

## Supplemental Document 4

### Statistical Analysis of Students' Response to the Teaching Survey

#### 1. Statistical comparison of students' response in the survey

Two sample Kolmogorov-Smirnov (KS) test was applied to study the statistical difference in: 1) students' response to Items 1 and 2 shown in the following table (taken from Figure 3A), and 2) the responses of onsite and distance learners to Items 1 through 10.

Table s1, A table listing several items from the survey for MATLAB training strategies

Items	Survey of student's experience with MATLAB programming
1	Rate your understanding of MATLAB programming to model and analyze a biological system prior to taking CHE 8663.
2	Rate your understanding of MATLAB programming to model and analyze a biological system after taking CHE 8663.
3	Rate the usefulness of MATLAB programming for understanding/modeling complicated biological systems such as signaling pathways and metabolic networks.
Survey of the instructor's teaching strategies on MATLAB programming	
4	The instructor trained MATLAB programming using examples with real biochemical engineering application.
5	Reference MATLAB codes were provided for all examples in the lecture
6	At the end of each lecture, the instructor offered 30 to 45 minutes for students to interact with the instructor and ask him questions related to MATLAB programming.
7	In-class assignments were assigned for students to complete in the lecture.
8	Homework problem sets were posted before each lecture and due on the day following the next lecture.
9	Solutions of homework problems, especially the MATLAB codes, were given.
10	Each student is required to complete a term project in which he should apply MATLAB programming skills.

Table s2, Analysis of statistical difference in students' response to Items 1 and 2

Item 1 VS Item 2	Statistically different (Yes/No)		P-value	
	Onsite learners	DL learners	Onsite learners	DL learners
Result	Yes	Yes	1.1886e-04	4.4887e-04

Table s3, Comparison of the responses of onsite and distance learners to Items 1 through 10

Onsite VS DL	Statistically different (Yes/No)	P-value
Item 1	No	0.9999
Item 2	No	0.9642
Item 3	No	0.7668
Item 4	No	1.0000
Item 5	No	0.9999
Item 6	Yes	<b>0.0007</b>
Item 7	No	0.7668
Item 8	No	0.1321
Item 9	No	1.0000
Item 10	No	0.9642

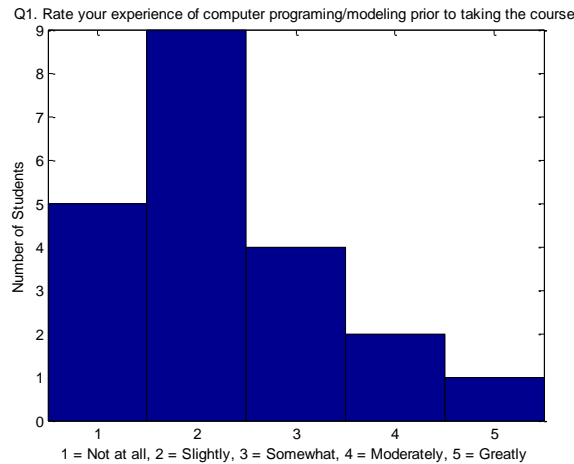
## 2. Mean, standard deviation, and distribution of students' response to each question

**Note: 1) the question numbers may be different from those in the paper. They are consistent with those in the teaching survey (i.e., Supplemental Document 3); 2) the data for both on-site and distance learners in both 2012 and 2013 are included in the analysis; 3) we have tried to include as many results as possible.**

### Q1. Rate your experience of computer programing/modeling prior to taking CHE 8663

Mean Score (out of 5): 2.2857

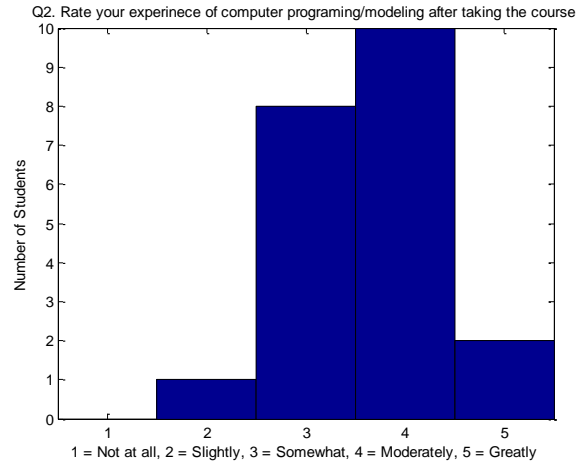
Standard Deviation: 1.1019



### Q2. Rate your experience of computer programing/modeling after taking CHE 8663

Mean Score (out of 5): 3.6190

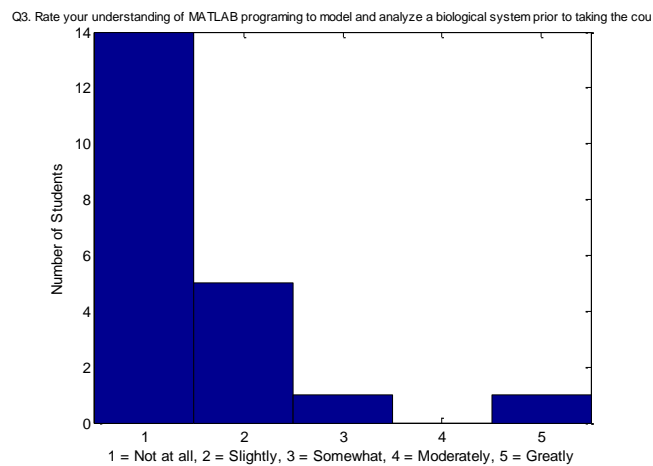
Standard Deviation: 0.7400



**Q3. Rate your understanding of MATLAB programming to model and analyze a biological system (such as the target system in your term project) prior to taking CHE 8663**

Mean Score (out of 5): 1.5238

Standard Deviation: 0.9808

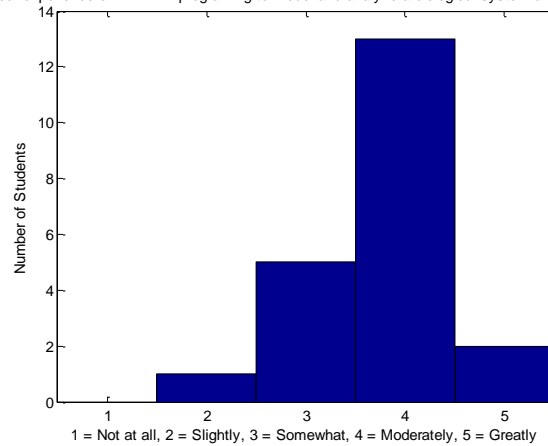


**Q4. Rate your experience of MATLAB programming to model and analyze a biological system (such as the target system in your term project) after taking CHE 8663**

Mean Score (out of 5): 3.7619

Standard Deviation: 0.7003

Rate your experience of MATLAB programming to model and analyze a biological system after taking t

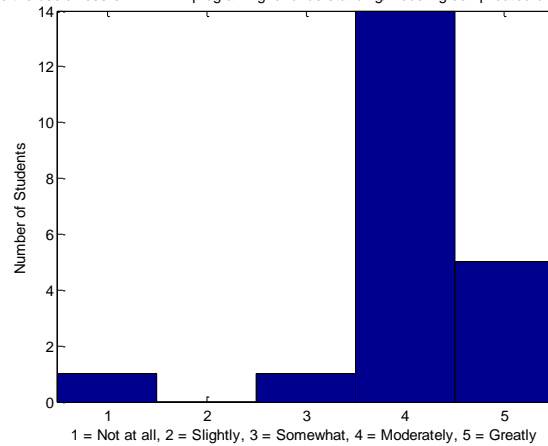


**Q5. Rate the usefulness of MATLAB programing for understanding/modeling complicated biological systems such as signaling pathways and metabolic networks**

Mean Score (out of 5): 4.0476

Standard Deviation: 0.8646

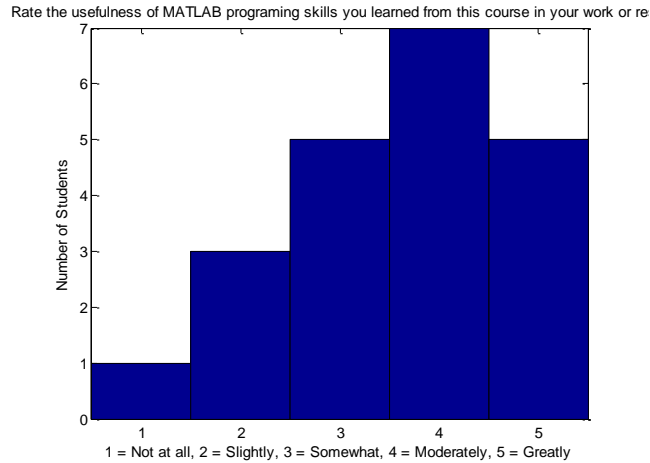
Rate the usefulness of MATLAB programing for understanding/modeling complicated biological sy



**Q6. Rate the usefulness of MATLAB programing skills you learned from this course in your work or research**

Mean Score (out of 5): 3.5714

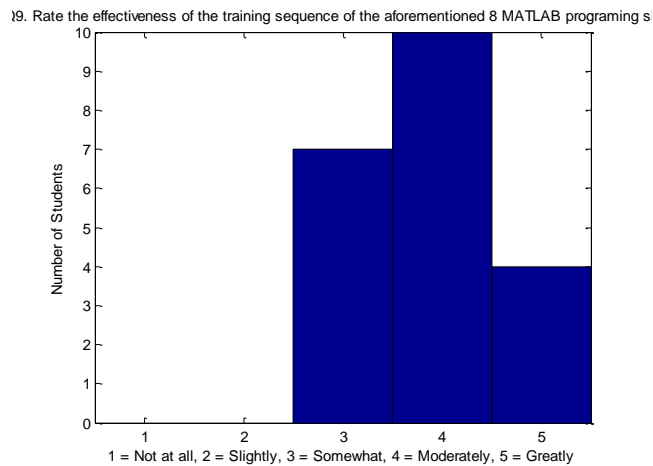
Standard Deviation: 1.1650



**Q9. Rate the effectiveness of the training sequence of the aforementioned 8 MATLAB programing skills**

Mean Score (out of 5): 3.8571

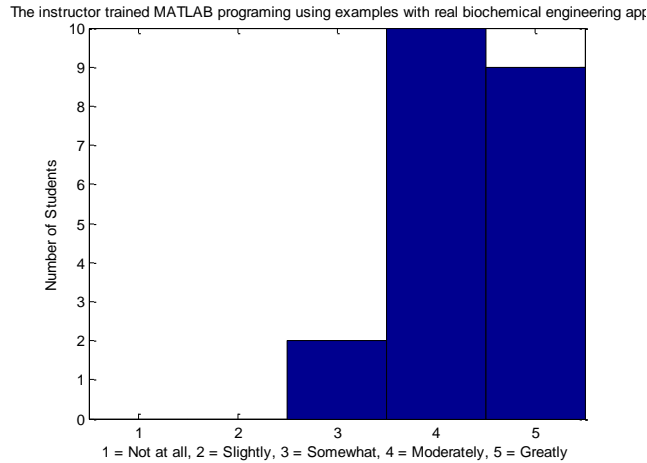
Standard Devication: 0.7270



**Q10. The instructor trained MATLAB programing using examples with real biochemical engineering application (e.g., application of sensitivity analysis to IL-6 signaling to identify targets for drug development). Rate the usefulness of this teaching strategy on motivating and facilitating you to learn MATLAB**

Mean Score (out of 5): 4.3333

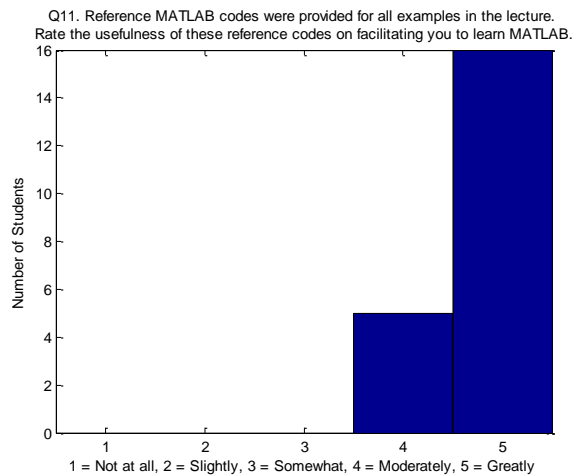
Standard Devication: 0.6583



**Q11. Reference MATLAB codes were provided for all examples in the lecture. Rate the usefulness of these reference codes on facilitating you to learn MATLAB.**

Mean Score (out of 5): 4.7619

Standard Devication: 0.4364

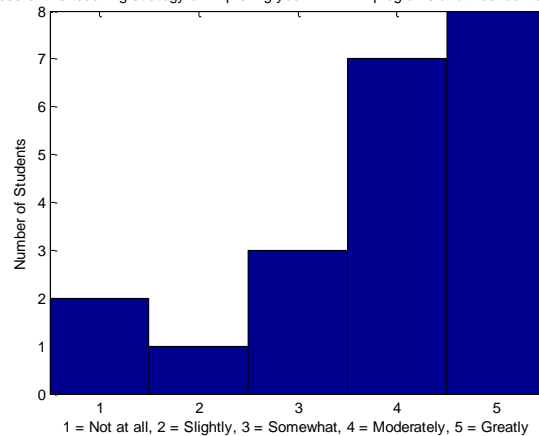


**Q12. At the end of each lecture, the instructor offered 30 to 45 minutes for students to interact with the instructor and ask him questions related to MATLAB programing. Rate the effectiveness of this teaching strategy on improving your MATLAB programs and thus facilitating you to learn MATLAB.**

Mean Score (out of 5): 3.8571

Standard Devication: 1.2762

At the end of each lecture, the instructor offered 30 to 45 minutes for students to interact with the i  
tiveness of this teaching strategy on improving your MATLAB programs and thus facilitating you to

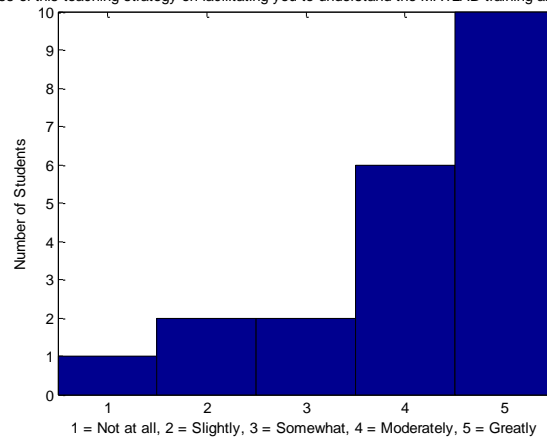


**Q13. Homework problem sets were posted before each lecture and due on the day following the next lecture. Rate the effectiveness of this teaching strategy on facilitating you to understand the MATLAB training and interact with the instructor (as you can ask him questions related to the homework during the 30-45 minute question section at the end of the lecture).**

Mean Score (out of 5): 4.0476

Standard Deviation: 1.2032

. Homework problem sets were posted before each lecture and due on the day following the next l  
eness of this teaching strategy on facilitating you to understand the MATLAB training and interact

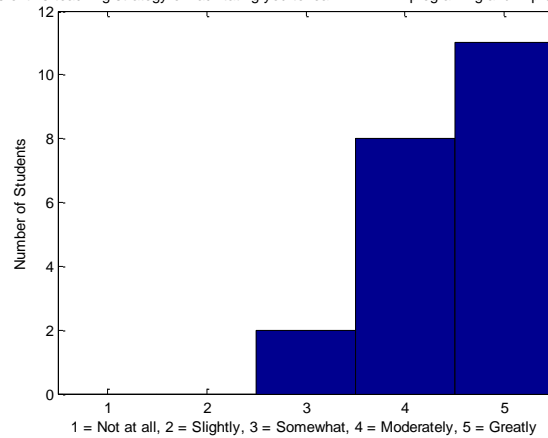


**Q14. Solutions of homework problems, especially the MATLAB codes, were given, as well as feedback and suggestions on your MATLAB programs. Rate the effectiveness of this teaching strategy on facilitating you to learn MATLAB programming and improve MATLAB programming skills.**

Mean Score (out of 5): 4.4286

Standard Deviation: 0.6761

work problems, especially the MATLAB codes, were given, as well as feedback and suggestions on the effectiveness of this teaching strategy on facilitating you to learn MATLAB programming and improve MATLAB

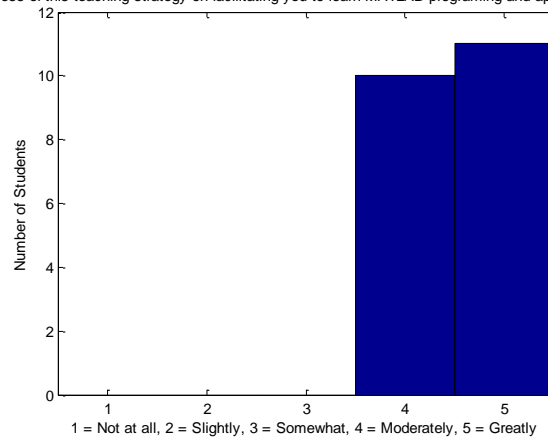


**Q15. Homework problems were designed to be similar to those examples shown in the lecture. Rate the effectiveness of this teaching strategy on facilitating you to learn MATLAB programming and apply these programming skills.**

Mean Score (out of 5): 4.5238

Standard Deviation: 0.5118

Q15. Homework problems were designed to be similar to those examples shown in the lecture. Rate the effectiveness of this teaching strategy on facilitating you to learn MATLAB programming and apply these



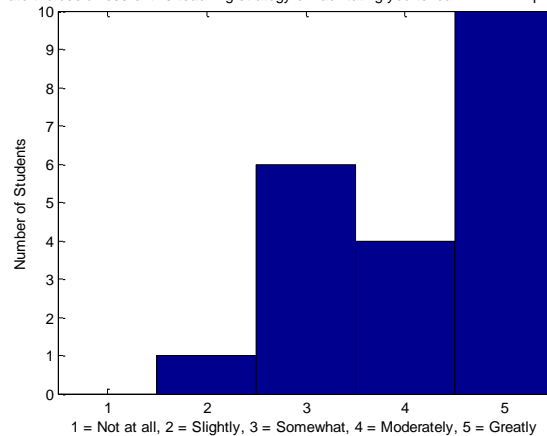
**Q16. In-class assignments (such as deriving the stoichiometric matrix for a metabolic pathway) were assigned for students to complete in the lecture. Rate the usefulness of this teaching strategy on facilitating you to learn MATLAB programming.**

Mean Score (out of 5): 4.0952

Standard Deviation: 0.9952



Q16. In-class assignments were assigned for students to complete in the lecture.  
Rate the usefulness of this teaching strategy on facilitating you to learn MATLAB programming.

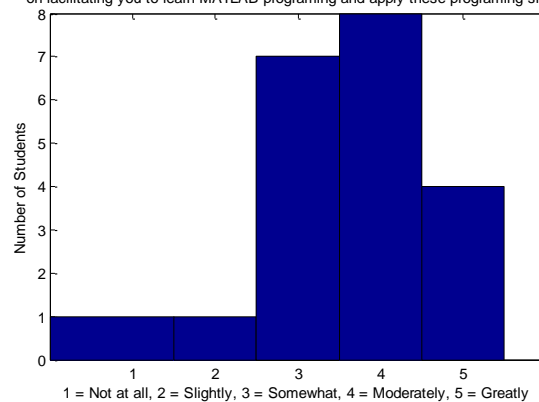


**Q17. Each student is required to complete a term project in which he should apply MATLAB programming skills to solve a real modeling problem/application that is related to his work or research. Rate the effectiveness of this strategy on facilitating you to learn MATLAB programming and apply these programming skills.**

Mean Score (out of 5): 3.5714

Standard Deviation: 1.1650

Q17. Each student is required to complete a term project in which  
ply MATLAB programming skills to solve a real modeling problem/application that is related to his w  
Rate the effectiveness of this strategy  
on facilitating you to learn MATLAB programming and apply these programming skills.



### 3. Suggestions for improving teaching strategies for facilitating your to learn MATLAB programming in biochemical engineering (open ending questions)

The course can be broken down to the following sections:

- (1) Lecture – MATLAB training in Systems Biology and reference MATLAB codes
- (2) Homework problems
- (3) In-class assignments
- (4) Interaction time with instructor at the end of each lecture
- (5) Term project

**1. Which components listed above did you find most helpful in learning MATLAB? Explain.**

- (2) the homework enabled me to practice and apply what was given in the previous lecture. Also, I learned some troubleshooting/debugging technique while performing the homework
- (5) The term project really helped getting familiarized with MATLAB
- (2) the homework problems help me get more understanding of what I learned from lecture and as a good practice
- (2) The homework problem, it is one thing to follow the lecture and another to practice the theories learnt. So it was helpful to learn via homework
- (2) Homework problems: they were very similar to lecture examples. So they are not very hard to complete. However, they don't really (or not necessarily) provide better understanding of modeling. Still, homework problems definitely are the most helpful in learning modeling
- (1) Lecture because it provides the codes that is useful
- (4) and (2)
- (4)
- (2) the homework was most helpful since this was a good opportunity to practice the programming techniques
- (1) (2) (3)
- (1) (2) (4) I think for the level of student capability (and breadth), a traditional lecture, homework, test structure is more helpful. I thought the first half was good but many seemed to tune out for second half
- (1) (2)
- (most) 1,2,5,3,4 (least) As stated above, interaction time with instructor at the end of the lecture is not applicable for DL students; I have recognized that this is a disadvantage for DL students. However, the professor is very responsive to emails and is frequently available for office hours, which is very helpful to learning the skills in MATLAB. As a DL student, the lecture, HW problems, and Term project were most helpful for my learning.
- Interaction time with instructor because I was able to understand better

## 2. Which components listed above need to be improved? Explain.

- (2) Less time going over biology and more time going over MATLAB and example problems
- Homework is a little hard sometimes and lectures cover a lot
- (5) Not enough time to do a good term project
- The interaction time with instructor at the end of lecture wasn't managed well most times we had that opportunity to interact at the end of the lecture
- (1) Lecture – MATLAB training: modeling is the most important technique needs to be delivered. So, in order to improve overall learning experience, more time should be spent to provide programming training
- None, very well done on complicated material
- (1) for those unfamiliar with MATLAB, they may not catch "dummy characters" included in the notes. Additionally, more time could have been spent on introducing basic MATLAB principles
- More in-class assignments could be useful learning the material
- (5)
- Use a final exam instead of term project
- (5) some of the UCSD models were hard to work with
- Interaction time with instructor is limited for DL students. In-class assignments are not as valuable for the same reason; limited interaction with professor. Re-writing MATLAB codes presented in class is somewhat helpful, but I would prefer homework problems that require application of the codes learned in class
- Term project – difficult to find a project with the data, models that can be applied to the skills learned or the skills tested, hence making it difficult to get a good grade

## 3. Do you have any other suggestions for improving the MATLAB learning process, or the course in general?

- More example problems in class and clearer insight in the MATLAB language and functions
- More MATLAB Tutorial
- I hope professor could give more reading list or material
- For the term project, have the instructor find projects from which students can choose from

- Example problems can be quite lengthy and include many codes for different purposes all together. By making the example problems more focused to each topic, and present many small example problems can be beneficial
- No, tough program to teach but done very well
- The notes could be condensed into a more efficient format – all the text was hard to follow during lectures
- Need to spend more time introducing program – it is very hard to pick up not having used it before
- Please have lecture note 24 hours before class. Part time students who are working may not be able to print them out on the day of class due to work commitments
- More examples
- Inform the students about the extent of MATLAB needed and more time associated with term project

**4. As for Distance Learners, please list suggestions making your experience as a Distance-Learning or Part-Time student in learning MATLAB programing more effectively.**

- (2) Less time going over biology and more time going over MATLAB and example problems
- Experiencing this course as a DL student has been a significant challenge. It is difficult to learn the MATLAB code as a DL student, since we do not have the same advantages of in-class time for questions on HW, in-class assignments, and our projects. The professor is very responsive to emails and is available for office hours, which is very much appreciated; not many professors are as accessible. However, it is difficult with work responsibilities to attend office hours as frequently as I would need to compensate for the in-class time that is missed. It is also difficult to communicate coding issues via emails, so there is a lot of back-and-forth before a solution can be reached. I would recommend that students interested in this class should take it as in-class only, unless they have previous experience with MATLAB.
- Opportunities for in class assignment, more time for interaction if needed (though it was possible), additional assistance, accommodation for time to help with term project. Be more flexible/understanding with term project as it is difficult choosing project, finding data etc