2016

MATL 260/360: Elements of Materials Science—A Peer Review of Teaching Project Benchmark Portfolio

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Benchmark Portfolio

THE PEER REVIEW OF TEACHING PROJECT FOR ACADEMIC YEAR 2015-2016

ELEMENTS OF MATERIALS SCIENCE

MATL 260/360

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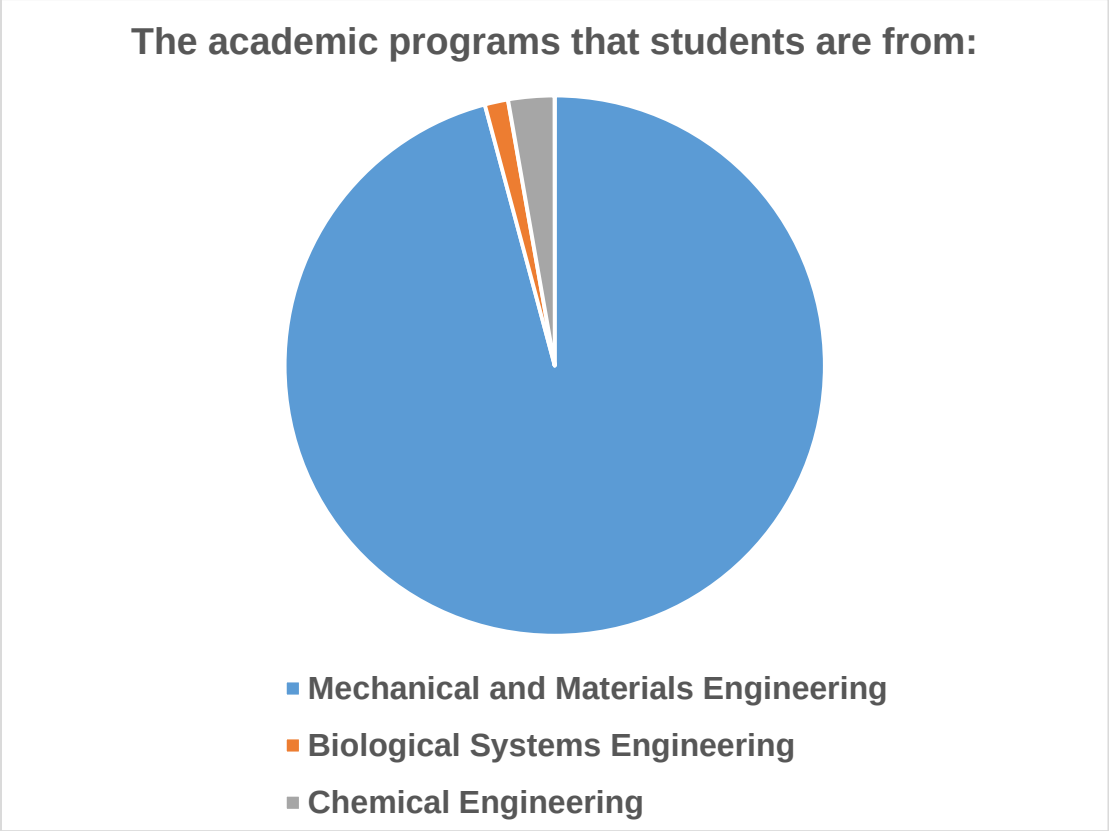
Contents

1. REFLECTIONS ON COURSE CONTENT

1.1. Introduction: MATL 260/360 Elements of Materials Science

This fundamental undergraduate course is taught to students who are from mostly in the third-year of the Mechanical and Materials Engineering (MME) program (69/72), but there is a small portion of (3/72) students who are from the Biological Systems Engineering (1/72) and the Chemical Engineering (2/72).

This course covers both the science and engineering components in materials science. It is very significant that it is the first course in the materials subject that the MME students will take during their undergraduate study. After this fundamental course, they can take other advanced courses in the materials subject, such as Advanced Metallurgy, Advanced Manufacturing, X-Ray Diffraction, Phase Transformation, Corrosion, and Electron Microscopy. This course lies as the foundation for those advanced courses. Therefore, the MME department chair, Prof. Shield, had asked me to “inspire the students’ interest in materials science”.



1.2. The Goal of This Course

The *Goal* of this course to make students understand the fundamental concepts of the microstructure-property relationship of metals, ceramics and polymer materials. The course content is connected to the general goals of the MME department and the College of Engineering's general study guidelines in the fact that both the science and engineering are integrated into a course and that this is a research-orientation course.

This course will make students know the basic principles of materials science and engineering. It is expected the students, after they take this course, will be able apply the knowledge into their own research or engineering career that is relevant to materials science. They are expected to understand the basic principles. What will be retained are those principles and training in this class would help them in their future career in materials-related field, for example, as an engineer in metallurgy, manufacturing, aeronautic, or petroleum industries. I want them to have a perspective of exploring new knowledge that is beyond their own research or education area. What is important is that they have the interests and motivations to learn. As a student or as a contributor to society, they should learn about the basic knowledge in the materials science field, as nowadays many career opportunities are related to materials science – very important for the industry worldwide.

The goals of my courses are structured into two distinctive parts: science and engineering. The students need to understand science first, and then they can apply it to engineering. I have a rough idea of how to tune these goals slightly to make them appropriate for students from different background, such as materials engineering or chemical engineering. The goals are reflected in the daily course structure that the science is always taught first, followed by a real application (or phenomenon) in the industry, and a discussion of student in small groups how this real application is related to those scientific principles or that phenomenon can be explained by the science.

1.3. Why I Choose This Course?

This particular course is a challenge because it is very important for a lot of engineering fields, and thus being taught to a very diverse group of student with different engineering backgrounds. This is the reason that led me to write a portfolio. This course is particularly noteworthy because it may be one of the good examples of similar courses that are taught to students from distinctive backgrounds. The specific challenges that I have are: (1) I have no idea how much foundation knowledge students already know from their fundamental

physics and chemistry classes; (2) how to tune this course to satisfy the expectations of a large number of undergraduate students.

1.4. Key Objectives of This Course Portfolio

I would like to address the following questions/concerns in teaching:

1) How could I teach new knowledge to students more effectively?
2) How could I increase student engagement in a large lecture class?
3) How could I promote the interests and motivations of students?
4) How could I use this course to improve the analysis and critical thinking skills of students?

1.5. Sort of Course Portfolio

This course portfolio will be anticipated to document my experience in teaching this class, to record my efforts to improve the teaching tools, to review what I have learned from the PRTP program and colleagues, and to significantly improve my teaching skills for the tenure through this process.

This portfolio will provide a broad overview of the entire course, covering both *Teaching Practices* and *Student Learning*. It will not focus on a specific aspect, nor a part of a large departmental effort.

1.6. The Syllabus of this Course

The syllabus of this course is shown in the next two pages. I am the instructor of the lectures, and there is another instructor for the labs. This portfolio only covers the teaching of lectures.

Syllabus- MATL 260/360 Elements of Materials Science

2nd version, Spring 2016

Objective: Fundamental concepts of the microstructure-property relationship of metals, ceramics and polymers.

Class Time: Monday & Wednesday & Friday 9:30-10:20 am

Location: SEC 318

Instructors: Lecture: Bai Cui, W331 NH, (402) 472-5740, bcui@unl.edu

Lab: Jeff Shield, W342 NH, jshield@unl.edu

Office hours: Wednesday 10.30-11.30 am, W331 NH

TAs: Soodabeh Azadehranjbar

Eric Anttila

Charles Nguyen

Colin Elley

Devin Elley

Textbook:

Materials Science and Engineering: An Introduction, by W.D. Callister, Jr. (9th Edition).

Grading:

MATL360 Score = 25% lab reports + 30% monthly tests + 35% final exam + 10% homework

MATL 260 Score = 45% monthly tests + 45% final exam + 10% homework

Lab reports will be graded by TAs and checked by the instructor.

Monthly Tests: in Jan, Feb and March, there will be a class of Practice followed by a class of Test. The quiz is a closed-book test. NO for the textbook, ppt slides, notes, etc.

Final Exam: Closed-book exam. NO for the textbook, ppt slides, notes, etc.

Homework will be due before the next lecture. Please hand in your homework to the mailbox of "MATL 260/360" in W342 NH.

Projected Schedule:

Jan 11: First class

Jan 18: No class. Martin Luther King Day.

Jan 25: Practice

Jan 27: January's test

Feb 15: Practice

Feb 17: **February's test**

March 9: Practice

March 11: **March's test**

March 20 - 27: No classes (Spring Vacation)

April 25, 27, 29: Review & Practice (prepare for final exam)

The Week of May 2: Final Exam

2. TEACHING PRACTICES

2.1. Teaching Methods

To address each of the key objectives/questions outlined in Section 1.4, the following course activities have been used during teaching this course (**Table 1**). Many of these course activities were learnt from the Peer Review of Teaching Project (PRTP), in particular some of them were thought out from the very helpful discussions with the teachers and classmates of PRTP.

The teaching methods of this course emphasize:

(1) The interaction between the instructor and students, for example the instructor will be involved in the small-group interaction and debate to hear what students say and provide feedback.

(2) The efficiency of teaching and learning. Beside the 75-min of each class, power point presentation (PPT) slides are given to students for after-class study; homework and the monthly tests are used to strengthen learning.

(3) The use of feedback to further improve the teaching. This will be demonstrated in Chapter 3, which show the survey to be used for evaluation of teaching and learning.

Table 1. The course activities to address key objectives/questions.

Key Objectives/Questions	Course Activities
How could I teach new knowledge to students more effectively?	(1) Relate the new knowledge with daily-life and industry examples; (2) Give PPT slides for after-class study;
How could I increase student engagement in a large lecture class?	(1) Assign homework questions after each lecture; (2) Take monthly practice classes and tests.
How could I promote the interests and motivations of students?	(1) Relate the scientific knowledge to real industrial problems; (2) Relate this fundamental course with other advanced courses.
How could I use this course to improve the analysis and critical thinking skills of students?	(1) Have small group discussions and debate; (2) Provide a bonus to the first student who get the best answer to difficult questions.

2.2. Course Assignments

Because the "MATL 260/360 Elements of Materials Science" is a foundation course for undergraduate students, "traditional" course assignments are used to strengthen the student learning. As shown in **Table 1**, students are expected to complete these assignments:

(1) Homework: several questions after each lecture.

(2) Monthly practice class and test: each month, there is a practice class in which the instructor or teaching assistant lead the students to solve some problems in the textbook. Following this practice class, a 60-minute test is held to evaluate the student learning in the last several weeks. Three monthly tests are held in January, February and March. The test results will be returned to students so that they can use them to improve the learning.

(3) Final practice class and test: in the final week of the spring semester, there are three practice classes in which the instructor will lead the students to solve important problems in the textbook. This is followed by the final test, in 90 minutes, to evaluate the student learning in the whole semester.

Among these, it has been found that the students like the practice classes very much, according to the Mid-Semester Feedback (see Chapter 3). The practice classes have helped them solve many questions associated with the textbook and the lectures, and make them more relax when taking the monthly tests and the final test.

2.3. Course Materials

To improve the efficiency of teaching and learning, the following course materials are used:

1. Textbook: Materials Science and Engineering: An Introduction, by W.D. Callister, Jr. (9th Edition). This is a very classic textbook which has been used for the previous instructors of this course for a long time. However, a number of errors have been found, which I always point out to students in the lectures. Another concern is that because this book was written 20 years ago, some new scientific progress of materials science is not mentioned, and some knowledge is not updated. I use my own knowledge, which are gained from my research experiences, to provide the update and new progress to students. For example, because one of my research areas is on electron microscopy, I am able to deliver the new electron microscopy techniques, such as focused ion beam and high-resolution transmission electron microscopy, to students which help them understand the modern ways to characterize the microstructures of materials. The students really enjoy these new scientific progress.
2. PPT slides. “Rough” PPT slides are provided by the publisher, Wiley. However, because of the similar problems with the textbook, I have made significant changes in the PPT slides to strengthen the most important points, to reduce the less important contents, to correct the errors, and to include the new scientific progress. The PPT slides are printed and distributed to students at the beginning of each class. The homework questions and important announcements (such as the date of practice classes and monthly tests) are also included in the last page of PPT slides. These PPT slides are also used for student in after-class study.
3. Practice questions. All the questions used in the practice classes are uploaded into MyRed, so that students can download and practice anytime. Besides the course time, I have office hours each Wednesday for students to visit and discuss with me about homework or practice questions.

3. STUDENT LEARNING

During this spring semester, I have used two surveys to receive feedback from students. The survey results are used to evaluate the teaching methods and improve the student learning. The surveys are anonymous to ensure the results to be objective and protect the privacy of the students.

3.1. Mid-Semester Feedback

This survey was carried out in the class on March 23. The survey paper was distributed to all students. The survey is anonymous. The questions of this survey are shown on the next page.

Mid-Semester Feedback

3/23/2016

1. What about the course have you found most effective?

2. What about the course have you found least effective? That is, what about the course should be changed?

3. Please provide other comments about the course.

3.1.1. Results of Q.1: what about the course have you found most effective?

Ten pieces of typical feedback from the students are:

1. “Bai Cui was a great professor. He always was nice and tried his greatest to teach us this topic he is so passionate about. I liked how he gave us tips for materials that were directed towards specific fields of engineering.”
2. “It is a really good text book. Dr. Cui really enjoys the class.”
3. “The printed lecture slides help learning.”
4. “The slides covered every single bit of information that we needed to know.”
5. “Packets of slides were very useful”
6. “The PowerPoint slides were very helpful to have during class.”
7. “The power point slides worked really well to summarize the material in each chapter.”
8. “Application of the material in the course the instructor provided is very specific and helpful in learning this course”.
9. “The homework covered necessary points of the chapter without being extremely time consuming.”
10. “The reviews before the tests helped to recall the material.”

To summarize, the students are satisfied with the personality of the instructor, the printed lecture slides, the specific examples of applications in the lecture, and the review before the tests.

3.1.2. Results of Q.2: what about the course have you found least effective? That is, what about the course should be changed?

Ten pieces of typical feedback from the students are:

1. “The textbook used inconsistent notation and different notation for the materials property section (that is like my EBodies class). It's called E, the elastic modulus, the shear modulus in a homework problem.”
2. “Some of the material should be skipped over because it isn't really relevant to mechanical engineering. The material where it talks about things like molecular size and Miller Indices. It would be much more helpful to learn about how materials are strengthened.”

3. “The due date for homework was decided based on when that section's lecture finished and this caused some problems.”
4. “Make your own homework questions so that they aren't on Chegg.”
5. “Assignments were overly short, and didn't provide a good indication of what was important to the class.”
6. “Often the projector wasn't working.”
7. “The first test was really easy and I had studied really hard. I had read the text book and enjoyed it but then after I realized I didn't need to study that much for the tests I lost my motivation for learning even though I think the material is very interesting in all regards.”
8. “Slides were not always clear. Slower pace of lecture and/or lecture was not always clear.”
9. “Don't hand out slides for the material. Force students to engage.”
10. “Do more example problems.”

To summarize, the students provide specific and very helpful suggestions to improve the textbook, homework, equipment (projector), tests, lecture slides, etc. I will use such important feedback to further improve my methods of teaching this course.

3.2. Survey: Monthly Tests

To evaluate the effectiveness of monthly tests on student learning, I conducted a second survey in the class on April 23. The survey paper was distributed to all students. The survey is anonymous. The questions of this survey are shown on the next page.

Survey: Monthly Tests

4/23/2016

The objective of this survey is to evaluate the effectiveness of monthly tests on student learning. Please do your best to answer the questions accurately. Your feedback will be much appreciated!

1. Overall, the monthly tests help me learn this class:

A. Strongly agree; B. Agree; C. Disagree; D. Strongly disagree.

2. The monthly tests improve my rational thinking and problem-solving ability:

A. Strongly agree; B. Agree; C. Disagree; D. Strongly disagree.

3. The monthly tests fairly measure my understanding of the course materials:

A. Strongly agree; B. Agree; C. Disagree; D. Strongly disagree.

4. The number of test questions is reasonable for what I am expected to learn:

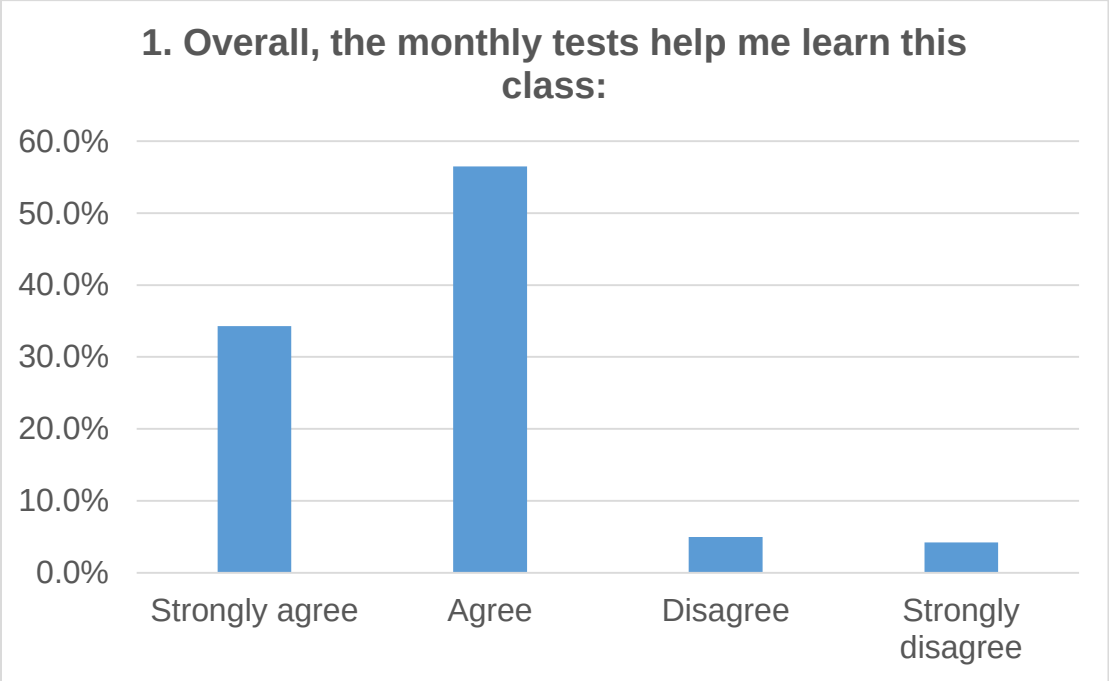
A. Strongly agree; B. Agree; C. Disagree; D. Strongly disagree.

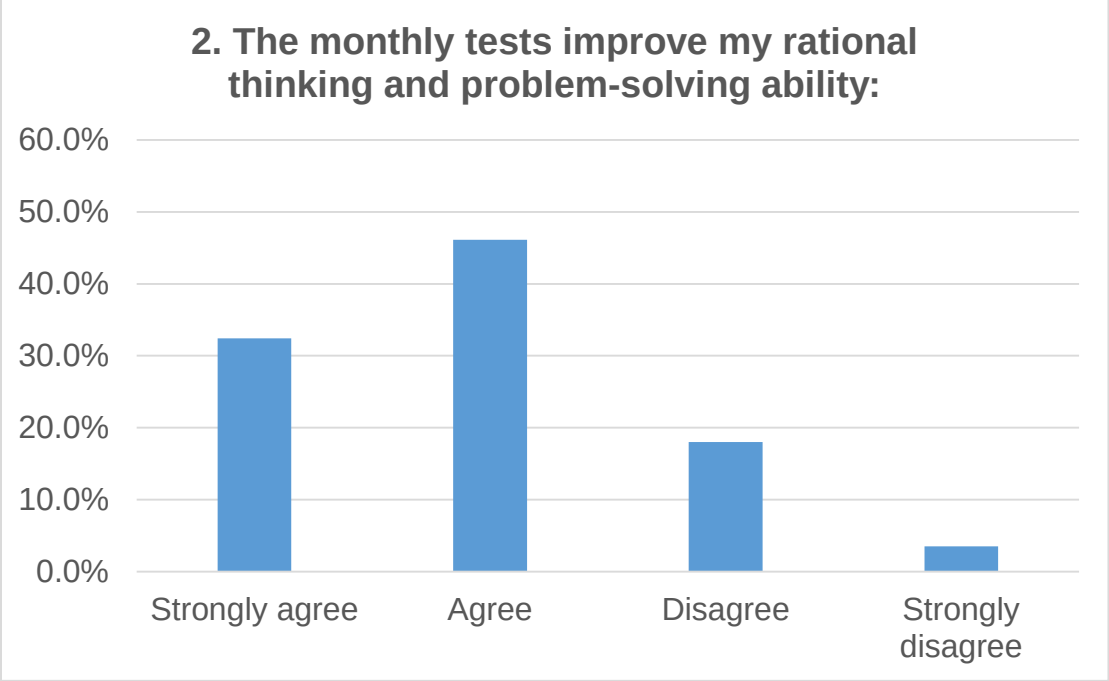
5. My test grades are fair representations of my learning:

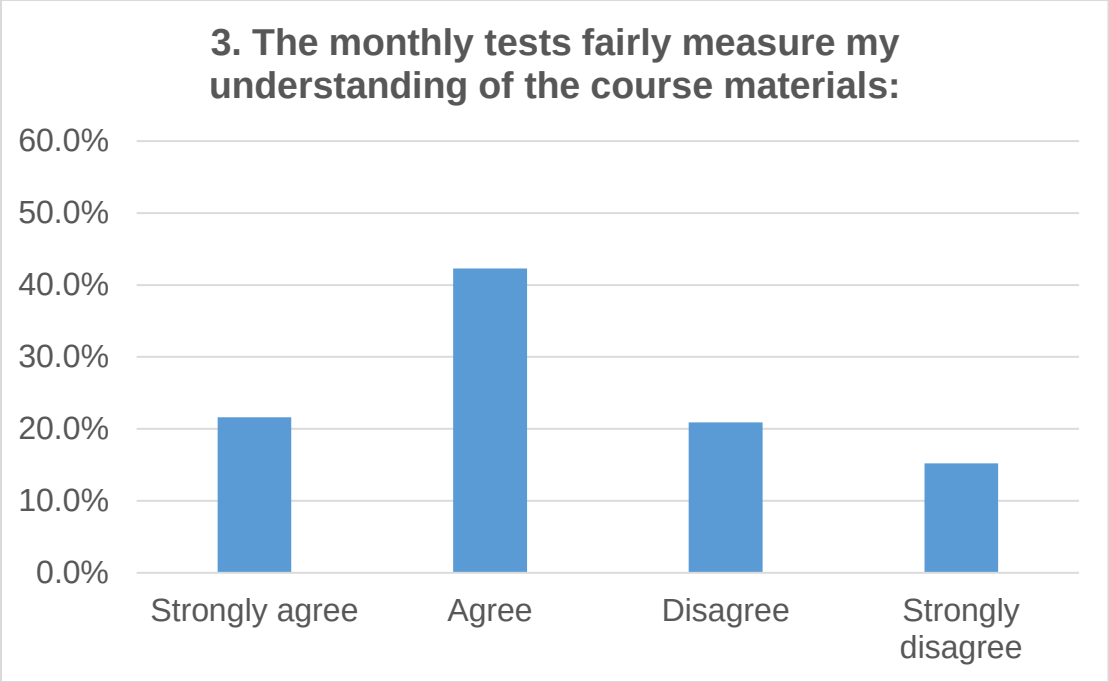
A. Strongly agree; B. Agree; C. Disagree; D. Strongly disagree.

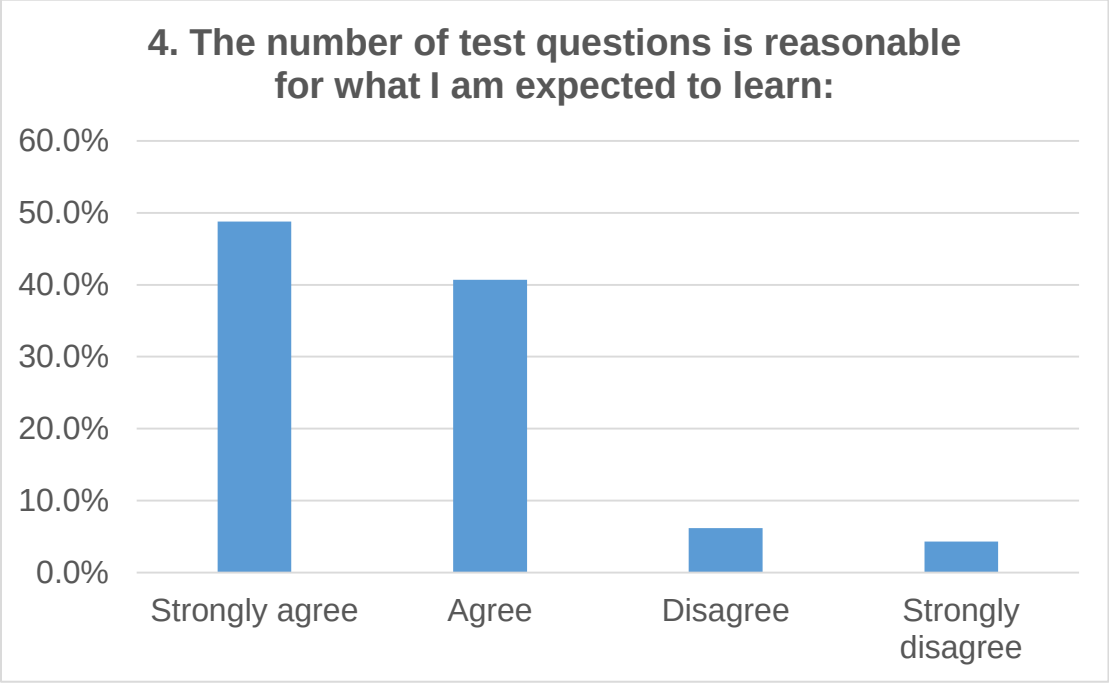
3.2.1 Survey Results

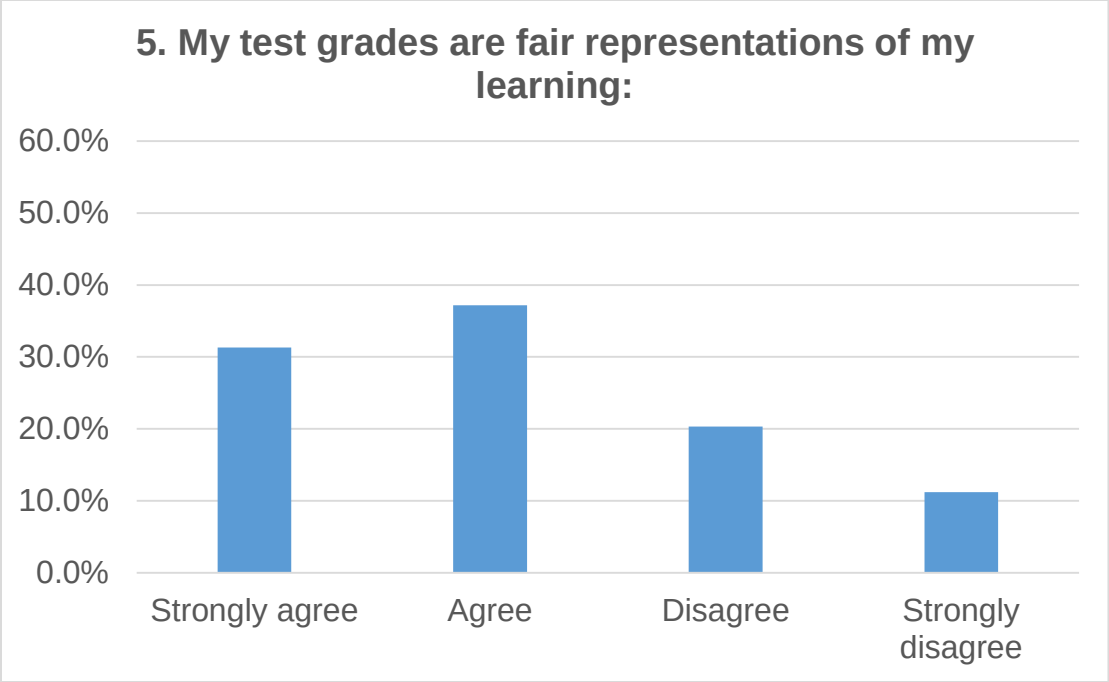
The statistical analysis of the survey results is shown below.






3. The monthly tests fairly measure my understanding of the course materials:
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
Strongly agree
Agree
Disagree
Strongly disagree


4. The number of test questions is reasonable for what I am expected to learn:
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
Strongly agree
Agree
Disagree
Strongly disagree



3.2.2 Analysis of Survey Results

It is shown from the survey that:

(1) More than 90% of students support that monthly tests help them learn this class. 34.3% of survey participants strongly agree with this, 56.5% agree, with 5.0% disagree and 4.2% strongly disagree.

(2) More than 78% of students support that the monthly tests improve their rational thinking and problem-solving ability. 32.4% of survey participants strongly agree with this, 46.1% agree, with 18.0% disagree and 3.5% strongly disagree.

(3) More than 63% of students agree that the monthly tests fairly measure their understanding of course materials. 21.6% of survey participants strongly agree with this, 42.3% agree, with 20.9% disagree and 15.2% strongly disagree.

(4) More than 89% of students agree that the number of test questions is reasonable for what they are expected to learn. 48.8% of survey participants strongly agree with this, 40.7% agree, with 6.2% disagree and 4.3% strongly disagree.

(5) More than 68% of students think that the test grades are a fair representation of their learning. 31.3% of survey participants strongly

agree with this, 37.2% agree, with 20.3% disagree and 11.2% strongly disagree.

To summarize, the majority of students agree with that the monthly tests help them learn this class (90%), and the number of test questions is reasonable for what they are expected to learn (89%).

A less number of students (78%) support that the monthly tests improve their rational thinking and problem-solving ability. This can be understood that the tests are just one of the tools for promoting rational thinking and problem solving. There are many other teaching tools, such as small-group discussions in the lecture time and the homework, which can improve those.

What is important to note is that there is some concern about how effective the monthly tests can be used as a measure of student learning. The survey shows 63% of students agree that the monthly tests fairly measure their understanding of course materials, and 68% of students agree the test grades are a fair representation of their learning. This survey raises the questions to the instructor, including how to improve the questions in the monthly to be more representative for the “important” knowledge that students must know, and how to make the grades to be a more fair representation. A factor that needs be considered is that the students usually have a higher expectation of their grades than the reality. So the most significant changes that can be made to the monthly tests are the test questions, which need to be improved to better measure students’ understanding of course materials.

4. SUMMARY

The goal of MATL 260/360 Elements of Materials Science is to make undergraduate students understand the fundamental concepts of the microstructure-property relationship of metals, ceramics and polymer materials. This course is taught to students who are from mostly in the third-year of the Mechanical and Materials Engineering program.

This course portfolio addresses the following questions/concerns in teaching:

1) How could I teach new knowledge to students more effectively?
2) How could I increase student engagement in a large lecture class?
3) How could I promote the interests and motivations of students?
4) How could I use this course to improve the analysis and critical thinking skills of students?

To address each of the key objectives/questions, a number of course activities have been used during teaching this course, which include: relating the new knowledge with daily-life and industry examples; giving PPT slides for after-class study; assigning homework questions after each lecture; taking monthly practice class and test; relating the scientific knowledge with real industrial problems; relating this fundamental course with other advanced courses; having small group discussions and debate; and providing bonus to the first student who get the best answer to difficult questions.

Two surveys have been used to evaluate the teaching methods and improve the student learning.

The mid-semester survey shows that the students are satisfied with the personality of the instructor, the printed lecture slides, the specific examples of applications in the lecture, and the review before the tests. On the other hand, the survey provides very specific feedback and suggestions to improve the textbook, homework, equipment (projector), tests, lecture slides, etc.

The survey of monthly tests shows the majority of students agree with that the monthly tests help them learn this class (90%), and the number of test questions is reasonable for what they are expected to learn (89%). However, there is some concern about how effective the monthly tests can be used as a measure of student learning. The survey shows 63% of students agree that the monthly tests fairly measure their understanding of course materials, and 68% of students agree the test grades are a fair representation of their learning.

5. ACKNOWLEDGEMENT

I would like to express my great gratitude to Dr. Jody Kellas for enrolling me into this program and leading me, step by step, in learning and improving my teaching methods.

I would like to thank Dr. Sarah Karle for Small Group Meetings. The locations that she selected for the meeting were impressive, and what I have learnt from such small group meetings are very helpful.

In this one-year program, I feel like a lot of things about my teaching philosophy have been permanently changed. My teaching experiences have been filled with more interests. I will highly recommend this program to my colleagues who are on the early career stage and need professional advice on improving the teaching and learning.

Finally, I gratefully acknowledge the department of Mechanical and Materials Engineering and the College of Engineering for the strong support of my teaching of this course.