1. **DEPARTMENT:** Mathematics, Statistics and Computer Science (MSCS)

2. **GENERAL EDUCATION CATEGORY:** Analytic Reasoning (ANRSN)

3. **COURSE NUMBER AND TITLE:**
   - CS-141 Computer Programming-BASIC
   - CS-144 Computer Science I
   - MATH-118 Concepts of Mathematics
   - MATH-120 Introductory College Mathematics I
   - MATH-121 Introductory College Mathematics II
   - MATH-123 Finite Mathematics
   - MATH-153 Calculus I
   - MATH-154 Calculus II
   - MATH-156 Calculus and Analytic Geometry I
   - MATH-157 Calculus and Analytic Geometry II
   - STAT-130 Elementary Statistics
   - STAT-320 Statistical Methods

   **Individual reports for each of these courses are found below.**

4. **NUMBER OF SECTIONS INCLUDED IN THIS ASSESSMENT:**
   Various – will be listed below.

5. **GENERAL EDUCATION OBJECTIVES:**

   2. Formulate logical and mathematical reasoning related to various branches of knowledge.

   4. Think creatively, analyze critically, synthesize clearly and act responsibly.

6. **METHODOLOGY:**

   Objectives (2) and (4) are assessed simultaneously. In particular, for our courses, the emphasis for Objective (4) is on “analyze critically” and “synthesize clearly.”

   To assess these objectives, for the past several years the MSCS Department has used “embedded assessment,” which had been recommended by the General Education Committee. More precisely, an instructor designs a problem (or problems) on an exam (usually the final exam) which requires a high level of analytic reasoning. Then, a specific rubric is created in order to evaluate student learning according the following scale:

   - 0 = no score
     attempted with no understanding of concepts and procedures
   - no attempt
   - off topic

   **Individual reports for each of these courses are found below.**
A challenge for our department is that we have a number of general education courses, each with a large number of sections being offered, and taught by numerous instructors who change from semester-to-semester. One goal for this year’s departmental assessment practice has been to create consistency across sections by using the same assessment tool in every section, and to in fact assess a high proportion of our sections. For the most part, we have been successful with this, but we need to continue working on this.

For each course, the precise details of the embedded assessment tool and performance rubric will be given below. Since the tool is a final (or other) exam question, usually all students in the section were evaluated.

7. RESULTS: Results for each course will be given below.

8. REFLECTION: Reflection will be given for each course below.

Along with the aforementioned goal of having a consistent assessment tool across sections, the department is working to have more group discussion/reflection of the assessment results so that we can better understand the effectiveness of the course as a whole rather than individual sections. As above, with the large number of sections and instructors involved, this continues to be a challenge for our department. The group of instructors teaching MATH-120 this year did the best job of this. We will continue to work on this in the future.

Another challenge for our department is the inherent nature of mathematics and statistics. When evaluating student performance on a problem, it can be difficult to separate “mathematical knowledge” from “analytical reasoning.” For example, if a student leaves a problem unanswered, this most likely does not mean that they have no analytical reasoning abilities, rather it is more likely that they have forgotten/never learned some fundamental mathematical principle for getting started on the problem. The department will continue to work to create good assessment tools which strive to accurately assess analytical reasoning.

Also, when reflecting on student performance, instructors somewhat naturally focus on the mathematics of the problem studied and reflect on what they can do to improve student performance on that type of problem. The department will continue to work on reflecting on the larger objective of analytical reasoning rather than just one particular problem.
9. OTHER COMMENTS AND/OR SUGGESTIONS:

In addition to the comments above, the department will continue to work for consistency from year-to-year. The department chair will see that instructors are given the assessment tool and reflections from the previous year so that this information can be used as a basis for the next round of assessment. This will allow the department to better measure progress from year-to-year. And the department will work to promote on-going discussion and reflection about whether or not we are meeting the general education objectives.
1. **DEPARTMENT:** Mathematics, Statistics and Computer Science (MSCS)

2. **GENERAL EDUCATION CATEGORY:** Analytic Reasoning (ANRSN)

3. **COURSE NUMBER AND TITLE:** CS-141 Computer Programming-BASIC

4. **NUMBER OF SECTIONS INCLUDED IN THIS ASSESSMENT:** 1 (21 students)
   This is the single section offered in the Fall 2006 semester. No sections were offered during the Spring 2007 semester.

5. **GENERAL EDUCATION OBJECTIVES:**
   2. Formulate logical and mathematical reasoning related to various branches of knowledge.
   4. Think creatively, analyze critically, synthesize clearly and act responsibly.

6. **METHODOLOGY:**
   Objectives (2) and (4) were assessed simultaneously. In particular, for our courses, the emphasis for Objective (4) is on “analyze critically” and “synthesize clearly.”

   This course requires students to analyze basic problems in computer science and write computer programs to implement a solution. The final exam for this course consisted of a collection of problems of varying level of difficulty covering the major topics for the course. The problems ranged from some very simple problems that just required knowledge of the syntax of the Visual Basic language to more involved questions that required writing subroutines and functions and writing code for iteration, alternation, reading from data files and working with arrays. For example, one problem on the final exam required the students to write a Basic Function to calculate the Christmas bonus for employees based on their total annual sales. Other problems required the students to write a Basic Subroutine to delete an element from an array, and to read through a data file, loading the information from the file into arrays. Most individual problems on the final focused on one particular programming concept, and all required knowledge of the Basic programming language. The students’ performance on the final exam represents their overall mastery of the problem analysis and programming skills taught in this course. So student performance on the exam as a whole was used as the assessment tool.

   Specifically, student demonstration of logical reasoning skills was evaluated by using a rubric with a 0 to 4 scale where 0 represents no display of logical reasoning skills and 4 represents the greatest display of logical reasoning skills. The specific scale is given in the summary of results in the next section.

   Since this was the final exam, all students completing the course were included in the assessment.
7. RESULTS: The following table summarizes student performance.

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Description of Performance Level</th>
<th>Number of Students at Level</th>
<th>% of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Less than 60% on final exam</td>
<td>7</td>
<td>33.33 %</td>
</tr>
<tr>
<td>1</td>
<td>Between 60% and 69% on final exam</td>
<td>2</td>
<td>9.52 %</td>
</tr>
<tr>
<td>2</td>
<td>Between 70% and 79% on final exam</td>
<td>6</td>
<td>28.57 %</td>
</tr>
<tr>
<td>3</td>
<td>Between 80% and 89% on final exam</td>
<td>4</td>
<td>19.05 %</td>
</tr>
<tr>
<td>4</td>
<td>Between 90% and 100% on final exam</td>
<td>2</td>
<td>9.52 %</td>
</tr>
</tbody>
</table>

8. REFLECTION:
This is a difficult course for several reasons. First, the course provides an introduction to programming using Visual Basic. The students are expected to learn basic programming structures such as subroutines, functions, “if” statements, loops, arrays, file I/O, in the GUI based development environment provided by Visual Basic. This is very nearly the same set of skills that are taught in the Computer Science 1 (CS-144) course. However, this course meets only two hours per week while the Computer Science 1 course meets four hours a week.

Second, while current students are very familiar with the use of computers, they are generally not familiar with the concepts required to program computers. The difference between using and programming computers is huge, like the difference between driving a car and build a car. This difference is further hidden by using the Visual Basic environment to lay out the GUI for applications.

Since 1/3 of the students enrolled in this course failed to master the topics, perhaps the goals & context of the course are too ambitious for current students. We should consider how the course might be revised to focus attention on the fundamental concepts and problem solving skills inherent in Computer Science.

On the positive side, nearly 60% of the students displayed a fairly high level of logical reasoning skills (levels 2, 3, and 4).

9. OTHER COMMENTS AND/OR SUGGESTIONS:
Due to declining enrollments in this course and budgetary constraints, this course will not be offered during the 2007-2008 academic year, and may not be offered in the future.
1. **DEPARTMENT:** Mathematics, Statistics and Computer Science (MSCS)

2. **GENERAL EDUCATION CATEGORY:** Analytic Reasoning (ANRSN)

3. **COURSE NUMBER AND TITLE:** CS-144 Computer Science I

4. **NUMBER OF SECTIONS INCLUDED IN THIS ASSESSMENT:** 3 (77 students)
This includes all 3 sections from the Fall 2006 semester. One section was offered in the Spring 2007 semester, and it was not assessed.

5. **GENERAL EDUCATION OBJECTIVES:**
2. Formulate logical and mathematical reasoning related to various branches of knowledge.
4. Think creatively, analyze critically, synthesize clearly and act responsibly.

6. **METHODOLOGY:**
Objectives (2) and (4) were assessed simultaneously. In particular, for this course, the emphasis is on analyzing critically, synthesizing through programming, and problem solving. To assess these objectives, the MSCS Department uses “embedded assessment.” For this course, one program from a mid-term programming exam was chosen for assessment.

Program: Converting miles to feet
In this program you will write a class called Distance according to the UML.

<table>
<thead>
<tr>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>- miles : double</td>
</tr>
<tr>
<td>+ Distance ( dist: double) : double</td>
</tr>
<tr>
<td>+ getMiles ( ) : double</td>
</tr>
<tr>
<td>+ setMiles ( dist : double) : void</td>
</tr>
<tr>
<td>+ convertToFeet ( ) : double</td>
</tr>
</tbody>
</table>

- miles - contains the number of miles in the distance
- Distance - constructor initializes the miles to the parameter value
- getMiles - accessor method, returns the number of miles
- setMiles - mutator method, sets the miles to the parameter value
- convertToFeet - converts the miles to feet \( (feet = miles \times 5280) \)

Write another class to demonstrate the Distance class, use the following algorithm to create your main method.

*Prompt the user to enter the number of miles to convert to feet.*
*Read in the user’s input and store it.*
*If the user entered a negative number*
  *Store 0 over the user’s input*
  *Print a statement indicating the user entered an invalid value, so 0 will be used*
Create a Distance object with the user’s input.
Call the accessor method and the conversion method to display the information with appropriate labels
Prompt the user to enter another number of miles to convert to feet
Read in the user’s input and store it.
If the user entered a negative number
    Store 0 over the user’s input
    Print a statement indicating the user entered an invalid value, so 0 will be used
Call the mutator method to change the number of miles in the distance object
Call the accessor method and the conversion method to display the information with appropriate labels

Your output should be as follows:
Enter the number of miles to convert to feet: 2
There are 10560.0 feet in 2.0 miles
Enter another number of miles to convert to feet: 1.5
There are 7920.0 feet in 1.5 miles

Student demonstration of logical reasoning skills was then evaluated by using a common rubric with a 0 to 4 scale where 0 represents no display of logical reasoning skills and 4 represents the greatest display of logical reasoning skills. The specific scale is given in the summary of results in the next section.

All students taking the exam were included in the assessment.

7. RESULTS: The following table summarizes student performance.

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Description of Performance Level</th>
<th>Number of Students at Level</th>
<th>% of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No clue</td>
<td>0</td>
<td>0 %</td>
</tr>
<tr>
<td>1</td>
<td>Program fragments show some understanding of problem.</td>
<td>8</td>
<td>10.4 %</td>
</tr>
<tr>
<td>2</td>
<td>Program not completely debugged, but program shows understanding of problem and how to address it.</td>
<td>6</td>
<td>7.8 %</td>
</tr>
<tr>
<td>3</td>
<td>Program runs, a few requirements may not be met.</td>
<td>10</td>
<td>13 %</td>
</tr>
<tr>
<td>4</td>
<td>Program runs and solves the problem as required.</td>
<td>53</td>
<td>68.8 %</td>
</tr>
</tbody>
</table>

8. REFLECTION:
These results are typical of midterm programming understanding and application in a first semester class in computer science. Students show a good comprehension of programming concepts and how to apply them to solve problems that are presented. No changes are planned for next semester.

9. OTHER COMMENTS AND/OR SUGGESTIONS: None.
1. **DEPARTMENT**: Mathematics, Statistics and Computer Science (MSCS)

2. **GENERAL EDUCATION CATEGORY**: Analytic Reasoning (ANRSN)

3. **COURSE NUMBER AND TITLE**: MATH-118 Concepts of Mathematics

4. **NUMBER OF SECTIONS INCLUDED IN THIS ASSESSMENT**: 9 (321 students)
   This includes 4 of 8 sections from the Fall 2006 semester and 5 of 7 sections from the Spring 2007 semester.

5. **GENERAL EDUCATION OBJECTIVES**:
   2. Formulate logical and mathematical reasoning related to various branches of knowledge.
   4. Think creatively, analyze critically, synthesize clearly and act responsibly.

6. **METHODOLOGY**:
   Objectives (2) and (4) were assessed simultaneously. In particular, for our courses, the emphasis for Objective (4) is on “analyze critically” and “synthesize clearly.”

   To assess these objectives, the MSCS Department uses “embedded assessment.” For the nine sections assessed, the following question was asked on the final exam for the course.

   **Question**: on Venn Diagrams and Probability
   In a certain group of students at Monroe Community College, the following information was obtained: 44 students subscribe to Sports Illustrated, 26 students subscribe to People, and 14 subscribe to both magazines. Nineteen of the students in the group get neither of the magazines. 1. Make a Venn diagram of the information in the problem and use it to answer each of the following questions. 2. What is the total number of students in this group? 3. How many students in this group subscribe to People or Sports Illustrated, or both? 4. If one of the students in this group is chosen at random, what is the probability that s/he subscribes only to People magazine?

   Student demonstration of logical reasoning skills was then evaluated by using a common rubric with a 0 to 4 scale where 0 represents no display of logical reasoning skills and 4 represents the greatest display of logical reasoning skills. The specific scale is given in the summary of results in the next section.

   Since this was a final exam question, all students completing these sections of the course were included in the assessment.
7. RESULTS: The following table summarizes student performance.

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Description of Performance Level</th>
<th>Number of Students at Level</th>
<th>% of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Cannot construct the Venn diagram</td>
<td>65</td>
<td>20.2 %</td>
</tr>
<tr>
<td>1</td>
<td>Correctly constructs/fills the Venn diagram (but no further)</td>
<td>44</td>
<td>13.7 %</td>
</tr>
<tr>
<td>2</td>
<td>Level 1 and correctly answers question 2 (but not 3 and 4)</td>
<td>51</td>
<td>15.9 %</td>
</tr>
<tr>
<td>3</td>
<td>Level 2 and correctly answers question 3 (but not 4)</td>
<td>69</td>
<td>21.5 %</td>
</tr>
<tr>
<td>4</td>
<td>Complete and correct answers to all parts</td>
<td>92</td>
<td>28.6 %</td>
</tr>
</tbody>
</table>

8. REFLECTION:
In one section of the course, 20 out of 24 students in the course performed at level 0, apparently due to only a limited amount of time spent on this topic. As such, for that section, this tool does provide an accurate measurement of whether the general education objectives were met. In the future, it will be stressed that instructors need to spend appropriate time on the topic which will be assessed.

If those students are ignored, only about 15% of the students performed at level 0 or equivalently, 85% scored above that level. Even being able to correctly construct and fill-in the diagram, demonstrates a fair amount of logical reasoning ability. Of course one would like to see more students performing at the highest levels (3 and 4).

In the future, instructors will work more examples and give more homework problems in this area so that students get more practice with the basics. Then students will be better able to develop the reasoning skills necessary to work through the remaining parts of a problem such as this one.

9. OTHER COMMENTS AND/OR SUGGESTIONS: None.
1. **DEPARTMENT:** Mathematics, Statistics and Computer Science (MSCS)

2. **GENERAL EDUCATION CATEGORY:** Analytic Reasoning (ANRSN)

3. **COURSE NUMBER AND TITLE:** MATH-120 Introductory College Mathematics I

4. **NUMBER OF SECTIONS INCLUDED IN THIS ASSESSMENT:** 16 (611 students)
This includes 7 of 10 in-class sections and 1 of 1 on-line section from the Fall 2006 semester and 7 of 7 in-class sections and 1 of 1 on-line section from the Spring 2007 semester.

5. **GENERAL EDUCATION OBJECTIVES:**
2. Formulate logical and mathematical reasoning related to various branches of knowledge.
4. Think creatively, analyze critically, synthesize clearly and act responsibly.

6. **METHODOLOGY:**
Objectives (2) and (4) were assessed simultaneously. In particular, for our courses, the emphasis for Objective (4) is on “analyze critically” and “synthesize clearly.”

To assess these objectives, the MSCS Department uses “embedded assessment.” For both semesters, a set of questions from the common final exam were chosen. The on-line section used a different exam, but the questions chosen for assessment purposes were similar.

For the Fall 2006 sections, the following four questions were asked.

Q1: The length of a rectangular garden is 5 feet greater than the width. The area of the garden is 66 square feet. Find the length and width of the garden.

Q2: Find the inverse of the function \( f(x) = \frac{2x - 1}{x + 1} \).

Q3: A football is thrown by a quarterback to a receiver 40 yards away. The quadratic function
\[
s(t) = -0.025t^2 + t + 5
\]
models the football’s height above the ground, \( s(t) \), in feet, when it is \( t \) yards from the quarterback. How many yards from the quarterback does the football reach its greatest height? What is that height?

Q4: Solve the polynomial equation \( x^3 - 2x^2 - 7x - 4 = 0 \). [Hint: You may want to use synthetic division to find one root, then use this root to find all other roots of the equation.]

For the Spring 2007 sections, the following three questions were asked. See the Reflection section for information on this change.
Q1-New: A ball is thrown upward from the ground with an initial velocity of 80 feet per second. The height of the ball is given by the formula \( h = -16t^2 + 80t \). During which time interval will the ball’s height exceed 64 feet?

Q2-New = Q2 above; Q3-New = Q4 above

Student demonstration of logical reasoning skills was then evaluated by using a common rubric with a 0 to 4 scale where 0 represents no display of logical reasoning skills and 4 represents the greatest display of logical reasoning skills. The specific scale is given in the summary of results in the next section.

Since these were final exam questions, all students completing these sections of the course were included in the assessment.

7. RESULTS: The following tables summarize student performance.

Fall 2006: In these tables, the numbers without parentheses are from the in-class sections only. The numbers in parentheses also include students from the on-line section.

\[
\begin{array}{|c|c|c|c|}
\hline
\text{Performance Level} & \text{Description of Performance Level} & \text{Number of Students at Level} & \text{\% of Students} \\
\hline
0 & No attempt & 28 (29) & 9.3 (8.6) \\
1 & Set up area equation & 45 (45) & 15 (13.4) \\
2 & Attempt at solving quadratic equation & 23 (27) & 7.7 (8.0) \\
3 & Found the width (but not length) & 12 (18) & 4 (5.3) \\
4 & Correct answer with units & 192 (218) & 64 (64.7) \\
\hline
\end{array}
\]

\[
\begin{array}{|c|c|c|c|}
\hline
\text{Performance Level} & \text{Description of Performance Level} & \text{Number of Students at Level} & \text{\% of Students} \\
\hline
0 & No attempt & 80 (82) & 26.7 (24.3) \\
1 & Began attempt at finding inverse & 125 (129) & 41.6 (38.3) \\
2 & Substantial work but incomplete and inverse not found & 47 (47) & 15.7 (14) \\
3 & Inverse found but sign error occurred & 20 (21) & 6.7 (6.2) \\
4 & Correct answer & 28 (58) & 9.3 (17.2) \\
\hline
\end{array}
\]
Q3: Results were obtained from only 5 in-class sections.

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Description of Performance Level</th>
<th>Number of Students at Level</th>
<th>% of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No attempt</td>
<td>54 (59)</td>
<td>24.9 (23.2)</td>
</tr>
<tr>
<td>1</td>
<td>Recognized need to find vertex</td>
<td>63 (66)</td>
<td>29 (26)</td>
</tr>
<tr>
<td>2</td>
<td>Found vertex correctly</td>
<td>33 (33)</td>
<td>15.2 (13)</td>
</tr>
<tr>
<td>3</td>
<td>Attempt to use vertex to find height</td>
<td>8 (12)</td>
<td>3.7 (4.7)</td>
</tr>
<tr>
<td>4</td>
<td>Correct answers with units</td>
<td>59 (84)</td>
<td>27.2 (33.1)</td>
</tr>
</tbody>
</table>

Q4:

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Description of Performance Level</th>
<th>Number of Students at Level</th>
<th>% of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No attempt</td>
<td>55 (60)</td>
<td>18.4 (17.8)</td>
</tr>
<tr>
<td>1</td>
<td>Found one root</td>
<td>30 (43)</td>
<td>10 (12.8)</td>
</tr>
<tr>
<td>2</td>
<td>Use synthetic division to factor</td>
<td>28 (33)</td>
<td>9.3 (9.8)</td>
</tr>
<tr>
<td>3</td>
<td>Attempt at solving remaining quadratic factor</td>
<td>24 (31)</td>
<td>8 (9.2)</td>
</tr>
<tr>
<td>4</td>
<td>Correct roots</td>
<td>163 (170)</td>
<td>54.3 (50.4)</td>
</tr>
</tbody>
</table>

Spring 2007: As above, in these tables, the numbers without parentheses are from the in-class sections only. The numbers in parentheses also include students from the on-line section.

Q1:

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Description of Performance Level</th>
<th>Number of Students at Level</th>
<th>% of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No attempt</td>
<td>30 (35)</td>
<td>12.8 (12.8)</td>
</tr>
<tr>
<td>1</td>
<td>Problem set up</td>
<td>90 (94)</td>
<td>38.5 (34.3)</td>
</tr>
<tr>
<td>2</td>
<td>Problem half way complete</td>
<td>37 (44)</td>
<td>15.8 (16.1)</td>
</tr>
<tr>
<td>3</td>
<td>Problem complete but with small error</td>
<td>20 (28)</td>
<td>8.5 (10.2)</td>
</tr>
<tr>
<td>4</td>
<td>Problem correct</td>
<td>57 (73)</td>
<td>24.4 (26.6)</td>
</tr>
</tbody>
</table>
Q2:

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Description of Performance Level</th>
<th>Number of Students at Level</th>
<th>% of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No attempt</td>
<td>96 (104)</td>
<td>41.0 (38.0)</td>
</tr>
<tr>
<td>1</td>
<td>Problem set up</td>
<td>82 (83)</td>
<td>35.0 (30.3)</td>
</tr>
<tr>
<td>2</td>
<td>Problem half way complete</td>
<td>35 (36)</td>
<td>15.0 (13.1)</td>
</tr>
<tr>
<td>3</td>
<td>Problem complete but with small error</td>
<td>13 (16)</td>
<td>5.6 (5.8)</td>
</tr>
<tr>
<td>4</td>
<td>Problem correct</td>
<td>8 (35)</td>
<td>3.4 (12.8)</td>
</tr>
</tbody>
</table>

Q3:

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Description of Performance Level</th>
<th>Number of Students at Level</th>
<th>% of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No attempt</td>
<td>58 (67)</td>
<td>24.8 (24.5)</td>
</tr>
<tr>
<td>1</td>
<td>Problem set up</td>
<td>42 (49)</td>
<td>17.9 (17.9)</td>
</tr>
<tr>
<td>2</td>
<td>Problem half way complete</td>
<td>23 (32)</td>
<td>9.8 (11.7)</td>
</tr>
<tr>
<td>3</td>
<td>Problem complete but with small error</td>
<td>21 (25)</td>
<td>9.0 (9.1)</td>
</tr>
<tr>
<td>4</td>
<td>Problem correct</td>
<td>90 (101)</td>
<td>38.5 (36.8)</td>
</tr>
</tbody>
</table>

8. REFLECTION:

Fall 2006: Based on the outcomes, several suggestions were made to improve student learning.

- To work on more application problems perhaps in small groups to ease students’ anxiety when first learning how to solve them.
- To use relevant application problems to engage students more effectively.
- To cover a wider variety of functions when teaching inverses.
- To connect to “real world” formulas where finding the inverse is used (e.g., temperature conversion from Celsius to Fahrenheit).
- To connect finding inverses to the arithmetic idea of opposites (add-subtract, multiply-divide, etc).
- To continue to stress multiple approaches to solving problems in general.

It was also decided to change the assessment tool for future semesters in the following ways.

- Use three problems instead of four: an application problem (Q1), an inverse problem (Q2), and a finding solutions to an equation problem (Q3).
- Change the performance levels for each problem to follow a more general pattern. 
  0-no attempt
  1-problem set up
  2-problem half way complete
3-problem complete but with small error
4-problem correct

The committee also recommended that the department re-examine the length and common structure of the final exam in an attempt to better assess student learning.

Spring 2007 Compared to Fall 2006:
When the results are compared to the assessment results from the fall semester the results are lower in the spring. This was expected on the application problem (Q1) since a different more difficult problem was chosen for the spring. However the inverse (Q2) and the roots (Q3) problem, which were similar to ones assessed in the fall, were also lower. Unfortunately, fewer students got a correct answer and more students made no attempt.

General Comments/Suggestions for the future:
- The Math 120 instructors in the Fall of 2006 made various suggestions (see above). This is a key step in the assessment process. Unfortunately, it is not clear that these suggestions were implemented in the Spring of 2007. There needs to be better communication of such suggestions to future instructors.
- Particularly in the spring, instructors found a trend that students did either very poorly or very well on problems with few students in the middle range. There may be various factors at work here. Historical anecdotal evidence suggests that this is more likely to happen on final exams in the spring semester as students are just “ready to be done.” Assessment in future years will provide some evidence for/against this.
- Another factor is the increase in usage of on-line homework systems in Math 120. The nature of these systems, where students simply submit a correct answer may be creating some poor habits in students so that they do not start working through problems.
- Instructors need to constantly emphasize stamina and the importance of even finding partial solutions as key to developing one’s skills. In general, more emphasis may need to be placed on general problem solving processes throughout the semester.
- While instructors should not “teach to assessment” so-to-speak, instructors need to know at the beginning of the class what topics will be assessed so that they spend sufficient time on the topic. That way, the assessment can be an accurate measure of logical reasoning skills and not simply whether or not students know a certain topic.
- Students may be better served by spending more time on application problems and problems that are harder to solve in order to build up logical reasoning skills, rather than over-emphasizing basic skills, which students may be able to practice more easily on their own.

9. OTHER COMMENTS AND/OR SUGGESTIONS:
Instructors also recommended that the department re-examine the length and nature of the common final exam for the course. Currently it consists primarily of short questions that emphasize basic skills. To accurately assess students’ logical reasoning skills, the exam should contain some lengthier multi-step problems.
1. **DEPARTMENT:** Mathematics, Statistics and Computer Science (MSCS)

2. **GENERAL EDUCATION CATEGORY:** Analytic Reasoning (ANRSN)

3. **COURSE NUMBER AND TITLE:** MATH-121 Introductory College Mathematics II

4. **NUMBER OF SECTIONS INCLUDED IN THIS ASSESSMENT:** 8 (269 students)
   
   This includes 3 of 6 sections from the Fall 2006 semester and 5 of 5 sections from the Spring 2007 semester.

5. **GENERAL EDUCATION OBJECTIVES:**
   
   2. Formulate logical and mathematical reasoning related to various branches of knowledge.
   
   4. Think creatively, analyze critically, synthesize clearly and act responsibly.

6. **METHODODOLOGY:**

   Objectives (2) and (4) were assessed simultaneously. In particular, for our courses, the emphasis for Objective (4) is on “analyze critically” and “synthesize clearly.”

   To assess these objectives, the MSCS Department uses “embedded assessment.” Each semester a common question was given on the final exam for the sections assessed.

   For the Fall 2006 semester, the following question was asked.

   **Question:** A bird species in danger of extinction has a population that is decreasing exponentially according to the decay model

   \[ A = 1400e^{-0.0673t} \]

   Once the population drops to 100, the situation will be irreversible. When will this happen?

   For the Spring 2007 semester, it was decided to use a different question. See the Reflection section below.

   **Question:** A birder spots a snowy owl directly to the north. A second birder, 100 feet west of the first birder, also sees the snowy owl. The bearing from the second birder to the owl is N 49 degrees E. How far, to the nearest tenth of a foot, is the first birder from the snowy owl?

   Student demonstration of logical reasoning skills was then evaluated by using a common rubric with a 0 to 4 scale where 0 represents no display of logical reasoning skills and 4 represents the greatest display of logical reasoning skills. The specific scale is given in the summary of results in the next section.

   Since these were final exam questions, all students completing these sections of the course were included in the assessment.
7. RESULTS: The following tables summarize student performance.

Fall 2006:

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Description of Performance Level</th>
<th>Number of Students at Level</th>
<th>% of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No attempt, or attempt with no success.</td>
<td>13</td>
<td>11.5%</td>
</tr>
<tr>
<td>1</td>
<td>Rudimentary understanding of the concepts.</td>
<td>12</td>
<td>10.6%</td>
</tr>
<tr>
<td>2</td>
<td>Some understanding of concepts, about half correct.</td>
<td>4</td>
<td>3.5%</td>
</tr>
<tr>
<td>3</td>
<td>Essentially correct except some minor errors.</td>
<td>3</td>
<td>2.7%</td>
</tr>
<tr>
<td>4</td>
<td>Correct solution to the problem.</td>
<td>81</td>
<td>71.7%</td>
</tr>
</tbody>
</table>

Spring 2007:

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Description of Performance Level</th>
<th>Number of Students at Level</th>
<th>% of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No attempt, or attempted with no success.</td>
<td>14</td>
<td>9.0%</td>
</tr>
<tr>
<td>1</td>
<td>Rudimentary understanding of concepts.</td>
<td>12</td>
<td>7.7%</td>
</tr>
<tr>
<td>2</td>
<td>Some understanding of concepts, about half correct.</td>
<td>16</td>
<td>10.3%</td>
</tr>
<tr>
<td>3</td>
<td>Essentially correct except for minor errors.</td>
<td>79</td>
<td>50.6%</td>
</tr>
<tr>
<td>4</td>
<td>Correct solution to problem.</td>
<td>35</td>
<td>22.4%</td>
</tr>
</tbody>
</table>

8. REFLECTION:
After Fall 2006: This course is a prerequisite for calculus. In order to help the students gain the algebraic skills needed in calculus, much of the course work in and out of class involves practice solving algebraic problems. The formal definition of Analytic Reasoning Skills includes two parts: “A: The study and application of processes of inductive or deductive reasoning. B: The study of quantitative or formula based reasoning.” The particular problem chosen to assess was more closely aligned with part (B) than part (A). The overall performance of students on this problem was very good and so suggests that we are meeting this aspect of the objective. However, the assessment does not give much information on student performance relative to part (A).

As a result, it was suggested that in the Spring of 2007, instructors be sure to spend sufficient time on activities that promote “critical thinking” (such as proofs and showing where formulas come from), rather than just showing how to use the formulas. Further, course homework, exams and/or quizzes should be modified where possible to include material relating to part (A).
Finally, the final exam should be modified to include a question that requires more critical thinking, to help assess student performance on part (A).

Spring 2007: Instructors attempted to carry-out the above recommendations in terms of course activities and an assessment problem. Finding a “better” final exam question for assessment purposes turned out to be a challenge. For this course (MATH 121), the identical exam is given to all sections of the course. Further the same exam is typically used for several semesters. There had been some discussion of changing the exam for the Spring 2007 semester but this did not occur. As a result, instructors were constrained to choosing a problem from the same version of the exam or using an alternate means of assessment. For this semester it was decided to choose the “best” problem they could find (the one above) from the exam.

In reflecting on those results, the instructors came to similar conclusions – that students seemed to be doing well with formula-based reasoning but the chosen problem still did not require a high level of critical thinking. The instructors recommended that future instructors continue to emphasize critical thinking and that a better tool should be used for assessment purposes.

9. OTHER COMMENTS AND/OR SUGGESTIONS:
The nature of the common final exam for MATH 121 (and MATH 120) is an on-going discussion within the MSCS Department. Hopefully these assessment results will help guide the department in creating good tools for evaluating (and assessing) student performance.
1. **DEPARTMENT**: Mathematics, Statistics and Computer Science (MSCS)

2. **GENERAL EDUCATION CATEGORY**: Analytic Reasoning (ANRSN)

3. **COURSE NUMBER AND TITLE**: MATH-123 Finite Mathematics

4. **NUMBER OF SECTIONS INCLUDED IN THIS ASSESSMENT**: 6 (237 students)
   This includes 1 of 4 sections from the Fall 2006 semester and all 5 sections from the Spring 2007 semester. Two of the Spring 2007 sections were taught in a combined online/classroom format.

5. **GENERAL EDUCATION OBJECTIVES**:
   2. Formulate logical and mathematical reasoning related to various branches of knowledge.
   
   4. Think creatively, analyze critically, synthesize clearly and act responsibly.

6. **METHODOLOGY**:
   Objectives (2) and (4) were assessed simultaneously. In particular, for our courses, the emphasis for Objective (4) is on “analyze critically” and “synthesize clearly.”

   To assess these objectives, the MSCS Department uses “embedded assessment.” For the sections assessed, a question similar to the following was asked on the final exam for the course.

   **Question:** Linear programming problem to maximize an objective function
   A boat manufacturer makes fishing boats which are sold for a profit of $400 each and canoes which are sold for a profit of $250 each. Each fishing boat requires 100 assembly hours and 25 finishing hours, while each canoe requires 75 assembly hours and 50 finishing hours. The manufacturer has a total of 8000 assembly hours and 3000 finishing hours available.
   (a) Formulate, but do not solve, the linear programming problem for how many fishing boats and how many canoes should be made to maximize the manufacturer’s profit. (b) Set up the initial simplex matrix that you would use to solve the problem with the simplex method. Circle the first pivot element. (c) Solve the linear programming problem.

   Student demonstration of logical reasoning skills was then evaluated by using a common rubric with a 0 to 4 scale where 0 represents no display of logical reasoning skills and 4 represents the greatest display of logical reasoning skills. The specific scale is given in the summary of results in the next section.

   Since these were final exam questions, all students completing these sections of the course were included in the assessment.
7. RESULTS: The following tables summarize student performance.

Fall 2006:

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Description of Performance Level</th>
<th>Number of Students at Level</th>
<th>% of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>None of (a)-(c) is correct</td>
<td>7</td>
<td>16 %</td>
</tr>
<tr>
<td>1</td>
<td>At least one of (a)-(c) is correct</td>
<td>14</td>
<td>33 %</td>
</tr>
<tr>
<td>2</td>
<td>Both (a) and (b) are correct</td>
<td>1</td>
<td>2 %</td>
</tr>
<tr>
<td>3</td>
<td>All (a)-(c) are correct with possibly minor mistakes</td>
<td>11</td>
<td>26 %</td>
</tr>
<tr>
<td>4</td>
<td>All (a)-(c) are correct with no errors</td>
<td>10</td>
<td>23 %</td>
</tr>
</tbody>
</table>

Spring 2007:

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Description of Performance Level</th>
<th>Number of Students at Level</th>
<th>% of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No score,</td>
<td>14</td>
<td>7.2 %</td>
</tr>
<tr>
<td>1</td>
<td>Meets few relevant criteria</td>
<td>30</td>
<td>15.5 %</td>
</tr>
<tr>
<td>2</td>
<td>General understanding of concepts and procedures</td>
<td>28</td>
<td>14.4 %</td>
</tr>
<tr>
<td>3</td>
<td>Meets all or most relevant criteria</td>
<td>78</td>
<td>40.2 %</td>
</tr>
<tr>
<td>4</td>
<td>Meets or exceeds all relevant criteria</td>
<td>44</td>
<td>22.7 %</td>
</tr>
</tbody>
</table>

8. REFLECTION:

Fall 2006: Nearly 50% of the students showed a high level of analytical reasoning skills (levels 3 and 4), and most students showed at least some (level 1 or higher). For the future, the instructor recommends encouraging and emphasizing class attendance, and encouraging students to do homework problems besides those that are collected and to seek help as soon as each section’s class discussion is completed.

Spring 2007: Over 60% of the students showed a high level of analytical reasoning skills (levels 3 and 4), and most students showed at least some (level 1 or higher). Instructors made the following recommendations for the future. For in-class sections, it was again recommended that class attendance needs to be stressed. It was also recommended that more group activities might help student learning. For all sections (in-class or on-line), it was suggested that instructors use a more project-based approach and use technology to enhance students understanding of concepts (for example, more video clips) but emphasize responsible use of technology by students (particularly with online homework and testing). It was also recommended that there be more standardization of questions on exams across sections (beyond the one chosen for assessment purposes).

9. OTHER COMMENTS AND/OR SUGGESTIONS: None.
1. **DEPARTMENT:** Mathematics, Statistics and Computer Science (MSCS)

2. **GENERAL EDUCATION CATEGORY:** Analytic Reasoning (ANRSN)

3. **COURSE NUMBER AND TITLE:** MATH-153 Calculus I

4. **NUMBER OF SECTIONS INCLUDED IN THIS ASSESSMENT:** 8 (335 students)  
   This includes 4 of 4 sections from the Fall 2006 semester and 4 of 4 sections from the Spring 2007 semester (including one on-line section).

5. **GENERAL EDUCATION OBJECTIVES:**
   2. Formulate logical and mathematical reasoning related to various branches of knowledge.
   4. Think creatively, analyze critically, synthesize clearly and act responsibly.

6. **METHODOLOGY:**
   Objectives (2) and (4) were assessed simultaneously. In particular, for our courses, the emphasis for Objective (4) is on “analyze critically” and “synthesize clearly.” To assess these objectives, the MSCS Department uses “embedded assessment.” For the Fall 2006 semester, instructors created six problems to be common on the final exam for all sections. These questions were:
   
   (1) Evaluate the definite integral \( \int_{0}^{24} (1 - x^2) \, dx \).  
   (2) Evaluate the limit \( \lim_{x \to 4} \sqrt{x} - 2 \).  
   (3) Find the extrema of \( f(x) = 3x^4 - 4x^3 \) on the interval \([-1, 2]\).  
   (4) A farmer has a $400 budget for fencing a rectangular field along a straight river, as in the picture below. It costs $3 per yard to build along the river but only $2 per yard to build everywhere else because the labor is easier away from the river. What is the largest possible area that the farmer can fence in?  
   (5) Given the derivative function \( f'(x) = \frac{x^2 - 1}{x^2} \). Determine (a) the intervals on which the graph of \( f \) is increasing or decreasing, and (b) the intervals on which the graph of \( f \) is concave upward or concave downward.  
   (6) Air is being pumped into a spherical balloon at a rate of 6 cubic feet per minute. Find the rate of change of the radius when the radius is 3 feet.

Student demonstration of logical reasoning skills was then evaluated by using a common rubric with a 0 to 4 scale where 0 represents no display of logical reasoning skills and 4 represents the greatest display of logical reasoning skills. Instructors evaluated student performance on the six questions combined according to the scale given in the results sections below.

For the Spring 2007 semester, it was decided to simplify the assessment tool and look at the performance on two questions individually. See the Reflection section. Questions (4) and (5) were chosen for this purpose. The online class used slightly different but similar questions.

Student demonstration of logical reasoning skills was then evaluated by using a common rubric with a 0 to 4 scale where 0 represents no display of logical reasoning skills and 4
represents the greatest display of logical reasoning skills. The specific scale is given in the summary of results in the next section.

Since these were final exam questions, all students completing these sections of the course were included in the assessment.

7. **RESULTS:** The following tables summarize student performance.

Fall 2006: **Percentage** = (student’s score on these 6 questions) / (total score of these 6 questions)

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Description of Performance Level (by percentage)</th>
<th>Number of Students at Level</th>
<th>% of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No more than 5%</td>
<td>0</td>
<td>0 %</td>
</tr>
<tr>
<td>1</td>
<td>6% - 25%</td>
<td>11</td>
<td>6.8 %</td>
</tr>
<tr>
<td>2</td>
<td>26% - 50%</td>
<td>30</td>
<td>18.6 %</td>
</tr>
<tr>
<td>3</td>
<td>51% - 75%</td>
<td>69</td>
<td>42.9 %</td>
</tr>
<tr>
<td>4</td>
<td>75% - 100%</td>
<td>51</td>
<td>31.7 %</td>
</tr>
</tbody>
</table>

Spring 2007:

**Q(4)**

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Description of Performance Level</th>
<th>Number of Students at Level</th>
<th>% of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No attempt</td>
<td>15</td>
<td>8.6 %</td>
</tr>
<tr>
<td>1</td>
<td>Set up the primary and secondary equation correctly</td>
<td>70</td>
<td>40.2 %</td>
</tr>
<tr>
<td>2</td>
<td>Reduce the primary (objective) function to one variable</td>
<td>18</td>
<td>10.3 %</td>
</tr>
<tr>
<td>3</td>
<td>Almost get the correct answer</td>
<td>14</td>
<td>8.0 %</td>
</tr>
<tr>
<td>4</td>
<td>Show work and find the correct answer</td>
<td>57</td>
<td>32.8 %</td>
</tr>
</tbody>
</table>
8. REFLECTION:
Fall 2006: Almost 75% of the students demonstrated a fair amount of logical reasoning ability (Level 3 and 4). Among the problems chosen, some required more technical knowledge than analytical reasoning skills. So it was recommended that for the spring semester, the assessment should consider only two questions which required a high amount of critical thinking to correctly solve the problem, and that these should be assessed independently rather than combining the scores as done in the fall.

Instructors also recommended the importance of assigning and grading homework in order that students practice and are given feedback.

Spring 2007: On both problems, over 90% of the students displayed at least some logical reasoning skills (Levels 1-4). Over 50% of the students displayed a high level of reasoning ability (Level 3 and 4) on the second question Q(5), while about 40% did so on the first question Q(4). This is to be expected as Q(4) is a word problem and requires a somewhat higher level of critical thinking. The crucial step (or misstep) in Q(5) seems to be at the level of understanding the problem. Students need to realize that they are being asked a question about a function but are given a formula for the derivative of the function and not the function itself. The importance of understanding the problem and critical reading is something instructors can continue to emphasize in this course.

The instructors made some recommendations for improving student performance on these problems and improving critical thinking more generally: Place greater emphasis on application problems by incorporating projects into the course. Use additional methods to emphasize the relationship between derivatives and increasing/decreasing, concavity.

Instructors also noted that quite a few students find the course challenging due to an apparent lack of necessary algebra and trigonometry (especially identities) knowledge. Instructors recommended spending more time on fundamental training/exercises.

9. OTHER COMMENTS AND/OR SUGGESTIONS: None.
1. **DEPARTMENT:** Mathematics, Statistics and Computer Science (MSCS)

2. **GENERAL EDUCATION CATEGORY:** Analytic Reasoning (ANRSN)

3. **COURSE NUMBER AND TITLE:** MATH-154 Calculus II

4. **NUMBER OF SECTIONS INCLUDED IN THIS ASSESSMENT:** 2 (58 students)  
   This includes the single section offered in the Fall of 2006 and the single section offered in the Spring of 2007.

5. **GENERAL EDUCATION OBJECTIVES:**
   2. Formulate logical and mathematical reasoning related to various branches of knowledge.
   4. Think creatively, analyze critically, synthesize clearly and act responsibly.

6. **METHODOLOGY:**
   Objectives (2) and (4) were assessed simultaneously. In particular, for our courses, the emphasis for Objective (4) is on “analyze critically” and “synthesize clearly.”

   To assess these objectives, the MSCS Department uses “embedded assessment.” For the two sections assessed, the following question was asked on the final exam for the course.

   **Question:** An application of integration to finding area/volume.  
   Given a region bounded by four curves (three of which are lines) the question has the following four parts:
   
   (a) Sketch the region and find its area.
   (b) Set up the integral for the volume of the solid that is formed by revolving the region about x-axis. (use disk method)
   (c) Set up the integral for the volume of the solid that is formed by revolving the region about y-axis. (use shell method)
   (d) Set up the integral for the volume of the solid that is formed by revolving the region about the line x=1.

   Student demonstration of logical reasoning skills was then evaluated by using a common rubric with a 0 to 4 scale where 0 represents no display of logical reasoning skills and 4 represents the greatest display of logical reasoning skills. The specific scale is given in the summary of results in the next section.

   Since these were final exam questions, all students completing these sections of the course were included in the assessment.
7. RESULTS: The following table summarizes student performance.

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Description of Performance Level</th>
<th>Number of Students at Level</th>
<th>% of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Shows no understanding of the problem [all parts (a)-(d)]</td>
<td>2</td>
<td>3.4 %</td>
</tr>
<tr>
<td>1</td>
<td>Shows formula based reasoning skills [at least one of (a) - (d)]</td>
<td>3</td>
<td>5.2 %</td>
</tr>
<tr>
<td>2</td>
<td>Shows analytical reasoning with the aid of Coordinate / Euclidean Geometry and Calculus towards a correct solution [at least one of (b), (c), (d)]</td>
<td>24</td>
<td>41.4 %</td>
</tr>
<tr>
<td>3</td>
<td>Shows analytical reasoning and completes the solutions [both (b) and (c)]</td>
<td>13</td>
<td>22.4 %</td>
</tr>
<tr>
<td>4</td>
<td>Shows critical thinking and analytical reasoning and completes the solution [(a)-(d)]</td>
<td>16</td>
<td>27.6 %</td>
</tr>
</tbody>
</table>

8. REFLECTION:
All but two students (level 0) showed at least some level of reasoning skills and over 90% showed some higher level reasoning skills (levels 2, 3, and 4). However, one would like to see a greater percentage in the level 3 and 4 range. The instructors noted that there were some technical details which they could emphasize more in class (highlighting coordinates of points as distances and showing examples of finding distances using coordinates of points that are on curves given with formulae) to help student performance on this sort of problem.

Instructors also suggested the need for stressing class attendance, and encouraging students to do more homework problems besides those that are collected and to seek help as soon as every section’s class discussion is completed.

9. OTHER COMMENTS AND/OR SUGGESTIONS: None.
1. **DEPARTMENT:** Mathematics, Statistics and Computer Science (MSCS)

2. **GENERAL EDUCATION CATEGORY:** Analytic Reasoning (ANRSN)

3. **COURSE NUMBER AND TITLE:** MATH-156 Calculus and Analytic Geometry I

4. **NUMBER OF SECTIONS INCLUDED IN THIS ASSESSMENT:** 1 (19 students)
   This is the single section offered during the Spring of 2007. Neither of the two sections offered during the Fall of 2006 were assessed.

5. **GENERAL EDUCATION OBJECTIVES:**
   2. Formulate logical and mathematical reasoning related to various branches of knowledge.
   4. Think creatively, analyze critically, synthesize clearly and act responsibly.

6. **METHODOLOGY:**
   Objectives (2) and (4) were assessed simultaneously. In particular, for our courses, the emphasis for Objective (4) is on “analyze critically” and “synthesize clearly.”

   To assess these objectives, the MSCS Department uses “embedded assessment.” For this section, the following question was asked on the final exam for the course.

   **Question:** To developmentally find the derivative of a function by its limit definition.
   With the function’s formula given the problem has five parts:
   (a) Sketch the graph of the function.
   (b) On the same coordinate plane of part (a) label two given points (one of which is a variable point) and draw the secant line through them.
   (c) Write an expression for the slope of the secant line.
   (d) Simplify the expression.
   (e) Write the derivative of the function at the x-coordinate of the specific point as a limit of an expression and evaluate the limit.

   Student demonstration of logical reasoning skills was then evaluated by using a common rubric with a 0 to 4 scale where 0 represents no display of logical reasoning skills and 4 represents the greatest display of logical reasoning skills. The specific scale is given in the summary of results in the next section.

   Since this was a final exam question, all students completing this section of the course were included in the assessment.
7. RESULTS: The following table summarizes student performance.

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Description of Performance Level</th>
<th>Number of Students at Level</th>
<th>% of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Shows no understanding of the problem [(a)-(e)]</td>
<td>0</td>
<td>0 %</td>
</tr>
<tr>
<td>1</td>
<td>Shows analytic reasoning skills using graphs and function notations [both (a) and (b)]</td>
<td>4</td>
<td>21 %</td>
</tr>
<tr>
<td>2</td>
<td>Shows formula based reasoning skills [all of (a), (b), (c)]</td>
<td>7</td>
<td>37 %</td>
</tr>
<tr>
<td>3</td>
<td>Shows analytic reasoning using Coordinate Geometry, Algebra, and Function Notation [all of (a)-(d)]</td>
<td>4</td>
<td>21 %</td>
</tr>
<tr>
<td>4</td>
<td>Shows formula based reasoning skills and analytic reasoning using Calculus, Algebra, Coordinate Geometry, and Function Notation [all of (a)-(e)]</td>
<td>4</td>
<td>21 %</td>
</tr>
</tbody>
</table>

8. REFLECTION:
All students in the class showed at least some level of reasoning skills with over 40% showing a high level of reasoning ability (levels 3 and 4). One would like to see a higher percentage at levels 3 and 4.

The instructor noted some technical items which could be done to improve student performance on a problem like this (with examples, highlight correct use of function notations and extend and incorporate the method to find the derivative by its limit definition also in the sections that introduce the derivative formulae). More generally, it was suggested to reintroduce the algebraic rules that should be used in order to avoid the common algebraic mistakes which prevent students from completing a problem properly so that students can more fully develop their reasoning skills.

9. OTHER COMMENTS AND/OR SUGGESTIONS:
In the future, the department needs to insure that assessment is done in the fall when a larger number of students take the course.
1. **DEPARTMENT:** Mathematics, Statistics and Computer Science (MSCS)

2. **GENERAL EDUCATION CATEGORY:** Analytic Reasoning (ANRSN)

3. **COURSE NUMBER AND TITLE:** MATH-157 Calculus and Analytic Geometry II

4. **NUMBER OF SECTIONS INCLUDED IN THIS ASSESSMENT:** 1 (22 students)
   This is the single section offered during the Spring of 2007. The (slightly smaller) single section offered during the Fall of 2006 was not assessed.

5. **GENERAL EDUCATION OBJECTIVES:**
   2. Formulate logical and mathematical reasoning related to various branches of knowledge.
   4. Think creatively, analyze critically, synthesize clearly and act responsibly.

6. **METHODOLOGY:**
   Objectives (2) and (4) were assessed simultaneously. In particular, for our courses, the emphasis for Objective (4) is on “analyze critically” and “synthesize clearly.”

   To assess these objectives, the MSCS Department uses “embedded assessment.” For this section, the following question was asked on the final exam for the course.

   **Question:** An application of integration to finding area.
   Find the area of the regions inside both of the polar curves \( r=2\sin \theta \) and \( r=2(1-\cos \theta) \).

   Student demonstration of logical reasoning skills was then evaluated by using a common rubric with a 0 to 4 scale where 0 represents no display of logical reasoning skills and 4 represents the greatest display of logical reasoning skills. The specific scale is given in the summary of results in the next section.

   Since this was a final exam question, all students completing this section of the course were included in the assessment.

7. **RESULTS:** The following table summarizes student performance.

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Description of Performance Level</th>
<th>Number of Students at Level</th>
<th>% of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Unable to begin the problem in a meaningful way.</td>
<td>12</td>
<td>55 %</td>
</tr>
<tr>
<td>1</td>
<td>Is able to sketch the polar curves involved.</td>
<td>7</td>
<td>32 %</td>
</tr>
<tr>
<td>2</td>
<td>Is able to find points of intersection/limits of integration.</td>
<td>0</td>
<td>0 %</td>
</tr>
<tr>
<td>3</td>
<td>Is able to set up the correct integrals for the area.</td>
<td>3</td>
<td>3 %</td>
</tr>
<tr>
<td>4</td>
<td>Is able to evaluate the integrals.</td>
<td>0</td>
<td>0 %</td>
</tr>
</tbody>
</table>
8. REFLECTION:
The poor performance of students on this problem, particularly the large number at level 0, suggests that this tool does provide an accurate measurement of whether the general education objectives were met. It seems likely that this poor performance was fundamentally due to a lack of understanding of the mathematical techniques required for the problem, rather than poor reasoning skills. Although, the latter could be true as well.

The instructor noted that more time should be spent on polar coordinates and determining the points of intersection and setting up the integrals for polar areas. If that is done, then student performance on a question such as this should more accurately reflect the students’ analytical reasoning skills.

9. OTHER COMMENTS AND/OR SUGGESTIONS: None.
1. **DEPARTMENT**: Mathematics, Statistics and Computer Science (MSCS)

2. **GENERAL EDUCATION CATEGORY**: Analytic Reasoning (ANRSN)

3. **COURSE NUMBER AND TITLE**: STAT-130 Elementary Statistics

4. **NUMBER OF SECTIONS INCLUDED IN THIS ASSESSMENT**: 3 (107 students)
   This consists of 3 of the 18 sections offered in the Spring 2007 semester. None of the 15 sections from the Fall 2006 semester were assessed.

5. **GENERAL EDUCATION OBJECTIVES**:
   2. Formulate logical and mathematical reasoning related to various branches of knowledge.
   4. Think creatively, analyze critically, synthesize clearly and act responsibly.

6. **METHODOLOGY**:
   Objectives (2) and (4) were assessed simultaneously. In particular, for our courses, the emphasis for Objective (4) is on “analyze critically” and “synthesize clearly.”

To assess these objectives, the MSCS Department uses “embedded assessment. Each of three sections used a final exam question (or questions). Denote these three courses as Course A, B, and C with corresponding questions QA, QB, and QC.

**QA: On hypothesis testing.**
Dr. Dolittle is in the market to buy a 3 year old Chevy Corvette. Before shopping for the car, he wants to determine what he should expect to pay. According to the “blue book”, the mean price of a 3 year old Chevy Corvette is $37,500. Dr. Dolittle thinks that the mean price of a 3 year old Chevy Corvette is more than $37,500 in his neighborhood. After visiting 15 neighborhood dealers online, he found that the average price for Corvettes in his neighborhood was $38,246.90. Prior information tells us that the population standard deviation is $4100. (a) State the null and alternative hypotheses in words. (b) State the null and alternative hypotheses in terms of the mean. (c) Sketch a normal curve marking the mean of the distribution and the mean of the sample. Shade the area that corresponds to the P-value for this problem. (d) Calculate the P-value. (e) Is the result significant at the $\alpha = .01$ level (do we reject $H_0$)? (f) Explain what part E means in terms of the price of a Corvette in Dr. Dolittle’s neighborhood.

**QB: Similar question involving hypothesis testing.**
It had 4 parts: (a) Formulate the hypotheses, (b) Give the test statistic, (c) Find the p-value, and (d) Clearly write down the conclusion.

**QC: For Course C, a collection of six questions involving inference on topics such as the Central Limit Theorem, confidence intervals, and sample sizes was studied.**

Student demonstration of logical reasoning skills was then evaluated by using a common rubric with a 0 to 4 scale where 0 represents no display of logical reasoning skills and 4
represents the greatest display of logical reasoning skills. The specific scales are given in the summary of results in the next section.

Since these were final exam questions, all students completing these sections of the course were included in the assessment.

7. **RESULTS**: The following tables summarize student performance.

**Course A:**

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Description of Performance Level</th>
<th>Number of Students at Level</th>
<th>% of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Attempted with no understanding of concepts &amp; procedures, no attempt, off topic, cannot read</td>
<td>3</td>
<td>7.3 %</td>
</tr>
<tr>
<td>1</td>
<td>States null and alternative hypotheses correctly or calculates p-value correctly, meets few relevant criteria, shows rote or partial understanding of concepts &amp; procedures required by the task, occasionally applies appropriate concepts and procedures</td>
<td>18</td>
<td>43.9 %</td>
</tr>
<tr>
<td>2</td>
<td>At least 2 correct of hypothesis, p-value and sketch, shows general understanding of concepts and procedures, generally applies appropriate concepts and procedures, meets some criteria</td>
<td>12</td>
<td>29.3 %</td>
</tr>
<tr>
<td>3</td>
<td>Correct conclusion, careless mistakes only or correct translation based on wrong conclusion, meets all or most relevant criteria, shows thorough understanding of concepts and procedures, consistently applies appropriate concepts and procedures</td>
<td>6</td>
<td>14.6 %</td>
</tr>
<tr>
<td>4</td>
<td>Translates conclusion into language of problem, meets or exceeds all relevant criteria, extensive understanding of concepts and procedures, consistently and purposely applies appropriate concepts and procedures</td>
<td>2</td>
<td>4.9 %</td>
</tr>
</tbody>
</table>

**Course B:**

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Description of Performance Level</th>
<th>Number of Students at Level</th>
<th>% of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No attempt / no understanding</td>
<td>7</td>
<td>20.59</td>
</tr>
<tr>
<td>1</td>
<td>Answer correctly part(a)</td>
<td>6</td>
<td>17.65</td>
</tr>
<tr>
<td>2</td>
<td>Answer correctly part (a) and (b)</td>
<td>4</td>
<td>11.76</td>
</tr>
<tr>
<td>3</td>
<td>Answer correctly (a), (b), (c)</td>
<td>3</td>
<td>8.82</td>
</tr>
<tr>
<td>4</td>
<td>Answer all parts correctly</td>
<td>14</td>
<td>41.18</td>
</tr>
</tbody>
</table>
Course C:

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Description of Performance Level</th>
<th>Number of Students at Level</th>
<th>% of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No idea!</td>
<td>4</td>
<td>12.5%</td>
</tr>
<tr>
<td>1</td>
<td>Understands, but little else!</td>
<td>4</td>
<td>12.5%</td>
</tr>
<tr>
<td>2</td>
<td>Understands and attempts solutions!</td>
<td>8</td>
<td>25%</td>
</tr>
<tr>
<td>3</td>
<td>Understands, Applies, Gets Results!</td>
<td>10</td>
<td>31%</td>
</tr>
<tr>
<td>4</td>
<td>Understands, Applies, Interprets, Communicates!</td>
<td>6</td>
<td>19%</td>
</tr>
</tbody>
</table>

8. REFLECTION:
From the possible topics covered in Stat 130, the topic of hypothesis testing is an involved and complex topic that presents a good opportunity to assess students’ analytical reasoning abilities. However, it is traditionally one of the last topics covered in the course. Especially in the spring, students may not learn this topic very well. As a result, student performance may not accurately reflect their overall analytical reasoning skills.

Indeed, for Course A, the instructor notes that the results indicate that the students do not have a full understanding of hypothesis testing. In the future, the instructor will show the connection with other areas of statistical inference, have the students work on worksheets, and give a quiz on this topic before the final exam.

For Course B, the overall student performance was better, and 50% of the students displayed a high level of analytical reasoning ability (level 3 or 4).

For Course C, which assessed performance on multiple topics, the overall student performance was similar to Course B with 50% of the students displaying a high level of analytical reasoning ability (level 3 or 4).

The instructors of Courses B and C recommended emphasizing the importance of class attendance for in-class sections and the use of technology to further clarify concepts and ideas.

9. OTHER COMMENTS AND/OR SUGGESTIONS:
Given the large number of students who take this class (over 1000 per year), the MSCS Department needs to do a better job of assessment in these courses. With such a large number of sections offered, and taught by a large number of instructors, it has been challenging to coordinate an effective assessment tool. However, we will work to improve upon this next year.
1. **DEPARTMENT:** Mathematics, Statistics and Computer Science (MSCS)

2. **GENERAL EDUCATION CATEGORY:** Analytic Reasoning (ANRSN)

3. **COURSE NUMBER AND TITLE:** STAT-320 Statistical Methods

4. **NUMBER OF SECTIONS INCLUDED IN THIS ASSESSMENT:** 2 (51 students)
   This includes the single section offered in the Fall 2006 semester and the single section offered in the Spring 2007 semester.

5. **GENERAL EDUCATION OBJECTIVES:**
   2. Formulate logical and mathematical reasoning related to various branches of knowledge.

   4. Think creatively, analyze critically, synthesize clearly and act responsibly.

6. **METHODOLOGY:**
   Objectives (2) and (4) were assessed simultaneously. In particular, for our courses, the emphasis for Objective (4) is on “analyze critically” and “synthesize clearly.”

   To assess these objectives, the MSCS Department uses “embedded assessment.” For the sections assessed, the following question was asked on the final exam for the course.

   **Question:** Involving statistical inference.
   It has four parts: (a) Make a stem plot of the data. (b) Make box plot of the data and check for outliers. (c) Check for normality and construct a confidence interval. (c) Hypothesis testing regarding population mean.

   Student demonstration of logical reasoning skills was then evaluated by using a common rubric with a 0 to 4 scale where 0 represents no display of logical reasoning skills and 4 represents the greatest display of logical reasoning skills. The specific scale is given in the summary of results in the next section.

   Since these were final exam questions, all students completing these sections of the course were included in the assessment.
7. RESULTS: The following table summarizes student performance.

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Description of Performance Level</th>
<th>Number of Students at Level</th>
<th>% of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Shows no understanding of the problem (a) – (d).</td>
<td>0</td>
<td>0 %</td>
</tr>
<tr>
<td>1</td>
<td>Shows some understanding of (a) and (b).</td>
<td>5</td>
<td>9.8 %</td>
</tr>
<tr>
<td>2</td>
<td>Correctly completes (a) and (b).</td>
<td>17</td>
<td>33.3 %</td>
</tr>
<tr>
<td>3</td>
<td>Correctly completes part (c).</td>
<td>17</td>
<td>33.3 %</td>
</tr>
<tr>
<td>4</td>
<td>Shows complete understanding of the problem and complete part (a)-(d).</td>
<td>12</td>
<td>23.6 %</td>
</tr>
</tbody>
</table>

8. REFLECTION:
The results suggest that these students displayed good analytical reasoning skills. Indeed, about 57% of the students demonstrated a high level of analytical reasoning (levels 3 and 4), and about 90% displayed at least some logical or formula-based reasoning (levels 2, 3, and 4).

For the future, the instructor recommends stressing the importance of statistical inference by using more practical examples, emphasizing more use of technology for analyzing data, and encouraging class attendance.

9. OTHER COMMENTS AND/OR SUGGESTIONS: None.