	52	92	81	152	1212	78	304	47	0	0	11	16	5	5	1821	10048	20	194.35
11	44	7	74	61	676	20	141	9	0	0	1	1	2	2	1289	9407	7	171.65
12		9	67	25	465	12	49	9	0	0	0	0	0	0	240	353	1	15.57
13	18	240	459	129	1044	67	352	39	0	0	10	5	0	0	4129	47000	22	814.33
14	64	88	112	226	918	53	224	34	0	0	6	1	4	4	2493	12082	23	222.28
15	73	77	272	150	1891	73	266	36	0	0	1	0	5	5	1116	9421	16	197.5
Av	65.50	68.60	175.53	94.60	879.60	44.40	218.93	27.93	0.00	0.00	4.53	3.47	5.00	5.00	1485.80	10063.00	18.07	189.01
SD	23.42	56.64	150.29	54.24	474.82	21.38	155.38	12.66	0.00	0.00	5.00	5.26	6.55	6.55	1114.97	11368.82	9.74	194.29