

Course Level Assessment

**College Algebra – MTH 135
Fall 2008**

4.14.2009

Approved by LOT May 18, 2009

Submitted by Sharon Gott

Introduction

The purpose of this report is to present the methodology and findings for the course level assessment of College Algebra (MTH 135) during the fall 2008 semester. College Algebra serves as a college level course that meets the degree requirements for all programs at Eastern. This course presents fundamental algebraic concepts providing students with the foundation to advance to higher level mathematics courses or meet a 4-year degree requirement. To assure that College Algebra is meeting its intended purpose in the curriculum and that students are in fact achieving the defined course learning outcomes identified on the Master Course Record Form (See Attachment A), this course was selected for an ongoing course level assessment project to discern attainment of specified learning outcomes across multiple class sections. Instructors of College Algebra provided input as to which course outcomes to include in this assessment.

Methodology

College Algebra course outcomes will be assessed on a cyclical basis over three years beginning with the fall 2008 semester. Each year, a minimum of four course learning outcomes will be selected for evaluation. Dependent upon assessment findings, some outcomes will be assessed over multiple years to validate effectiveness of changes in curriculum or course materials. Exam questions addressing the target learning outcomes serve as indicators of student attainment of course learning outcomes. These exam questions are incorporated across all sections of MTH 135 during the assessment cycle. The minimum performance standard is set at 80%. At least 80% of the students completing the common indicators administered via the course examination will provide the correct response. In the event that the minimum performance standard is not met, the unmet learning outcome will be targeted for further monitoring. The results may also trigger an evaluation of course materials supporting the learning outcome, revision of course materials or further curriculum revision.

In the fall 2008 semester, eight course learning outcomes were selected for assessment in all sections of College Algebra. The target learning outcomes include:

- Outcome 1: Write an equation of a line
- Outcome 2: Form composite functions
- Outcome 3: Perform operations with complex numbers
- Outcome 4: Use properties of logarithms
- Outcome 5: Employ shifting and stretching techniques
- Outcome 6: Find roots of a polynomial
- Outcome 7: Perform operations on matrices
- Outcome 8: Solve verbal problems

To assess these learning outcomes standard questions were administered in two sections of College Algebra. All students enrolled in these sections completed the standard questions. Thirty-six students were included in this sample. The outcomes and corresponding indicators are listed in Figure 1. Results were compiled for each indicator denoting the percent of student’s response for each indicator as scored using a rubric. Findings from the data for each outcome are presented in the results section of this report.

| Learning Outcome | Indicator | | | | | | | | | | | | |
|--|--|-----|----|----|----|---|---|--------|----|----|---|---|----|
| Outcome 1: Write an equation of a line | P1 #3) Write a formula for a linear function f that models the data exactly. <table border="1" style="margin: 10px auto;"> <tr> <td style="padding: 5px;">x</td> <td style="padding: 5px;">-4</td> <td style="padding: 5px;">-2</td> <td style="padding: 5px;">0</td> <td style="padding: 5px;">2</td> <td style="padding: 5px;">4</td> </tr> <tr> <td style="padding: 5px;">$f(x)$</td> <td style="padding: 5px;">18</td> <td style="padding: 5px;">12</td> <td style="padding: 5px;">6</td> <td style="padding: 5px;">0</td> <td style="padding: 5px;">-6</td> </tr> </table> P1 #5) Find an equation of the line satisfying the following conditions. If possible, write the equation in slope-intercept form. $y = 4x + 5$ | x | -4 | -2 | 0 | 2 | 4 | $f(x)$ | 18 | 12 | 6 | 0 | -6 |
| x | -4 | -2 | 0 | 2 | 4 | | | | | | | | |
| $f(x)$ | 18 | 12 | 6 | 0 | -6 | | | | | | | | |
| Outcome 2: Form composite functions | Part 2 # 1) Evaluate as instructed. Use $f(x) = x - 3$ and $g(x) = x + 3$ to evaluate $(f \circ g)(x)$. | | | | | | | | | | | | |

| Learning Outcome | Indicator |
|--|--|
| Outcome 3: Perform operations with complex numbers | Part 1 # 22) Multiply and write the result in standard form. $(5 + 7i)(6 + 8i)$ Part 1 # 23) Perform the indicated operation. Write the result in standard form. $6i + (-3 - i)$ |
| Outcome 4: Use properties of logarithms | Part 2 # 12) Evaluate the expression. $6 \log 0.00001$ Part 2 # 13) Expand the expression. $\log_{10} xy$ Part 2 # 14) Write the expression as one logarithm. $\log_7 6 - \log_7 15$ |
| Outcome 5: Employ shifting and stretching techniques | Part 1 # 19) The given graph represents a translation of the graph of $y = x^2$. Write the equation of the graph. (A graph of $y = x^2 - 4$ is shown on exam.) |
| Outcome 6: Find roots of a polynomial | Part 1 # 17) Solve the quadratic equation symbolically. Express the solutions as reduced rational numbers or with radicals. $x^2 + 7x + 12 = 0$ Part 1 # 18) The graph of $f(x)$ is shown in the figure. Solve the inequality. $f(x) < 0 \rightarrow$ (A graph with roots of $x = -4, 2$ is shown on exam.) Part 1 # 20) The graph of a polynomial is given. Identify the degree of the polynomial, the turning points, and any x-intercepts. Also estimate any local maxima or minima and any absolute maxima or minima. (A graph with 3 distinct roots is shown on the exam.) |
| Outcome 7: Perform operations on matrices | Part 2 # 19) Perform the matrix operation. $\begin{bmatrix} 2 & 8 \\ 1 & -9 \\ -7 & 4 \end{bmatrix} + \begin{bmatrix} -5 & -2 \\ 5 & 7 \\ -1 & 8 \end{bmatrix}$ Part 2 # 20) Perform the matrix multiplication. $\begin{bmatrix} 3 & -1 \\ 6 & 0 \end{bmatrix} \begin{bmatrix} 0 & -1 \\ 3 & 6 \end{bmatrix}$ |

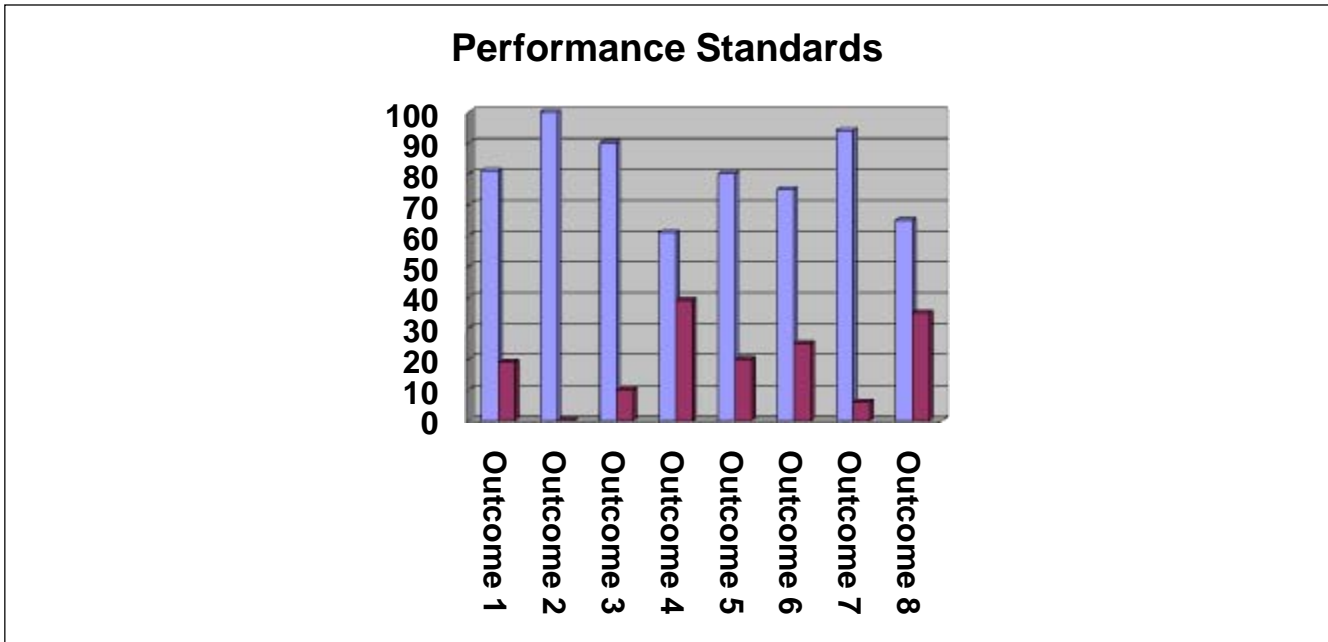
| Learning Outcome | Indicator |
|----------------------------------|---|
| Outcome 8: Solve verbal problems | <p>Part 2 # 10) At Allied Electronics, production has begun on the X-15 Computer Chip. The total revenue function is given by $R(x) = 45x - 0.3x^2$ and the total cost function is given by $C(x) = 11x + 12$, where x represents the number of boxes of computer chips produced. The total profit function, $P(x)$, is such that $P(x) = R(x) - C(x)$. Find $P(x)$.</p> <p>Part 2 # 24) How many combinations are there to choose 9 toppings on a pizza from a selection of 12 different toppings?</p> |

Figure 1: Assessed Outcomes and Indicators

Results

Based on the existing data, three of the eight learning outcomes were not successful at the minimum performance standard (See Table 1).

Table 1: Distribution of Performance Standards for Outcomes 1 Through 4



Outcome 1: Write an equation of a line

Two questions were included on the final exam covering this outcome (Figure 1). The percentage awarded for correct responses was 81% which is above the desired 80% attainment level. An online lab component to supplement in class instruction was incorporated during the fall 2008 semester. The online lab which accompanies the text has tutorial based questioning for the students to access to enhance their in-class lessons. These step-by-step tutorials could also have the effect of leading to these positive results this semester.

Outcome 2: Form composite functions

One question was included on the final exam covering this outcome (Figure 1). The percentage awarded for correct responses was 100% which is above the desired 80% attainment level. This outcome met the attainment level for this course.

Outcome 3: Perform operations with complex numbers

Two questions were included on the final exam covering this outcome (Figure 1). The percentage awarded for correct responses was 90% which is above the desired 80% attainment level.

Outcome 4: Use properties of logarithms

Three questions were included on the final exam covering this outcome (Figure 1). The percentage awarded for correct responses was 61% which is below the desired 80% attainment level.

Outcome 5: Employ shifting and stretching techniques

One question was included on the final exam covering this outcome (Figure 1). The percentage awarded for correct responses was 80% which is the desired 80% attainment level. This outcome met the attainment level for this course.

Outcome 6: Find roots of a polynomial

Two questions were included on the final exam covering this outcome (Figure 1). The percentage awarded for correct responses was 75% which is below the desired 80% attainment level.

Outcome 7: Perform operations on matrices

Two questions were included on the final exam covering this outcome (Figure 1). The percentage awarded for correct responses was 94% which is above the desired 80% attainment level.

Outcome 8: Solve verbal problems

Two questions were included on the final exam covering this outcome (Figure 1). The percentage awarded for correct responses was 65% which is below the desired 80% attainment level.

Conclusion and Action Plan

In conclusion, this course level assessment of College Algebra for fall 2008 finds that three of the eight outcomes are not being met at the minimum performance standard of 80%. For Outcome 4 (Use properties of logarithms) only 61% of the students answered the question correctly based on rubric scoring. The chapter in which this outcome is included had a take home test during the semester. This could be a reason for the low attainment level in that students did not learn these properties thoroughly during the semester since they had all resources available to them for their chapter test. No changes to the course will be implemented at this time. As more data are collected; a decision will be made to determine if any instructional changes need to occur.

Outcome 6 (Find roots of a polynomial) also did not meet the minimum standard of 80% correct responses. It came in at 75%, which is slightly below the attainment level. Out of the two exam questions that covered this outcome, one appeared to be answered incorrectly more than the other two. Plans are to emphasize the graphing method of finding roots of polynomials in the next sections of College Algebra. In addition to this emphasis, it will be analyzed in the next evaluation of this course to insure that it receives the emphasis that will enable students to be successful in all related outcomes.

Outcome 8 (Solve verbal problems) did meet the minimum performance standard in this course. Only 65% success was noted on this outcome. While follow up will be done to insure student success in

on this and the other low percentage outcomes, no changes in the content or instructional methods are recommended at this time. The continuation of the online tutorials will provide further strengthening of students' ability to master application problems in this and their future Math course work.

The participating faculty members have been made aware of the course level assessment and attainment of the outcomes for the classes they taught. Their continued input as to which outcomes to monitor will be utilized in future course level assessments.

Attachment A: Master Course Record Form for MTH 135 College Algebra

**Eastern WV Community & Technical College
Master Course Record**

| |
|---|
| Course Prefix and Number: MTH 135 |
| Course Title: College Algebra |
| Recommended Transcript Title (if over 40 characters) College Algebra |
| Date Approved/Revised |
| Credit Hours: 3 Contact hours per week (Based on 15 week term): Lecture: 3 Lab: |
| Prerequisite: MTH 123 OR minimum acceptable test scores for placement in college-level math: 1) Math ACT score 23 or higher; 2) SAT math score 540 or higher; 3) Accuplacer 112 or higher. Corequisite: Pre/Corequisite: |
| Grading Mode: Letter Grade |
| Catalog Description: This course covers the following topics: systems of equations, theory and application of matrices and determinants, theory of equations, complex numbers, graphs of relations and functions, sequences and series, the binomial theorem, and mathematical induction. |
| Course Outcomes: (See Competency Verb list for suggested language) <ol style="list-style-type: none"> 1. write an equation from its graph 2. define function 3. solve absolute value inequalities 4. use function algebra 5. form composite functions 6. form inverse functions 7. perform operations with polynomials 8. use synthetic division 9. use the remainder and factor theorems 10. use written communication skills to express mathematical ideas 11. solve rational and polynomial inequalities 12. perform operations with exponents 13. perform operations with complex numbers 14. use linear programming 15. analyze exponential and logarithmic functions 16. use the properties of logarithms 17. solve exponential growth and decay problems 18. use the change of base formula 19. solve exponential and logarithmic equations 20. employ shifting and stretching technique to graph functions 21. solve quadratic equations 22. utilize a graphing utility to analyze functions 23. find the roots of a polynomial |

| |
|---|
| <ul style="list-style-type: none"> 24. use the equation of a circle 25. use the equation of a hyperbola 26. use the equation of an ellipse 27. solve systems of linear equations using substitution 28. solve systems of linear equations using elimination 29. solve systems of linear equations using matrix methods 30. perform operations with matrices 31. solve systems of nonlinear equations 32. analyze arithmetic and geometric sequences 33. analyze symmetry of relations 34. use summation notation 35. use the binomial theorem 36. participate in collaborative projects 37. use graphs to model data 38. use internet resources 39. solve variables for a specified variable 40. classify real numbers 41. use set builder, interval, and functional notation 42. solve verbal problems 43. calculate distance and midpoint 44. write the equation of a line 45. solve variation problems 46. analyze series |
| Implementation Cycle: Spring Semester |
| Role in College Curriculum: (Check all that apply) <input checked="" type="checkbox"/> General Education Core (Specify category) <input type="checkbox"/> Technical Core (Specify Program) <input type="checkbox"/> Restricted Elective (Specify Program) <input type="checkbox"/> General Elective |
| Course Fee: None |
| Instructor's Qualifications: Master's Degree plus 18 graduate level mathematics credits. |
| Expanded Course Description (provides details regarding major course concepts, target audience, delivery format, etc) This course will focus on problem solving skills; preparing the student to be ready for future math and science courses; and developing the student to think mathematically. |

Prepared by:

Signature, Title Date

Approved by:

Dean, Academic Services Date

**Appendix B:
Summary of Outcomes, Indicators, Performance Standards and Results**

| Course Level Assessment: Fall 2006 College Algebra – MTH 135 | | | | | | | | | | | | | | | | |
|---|--|--------------------------------------|--------------------------------|--------------------------------|----|---|---|--------|----|----|---|---|----|-----|-----|-----|
| Learning Outcome | Indicator | Percent of Correct Awarded Responses | Percent of Incorrect Responses | Performance Standard Met (80%) | | | | | | | | | | | | |
| Outcome 1: Write an equation of a line | <p>P1 #3) Write a formula for a linear function f that models the data exactly.</p> <table style="margin-left: auto; margin-right: auto; border-collapse: collapse;"> <tr> <td style="border: 1px solid black; padding: 2px 10px;">x</td> <td style="border: 1px solid black; padding: 2px 10px;">-4</td> <td style="border: 1px solid black; padding: 2px 10px;">-2</td> <td style="border: 1px solid black; padding: 2px 10px;">0</td> <td style="border: 1px solid black; padding: 2px 10px;">2</td> <td style="border: 1px solid black; padding: 2px 10px;">4</td> </tr> <tr> <td style="border: 1px solid black; padding: 2px 10px;">$f(x)$</td> <td style="border: 1px solid black; padding: 2px 10px;">18</td> <td style="border: 1px solid black; padding: 2px 10px;">12</td> <td style="border: 1px solid black; padding: 2px 10px;">6</td> <td style="border: 1px solid black; padding: 2px 10px;">0</td> <td style="border: 1px solid black; padding: 2px 10px;">-6</td> </tr> </table> <p>P1 #5) Find an equation of the line satisfying the following conditions. If possible, write the equation in slope-intercept form. $y = 4x + 5$</p> | x | -4 | -2 | 0 | 2 | 4 | $f(x)$ | 18 | 12 | 6 | 0 | -6 | 81% | 19% | Yes |
| x | -4 | -2 | 0 | 2 | 4 | | | | | | | | | | | |
| $f(x)$ | 18 | 12 | 6 | 0 | -6 | | | | | | | | | | | |
| Outcome 2: Form composite functions | <p>Part 2 # 1) Evaluate as instructed. Use $f(x) = x - 3$ and $g(x) = x + 3$ to evaluate $(f \circ g)(x)$.</p> | 100% | - | Yes | | | | | | | | | | | | |
| Outcome 3: Perform operations with complex numbers | <p>Part 1 # 22) Multiply and write the result in standard form. $(5 + 7i)(6 + 8i)$</p> <p>Part 1 # 23) Perform the indicated operation. Write the result in standard form. $6i + (-3 - i)$</p> | 90% | 10% | Yes | | | | | | | | | | | | |
| Outcome 4: Use properties of logarithms | <p>Part 2 # 12) Evaluate the expression. $6 \log 0.00001$</p> <p>Part 2 # 13) Expand the expression. $\log_{10} xy$</p> <p>Part 2 # 14) Write the expression as one logarithm. $\log_7 6 - \log_7 15$</p> | 61% | 39% | No | | | | | | | | | | | | |

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| Learning Outcome | Indicator | Percent of Correct Awarded Responses | Percent of Incorrect Responses | Performance Standard Met (80%) |
|--|--|--------------------------------------|--------------------------------|--------------------------------|
| Outcome 5: Employ shifting and stretching techniques | Part 1 # 19) The given graph represents a translation of the graph of $y = x^2$. Write the equation of the graph. (A graph of $y = x^2 - 4$ is shown on exam.) | 80% | 20% | Yes |
| Outcome 6: Find roots of a polynomial | Part 1 # 17) Solve the quadratic equation symbolically. Express the solutions as reduced rational numbers or with radicals. $x^2 + 7x + 12 = 0$ Part 1 # 18) The graph of $f(x)$ is shown in the figure. Solve the inequality. $f(x) < 0 \rightarrow$ (A graph with roots of $x = -4, 2$ is shown on exam.) Part 1 # 20) The graph of a polynomial is given. Identify the degree of the polynomial, the turning points, and any x-intercepts. Also estimate any local maxima or minima and any absolute maxima or minima. (A graph with 3 distinct roots is shown on the exam.) | 75% | 25% | No |
| Outcome 7: Perform operations on matrices | Part 2 # 19) Perform the matrix operation. $\begin{bmatrix} 2 & 8 \\ 1 & -9 \\ -7 & 4 \end{bmatrix} + \begin{bmatrix} -5 & -2 \\ 5 & 7 \\ -1 & 8 \end{bmatrix}$ Part 2 # 20) Perform the matrix multiplication. $\begin{bmatrix} 3 & -1 \\ 6 & 0 \end{bmatrix} \begin{bmatrix} 0 & -1 \\ 3 & 6 \end{bmatrix}$ | 94% | 6% | Yes |

Course Level Assessment: Fall 2006
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| Learning Outcome | Indicator | Percent of Correct Awarded Responses | Percent of Incorrect Responses | Performance Standard Met (80%) |
|----------------------------------|---|---|---------------------------------------|---------------------------------------|
| Outcome 8: Solve verbal problems | <p>Part 2 # 10) At Allied Electronics, production has begun on the X-15 Computer Chip. The total revenue function is given by $R(x) = 45x - 0.3x^2$ and the total cost function is given by $C(x) = 11x + 12$, where x represents the number of boxes of computer chips produced. The total profit function, $P(x)$, is such that $P(x) = R(x) - C(x)$. Find $P(x)$.</p> <p>Part 2 # 24) How many combinations are there to choose 9 toppings on a pizza from a selection of 12 different toppings?</p> | 65% | 35% | No |