

NORTHERN ESSEX COMMUNITY COLLEGE

New Developments in College Algebra

A Summer Mathematics Workshop

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This document contains the work completed on constructing common learning outcomes for all College Algebra classes and methods to assess these outcomes such as a common final exam.

Outline

Introduction	----- Page 3
College Algebra – Issues and Outcomes	-----Page 4
Outcome Statements – List	-----Page 5
Outcome Statements – Details	----- Pages 6-10
Future Tasks and Considerations	----- Page 11
Course Outline – Topics and Assigned Problems from Textbook	----- Page 12
Final Exam Summary – Description, Textbook Sections, Outcomes	----- Page 13

Introduction

The mathematics team of Liliana Brand, Habib Maagoul, Linda Murphy, Nancy Nickerson, and Jim Sullivan met over a five-day work schedule during June 2009 with the following agenda:

1. Construct common learning outcomes for all College Algebra classes
2. Discuss ways to assess these outcomes
3. Develop assessment tools, such as a common final, as time permits

We accomplish the 3 main objectives and developed a working relationship that will continue into the future. The work we completed is an important start to providing the students at NECC with a high quality, outcomes based learning experience. In developing these outcomes we considered what are the essential algebraic concepts and skills that all our students need. The outcomes reflect the current course description as well as the College Algebra Guidelines recommended by the Mathematical Association of America and the American Mathematical Association of Two-Year College's standards document, *Beyond Crossroads*. The development of these outcomes is an important first step in assuring that all students of Northern Essex Community College possess the mathematical concepts needed in other college level courses as well as the quantitative reasoning skills needed to be successful in their future professions and daily lives as engaged citizens.

We discussed many ways to assess these learning outcomes including: common final, projects, discovery activities, portfolios, class participation, and online homework. The team developed a common final which will allow us to measure whether students have satisfied many of the desired outcome statements. Data will be gathered on the results from the final exam. An analysis of the collected data will allow us to identify any gaps in obtaining many of the desired outcomes. However, we need to develop alternative assessment tools since the common final does not address all outcomes and students need multiple ways to demonstrate their learning. Jim has agreed to author a short workbook of discovery activities which will give students the opportunity to develop a deep understanding of the core concepts and improve their problem solving ability. These activities will be piloted in the fall and made available to all classes in the Spring 2010. Other assessment tools, such as a portfolio, should also be considered for the future.

We have yet to address how we can help our students become self-motivated life-long learners. The team has developed a list of fundamental college skills students need, especially in math (see next page). One of our future tasks is to brainstorm ways to integrate these skills into all math courses in a natural way. This does not mean just adding a handout on study skills. It means developing curriculum and pedagogy that has the study skills built into the teaching and learning of mathematics.

Once College Algebra stands on solid footing, we should revisit our outcomes for Basic Algebra II. It is important to build a curriculum that allows a seamless transition between Basic Algebra II and College Algebra; however it is just as important that each course can stand alone as a worthwhile mathematical experience that might be a student's last in mathematics. We are not just preparing our students for calculus; we are also preparing them for life in a quantitative world where numbers are at the heart of almost every important decision that is made in business, industry, government, and at a personal level.

College Algebra – Issues and Outcomes

<p align="center">Fundamental College Skills Students Need (especially in math)</p> <p>Discipline and organizational skills Ability to read their book (and follow-through) Study skills (how to study math) Knowledge of homework system (My Math Lab) Self-confidence/self-efficacy – need a successful experience Stop working problems backward – see if they can reach a quick solution and if not, work backwards Can ask questions Know how to use calculators Lose math phobia/fear of math Active learner rather than passive recipient</p>	<p align="center">Other Skills (not necessarily math specific)</p> <p>Analytical reasoning and problem solving Critical thinking Vocabulary (math) Symbolism Communication skills Technology competence Application skills (to real world setting) Life skills</p>
<p align="center">Potential Outcomes – Knowledge</p> <p>Good solid foundation in math (need to define) Constructing and interpreting tables and graphs Variables and function (different types of functions) conceptual understanding of how to solve equations and inequalities Math history</p>	<p align="center">Potential Outcomes – Attitudes/Values/Behaviors</p> <p>An “I can” attitude toward math Comfort with applied math Perseverance through problems Attitude that math can be fun, engaging and useful Enjoying a challenge Willingness or desire to learn more Sensitivity to others Self-confidence to ask questions</p>
<p align="center">Potential Outcomes – Skills</p> <p>How to solve real world problems Logical/critical thinking Use technology easily Learn how to learn (understanding their learning Style, how to be a lifelong learner, where to find “it” when they need to learn new things) Ability to teach each other Communication skills Organizational skills How to gather, organize and interpret data and how to draw conclusions</p>	<p align="center">Tasks</p> <p>Determine if students learn or can do all the above outcomes after taking College Algebra, are we satisfied? Create well defined and measurable outcome statements/objectives Create methods/activities to facilitate the outcomes – especially soft skills How can we impact their educational careers/ success in this course (1 of 8 or so true gatekeeper courses) Can we create modules or tutorials to accomplish the teaching of the fundamental skills that could be done in the math center and required Create classroom activities to facilitate skills Create common syllabus Create assessment methods</p>

Outcome Statements

Students who successfully complete the course will :

1. Have increased comfort and confidence in their math ability.
2. Be able to develop and use a strategy to solve applied math problems.
3. Be able to understand and effectively use mathematical language (including vocabulary, terms and symbols).
4. Be able to read and understand their text book, and explain (orally and in writing) their interpretations and solutions.
5. Be able to follow an algorithm from start to finish.
6. Have a conceptual understanding of the core topics of mathematics.
7. Be able to understand, evaluate and classify types of functions.
8. Be able to use the course technology appropriately.
9. Have an appreciation of the history of math and how it impacted the development of modern mathematics.

Course: College Algebra

Outcome Statement 1:

Students will have increased comfort and confidence in their math ability.

Operational definition for area:	What specific skills must be measured:	Activity/assignment/assessment used to measure:
Feel math is less intimidating Participate more in class by: Asking questions Persevering through problems Positive attitude Willingness to share with others and explain things to others Value their own answers and information	That they ask questions in class That they participate in class They take responsibility for learning (come to class, do homework, etc.) Participate in group activities Share their answers with class (raise their hand)	Pre-post attitude assessment (survey) Daily participation grade (names in spreadsheet with daily 0-3 grade) Credit for activities Want to develop and offer sessions in the math center (for credit) on math anxiety, how to study math, using calculators, learning styles and math and using the My Math Lab

Outcome Statement 2:

Students will be able to develop and use a strategy to solve applied math problems. (a strategy is a plan of attack)

Operational definition for area:	What specific skills must be measured:	Activity/assignment/assessment used to measure:
Polya's four steps Gather, organize, and interpret data and draw conclusions	Select proper math skills that apply Translate verbal to symbolic and visa-versa Identify strategies	Discovery Activities (Jim Sullivan) Selected word problems on quizzes, tests and final exam (interesting and/or real life problems)

Course: College Algebra

Outcome Statement 3:

Students will be able to understand and effectively use mathematical language (including vocabulary, terms and symbols).

Operational definition for area:	What specific skills must be measured:	Activity/assignment/assessment used to measure:
Read for understanding Student expressions and use in communication Write correctly Communicate math concepts easily	Translate English to math and visa-versa Communicate mathematically with each other Can verbalize questions mathematically	Traditional exam/quiz Observation in class/group work Take off points when it is left out Portfolio includes math language summary of each chapter (developed by students showing correct usage in their own words, not copying textbook)

Outcome Statement 4:

Students will be able to read and understand their text book, and explain (orally and in writing) their interpretations and solutions.

Operational definition for area:	What specific skills must be measured:	Activity/assignment/assessment used to measure:
Gain concepts from reading and understanding vocabulary and language Speak about it to others Explain it to others Read quantitative data, interpret and explain concepts and results	Interpret quantitative data Explain it to others orally and in writing Create their own problems (questions for exam)	Discovery Activities (read, understand, interpret short body of text that includes numerical information) Class projects (make presentation to class) Portfolio documents demonstrating skills

Course: College Algebra

Outcome Statement 5:

Students will be able to follow an algorithm from start to finish.

Operational definition for area:	What specific skills must be measured:	Activity/assignment/assessment used to measure:
Understand, explain and justify steps in a process Evaluate the function Ability to sequence	Can explain the process Justify use of process Show their work	Cumulative assessments Tests/quizzes where they justify or explain their work Practice Test Projects/activities Homework Portfolio handout (class or HW activity that shows justification in writing)

Outcome Statement 6:

Students will have a conceptual understanding of the core topics of mathematics.

Operational definition for area:	What specific skills must be measured:	Activity/assignment/assessment used to measure:
Knowledge of topics Connections to established (old) knowledge Navigate through sections and chapters – become more independent Can explain at some concrete level	Can communicate what they know orally and in writing Distinguish between function classes Select best fit function to given data	Portfolio – demonstrating growth – what they think is important Calculator or computer activity Tests, quizzes, and homework Active learning questions at start of class (clickers or low tech methods) Game strategies (Jeopardy, any fun activity)

Course: College Algebra

Outcome Statement 7:

Students will be able to understand, evaluate and classify types of functions.

Operational definition for area:	What specific skills must be measured:	Activity/assignment/assessment used to measure:
Know informal definitions of function Be able to use the function Look at the function through the rule of four (numerically, symbolically, graphically, and verbally) Classify by type (4-5 elementary types)	Know difference between linear, exponential, quadratic and logarithm, etc. Identify domain and range of function Identify independent and dependent variable	Exams/tests Assignments and homework Activities/Projects My Math Lab Portfolio document

Outcome Statement 8:

Students will be able to use the course technology appropriately.

Operational definition for area:	What specific skills must be measured:	Activity/assignment/assessment used to measure:
Can navigate through and use Blackboard, calculators, My Math Lab, online tools and mathematical software to explore ideas and facilitate learning	Ability to use a calculator Ability to use technology as a problem solving tool Check hits on Blackboard and use in My Math Lab	Test or quiz Homework or class activity requiring technology to interpret and analyze data Check data in Blackboard & My Math Lab Projects/activities using technology Portfolio document

Course: College Algebra

Outcome Statement 9:

Students will have an appreciation of the history of math and how it impacted the development of modern mathematics.

Operational definition for area:	What specific skills must be measured:	Activity/assignment/assessment used to measure:
Ice breakers and light activities on mathematicians Group activities on mathematics history Portfolio assignments	Products completed Activities and assignments completed	Student activity involving historical figures (can include in portfolio) Student presentation on choice of different mathematicians Attitude survey

Future Tasks and Considerations

- Include study skill methods and habits of a successful student as a natural part of course instruction
- Workshops on how to effectively use CourseCompass as a teaching/learning vehicle (topics: store and access all class materials, use multimedia instruction, communicate with students, online homework, online quizzes and tests, access to supplements and learning tools, automatic grading, etc.)
- Professional development (time and monetary incentives)
- Make Web based, e-education platform like Coursecompass or Blackboard available to all students (students have 24/7 access to teaching/learning materials)
- Portfolio (three-ring binder containing students work, but move towards e-portfolio)
- Discovery Activities workbook
- Classify all math courses as critical thinking intensive to keep numbers to a maximum of 28
- Revisit outcome statements for Basic Algebra II

COURSE OUTLINE

<u>Topic:</u>	<u>Assigned Problems:</u>
Introduction - Review	
1.1 Graphing calculator exercises	p.10 #1,3,11,37,55,57,65,71,73,76,89,93,95, 101, 103
1.2 Relations and Functions	p. 20 # 1,5,13,17,25,29,31,33,37,43,47,51,55, 59,61,67,69 73,75
1.3 Linear Functions	p. 33 #3,9,17,25,31,33,35,37,41,43,45,47,49, 53, 55,69,73 77,80
1.4 Equations of Lines and Linear Models	p. 45 # 7,9,11,13,17,25,41,43,49,63,67,71
1.5 Linear Equations and Inequalities	p. 62 #11,13,15,25,27,35,37,47,49,55,57,61,67,77,79,85 91,95,99
1.6 Applications of Linear Functions	p. 73 # 13,17,19,21,33,79
Exam 1	
2.1 Continuity and Symmetry	p. 100 # 11,15,16,19,21,27,31,33,35,37,39,41,49,53,55,57 61,65,69
2.2 Vertical and Horizontal Shifts	p. 108 # 3,6,13,15,17,19,21,23,35,37,41,51,55,65a&c
2.4 Absolute Value Functions, Equat. & Ineq.	p. 134 # 7,15,17,29,31,39,41,47,51,61,63,65,77,79,81
2.5 Piecewise Functions	p. 145 # 5,15,16,17,21,23,35,37,51
2.6 Operations on Functions and Applications	p. 156 # 7,13,15,23,27,57,59,71,73,83,85,91
Exam 2	
3.1 Complex Numbers	p. 180 #17,19,25,26,28,29,35,39,41,47,51,63
3.2 Quadratic Functions and Applications	p. 190 # 1,3,5,11,15,17,19,21,23,25,31,33,35,37,39,41,43 45,55,57,59
3.3 Quadratic Equations and Inequalities	p. 205 # 1,5,13,18,25,26,40,41,49,52,61,63,65,71,73,75 92,94,95,99
3.4 Applications	p. 213 #2,7,12,13,23,28,29
Exam 3	
5.1 Inverse Functions	p. 346 # 1,5,7,9,11,15,24,37,39,43,46,55,57,59,63,65,73 77,79,85,103,113,117,118
5.2 Exponential Functions	p. 359 # 1,4,5,7,11,25,27,33,34,41,43,49,51,53,58,62,63 65,69,77,79,80,81,86
5.3 Logarithms	p. 371 # 1,3,5,6,8,11,13,16,22,28,29,35,36,45,49,50,53,57 59,60,69,74,77,81,83,84,89,92
5.4 Logarithmic Functions	p. 381 # 9,11,13,17,18,25,27,53,55,56,57,59,62,68,69
5.5 Exponential and Log Equations	p. 391 # 5,7,11,17,21,27,28,29,31,39,43,45,51,57,58,89
5.6 Applications	p. 402 #1,4,5,11,17,21,24,33,35,40,43,52
Exam 4	
7.1 Linear Systems in Two Variables	p. 474 # 7,9,15,17,23,26,41
7.2 Linear Systems in Three Variables	p. 485 # 9,15,21
FINAL EXAM	

Final Exam Summary

The table below presents a description of each question on the final exam, the section the concept/skill is covered, and the outcomes that are addressed in correctly answer the question. These questions cover the core ideas of the course. The instructor can add their own questions, in addition to the ones below, to evaluate other concepts, skills, and applications that were stressed in teaching this course.

#	Description	Sections	Outcomes
1	Evaluating an Absolute Value Function	1.2, 2.4	3, 5, 8
2	Applications: Pythagorean Theorem	1.1, 1.5, 3.4	2, 3, 5, 6
3	Domain and Range	1.2	3, 6
4	Relations and Functions	1.2	3, 6
5	Linear Functions	1.3	3, 6
6	Linear Functions	1.3	3, 6
7	Vertical Lines	1.4	3, 6
8	Solving Linear Inequalities	1.5	5, 8
9	Solving Linear Equations	1.5	5, 8
10	Solving Absolute Value Inequalities	1.5	3, 5, 8
11	Symmetry	2.1	3, 6
12	Incr., Decr. and Constant Functions	2.1	3, 6
13	Solving Absolute Value Equations	2.4	3, 5, 8
14	Solving Quadratic Equations	3.3	3, 5, 8
15	Solving Quadratic Inequalities	3.3	3, 5, 8
16	Applications: Quadratic Functions	3.2, 3.4	2, 3, 5, 6, 7, 8
17	Applications: Exponential Functions	5.2, 5.6	2, 3, 4, 5, 6, 8
18	Applications: Exponential Functions	5.2, 5.6	2, 3, 4, 5, 6, 8
19	Logarithmic Equations	5.3	3, 5, 8
20	Inverse Functions	5.1	3, 6, 7, 8
21	Applications: Exponential Functions	5.2, 5.5, 5.6	2, 5, 6, 7, 8
22	Different Types of Functions	1.3, 1.4, 3.2, 5.2, 5.3, 5.4	3, 6, 7
23	Different Types of Functions	1.3, 1.4, 3.2, 5.2, 5.3, 5.4	3, 6, 7
24	Different Types of Functions	1.3, 1.4, 3.2, 5.2, 5.3, 5.4	3, 6, 7
25	Different Types of Functions	1.3, 1.4, 3.2, 5.2, 5.3, 5.4	3, 6, 7
26	Different Types of Functions	1.3, 1.4, 3.2, 5.2, 5.3, 5.4	3, 6, 7