# Bergen Community College

### ASSESSMENT REPORT FORM FOR ACADEMIC PROGRAM

Assessment Period: Fall 2014- Spring 2016

Department/Program: Mathematics Department-Developmental Level

Department Chair: Dr. Randolph Forsstrom

Department Assessment Liaison: Afsheen Akbar

Assessment Committee (Developmental Mathematics): Afsheen Akbar, Idanis Hayes, Alinah Malik and Mark Wiener

#### Date Submitted:

#### Program Description or mission/goal statement of the Department/Program:

The Mathematics Department-Developmental Level provides the opportunity for students to learn the skills and concepts needed to be successful in college by offering various courses to most efficiently meet students' needs. The Mathematics Department-Developmental Levelseeks to foster student success through cultivating students' self-confidence, self-management, and by encouraging a positive attitude; as well as enhancing success through teaching and modeling study skills, problem solving, and critical thinking.

#### Program Learning Goals/Outcomes:

Mathematics Department-Developmental Level has five Program Learning goals as stated below: PLG1: Demonstrate a working knowledge of the principles of Basic Arithmetic PLG2: Demonstrate a working knowledge of the principles of Basic Algebra PLG3: Develop study and work habits that lead to the success in mathematics and Science Courses PLG4: Develop concise analytical thinking and problems skills that can be applied to their daily lives PLG5: Have an increase in confidence, reduction in anxiety related to mathematics

#### SEMESTER 1: CREATING PROGRAM-LEVEL ASSESSMENT PLAN

#### 1. Program Learning Goal(s) or Outcome(s) to be assessed (from the above section):

During this assessment cycle we will be focused on assessing Program Learning Goal 2 (PLG2) which is to "Demonstrate a working knowledge of the principals of Basic Algebra." The Student Learning Outcomes (SLO) that ties in with that are Student Learning Outcomes3 and 4 from our MAT040 and MAT048 courses. According to the course syllabus the student learning outcomes are as follows: SLO 3 is to "Solve equations, including linear equations in one variable, literal equations, absolute value equations, systems of linear equations and quadratic equations."

SLO 4 is to "Solve and graph linear inequalities in one variable."

The final exam questions we will be assessing are solving linear equations, solving systems of linear equations, and solving compound linear inequalities.

The developmental mathematics assessment committee (Afsheen Akbar, Idanis Hayes, Alinah Malik and Mark Wiener) along with input from the department decided on assessing PLG2 and to assess SLO3 and SLO4 because we feel that the students need those skills to succeed in future math classes. Also, the department wants to assess what changes to make, if necessary, to improve teaching of the new topics added to the Algebra courses.

#### 2. Means of Assessment:

The assessment committee selected the following open-ended final exam questions to assess which relate to the above-mentioned outcomes.

Solving Linear Equation with Variables on both sides

Solve: x + 5 - 2(x + 5) = 3(2x - 4)(question 10 from MAT040) Solve: 2(x - 1) - (x + 1) = -(2x - 1)(question 11 from MAT048)

Solving the Systems of Linear Equation

 $\begin{cases} 4x + y = 31 \\ 3x - 3y = 12 \end{cases}$ This is question 16 in MAT040 final exam and question 21 in MAT048 final exam

Solving Compound Inequalities

Solve:  $-13 \le -2x - 3 < -9$ The last is question 23 from MAT040 same as question 22 from MAT048.

The assessment committee decided to use an open-ended question instead of multiple choice to examine the variety of solutions students are presenting, indicating their understanding.

#### Assessment tool:

The assessment tool we will use is the following attached rubric.

#### **Generally- stated CRITERIA**

#### **3-Point Response**

The response shows complete understanding of the problem's essential mathematical concepts. The student executes procedures completely and gives relevant responses to all parts of the task. The response may contain a calculation error. The response contains a clear, mathematical or verbal detail indicating how the problem was solved so that the reader does not need to infer how and why decisions were made.

#### 2-Point Response

The response shows nearly complete understanding of the problem's essential mathematical concepts. The student executes nearly all procedures and gives relevant responses to most parts of the task. The response may have minor errors. The mathematical or verbal detail indicating how the problem was solved may not be clear, causing the reader to make some inferences

#### 1-Point Response

The response shows limited understanding of the problem's essential mathematical concepts. The response and procedures may be incomplete and/or may contain major errors. The mathematical or verbal detail indicating how the problem was solved may contribute to questions as to how and why decisions were made.

#### 0 Point Response

The response shows insufficient understanding of the problem's essential mathematical concepts. The procedures, if any, contain major errors. There may be no mathematical or verbal detail of the solution, or the reader may not be able to understand the solution. The reader may not be able to understand how and why decisions were made.

#### Sources of Data:

Final exams from Spring 2015semester submitted by all of MAT040and MAT048faculty.

#### SEMESTER 2: DEVELOPING ASSESSMENT TOOL (s) and TIMELINE

# 3A. Describe or attach assessment tool (s), including sources of data, timeline for data collection and how data will be analyzed.

With the assistance of previous assessment liaison and the current assessment committee, it was decided that we sample about 30% of the total students who took the MAT040Final duringSpring2015 semester. This 30% was applied proportionately per faculty member, so that the individual faculty who taught more students would be more heavily sampled than those who taught fewer students. For example we took 30% of Antwi-Agyei 20 finals from one section and sampled 6 finals from there rather than simply taking 30% of the total final exams. To preserve the anonymity of the faculty we randomly assigned numbers to

the booklets being reviewed and then separated them from the faculty exam folders so that the reviewers could not identify the faculty member whose students' final exam was being used for the assessment. The coding method was used solely for the purpose of re-filing the exam booklets after the assessment project was completed. See Exhibit A for the chart with anonymity codes.

- For MAT040 there were 628 students who took the final exam, 30% of which is 189 students. We randomly sampled their Finals and checked their performance on Final Exam questions 10, 16 and 23.
- For MAT048, we will also sampled about 30% of the Final Exams. There are 149 students who took the Final Exam, 30% of which is about 45 students. We randomly sampled these students from each class and looked at the students' Finals to check their performance on question numbers 11, 21, and 22.

We compared the performance of students from MAT040 to MAT048 students on each question.

The assessment committee consisting of Idanis Hayes, Alinah Malik and Mark Wiener with the assistant of the assessment liaison Afsheen Akbar, randomly sampled the desired number of finals from each of the classes (i.e. 30% for each MAT040 and MAT048 class). The sample was then divided into four equal parts and each of the committee members scored the participating question based on the rubric. The results were then complied together as presented in the Exhibit C.

#### 3B. Desired results faculty would like to see.

Our goal is to see at least 70% of students scoring 2s and 3s.

#### SEMESTER 3: COLLECTING AND ANALYZING DATA

#### 4. Summary of Results (attach aggregated data table, survey tool, etc., to support the summary)

See raw data attached as Exhibit C.

#### Results of solving linear equations

The Department is satisfied with the results on Question 10(for MAT040) and Question 11(for MAT048). In MAT040 86%, and in MAT048 about 91%, of the students surveyed have exhibited at least "nearly complete understanding" of the objective that upon completion of the course, the student would have an ability to:

• Solve equations, including linear equations in one variable, literal equations, absolute value equations, systems of linear equations and quadratic equations with respect to solving linear equations in one variable.

Upon closer review we noticed that there was no significant difference in the results among the MAT040 and MAT048 groups for this objective. Students have used a variety of methods to solve this equation, which has variables on both sides of the equation. This is indicative of a proper understanding of this concept. The same understanding is also reflected in the results of the 2<sup>nd</sup> question that was assessed.

#### Results of solving systems of linear equations

The Department is satisfied with the results on Question 16(for MAT040) and Question 21(for MAT048). In MAT040 83%, and in MAT048 about 77%, of the students surveyed have exhibited at least "nearly complete understanding" of the objective that upon completion of the course, the student would have an ability to:

• Solve equations, including linear equations in one variable, literal equations, absolute value equations, systems of linear equations and quadratic equations with respect to solving systems of linear equations.

In fact, upon closer review of the final examinations, it was revealed that the students used a variety of acceptable methods in reaching the correct results, solving the systems using both the elimination method and the substitution method, which demonstrated a true understanding rather than rote or robotic solving.

#### Results of solving compound inequalities

In MAT040 (Question 23) about 68%, and in MAT048 (Question 22) about 66%, of the students surveyed have exhibited at least "nearly complete understanding" of the objective: "Solve and graph linear inequalities in one variable."

We determined that there was no significant difference in the results among the MAT040 and MAT048 groups. Based on the sample size of 189 students in MAT040 group, the selected margin of error  $\pm 2\%$  does not leave a significant difference with the MAT048 group. MAT048 group has a sample size of only 44 students so the selected margin of error of  $\pm 4\%$  brings these results fairly close to the MAT040 group.

#### 5. Recommendations for Improvement:

For solving systems of linear equation, the question that remained to be answered is why the MAT040 group performed better on this question as compared to the MAT048 group. Since this topic as been a part of Algebra course material for a while, the committee feels that perhaps there are too many topics being covered in MAT048 leaving students with insufficient time to practice each topic thus resulting in a lower average. A memo will be sent to MAT048 committee, headed by Alinah Malik, to reconsider the amount of time set aside to teach each topic and corresponding homework assignments, so the results could improve in future studies.

The initial inspection of the results of solving compound inequalities, Question 23 (for MAT040) and Question 22 (for MAT048) is satisfying. In MAT040 about 68%, and in MAT048 about 66%, of the students surveyed have exhibited at least "nearly complete understanding" of the objective: "Solve and graph linear inequalities in one variable."

These results are just shy of the targeted 70%. One reason for that is this is the first time we have included this topic in both of our algebra classes. We may need to make slight changes to ensure there is enough time allotted to teaching the material. Also, the results of this study will serve as the baseline for future studies to see how we are improving in teaching this topic. Assessment committees' initial recommendation is to spend

extra time teaching this topic and more in depth. Along with it, MAT040 and MAT048 committees will be asked to revisit the homeworks associated with these sections and the final exam review sheet. MyMathlab homework serves as a template which has been created by a committee of experienced faculty, and which is reviewed during, after and before every semester. It is stressed by the course committees and by the MyMathLab coordinator who sets up and distributes the course templates that the homework in MyMathLab is a guide to be reviewed by each instructor for his or her class. Some instructor provides additional homework as worksheets and other material as well. Each instructor is further encouraged to make homework modification suggestions through the course coordinators and the MyMathLab coordinator for future homework modifications.

Both committees will revisit the departmental final to reconsider the solving compound inequalities question in specific, to see if the design of the question needs to be amended. As a general practice, developmental mathematics department after each annual or biennial assessment reviews the final exam to see if there is a pattern of error: are the same questions being missed, are the same errors being repeated, does it seem that the problem is the language of the question or a lack of understanding of the subject? This has continued to be reviewed and will continue to be reviewed.

#### SEMESTER 4: CLOSING THE LOOP AND SHARINGKNOWLEDGE

#### 6. Use of Results:

The committee is satisfied with the results of the solving linear equation with variables on both side and the systems of linear equation.

A note will be sent to the department to share the results of the study. The insufficiencies, particularly in solving compound inequalities, will be brought to the attention of the department so the instructors can delve into the topic even more. This will result in more understanding of the topic and better outcomes on the testing of this question. This topic was included for the first time in our algebra courses so this study result will also serve as the base-line for future studies.

A request will be sent to MAT048 course committee to possibly revise the tentative schedule for MAT048 to change the amount of time allotted to solving compound inequalities and solving systems of linear equation. Once it is approved and changes are made from there a memo will be sent to the department, mandating that instructors spend more time on these topics for next academic year.

# EXHIBIT A

## MAT040 Spring 2015

Anonymity		Sections	# of	
code	Faculty	MAT040	finals	sample size
72		018T	19	6
89		020T	19	6
59		010	18	5
70		601	20	6
58		606T	9	3
19		024LY	20	6
26		605T	20	6
25		029T	15	4
35		015	19	6
54		019T	14	4
56		028	18	5
51		021LS	15	4
100		098WB	13	4
65		099WB	15	5
88		001	22	7
74		004	22	7
8		007	20	6
6		016T	17	5
41		607LY	6	2
62		025LY	15	4
34		026LY	16	5
13		027LY	17	6
14		602	13	4
49		002	19	6
20		003	22	7
91		006	21	6
98		011	14	4
28		012	21	6
3		22T	17	5
10		017T	17	5
39		014	16	4
67		023LS	5	2
18		013	18	5
21		005	20	7
17		008	19	6
64		009	17	6
48			6	2
		30% of	628	187

## MAT048 Spring2015

Anonymity		Sections	# of	sample
code	Faculty	MAT048	Finals	size
81		009LY	16	5
99		010T	14	4
53		099WB	7	2
27		004	17	5
90		006T	10	3
15		001	16	5
18		003	21	6
93		601	15	5
11		007T	8	2
5		002	13	4
96		008T	12	4
		30% of	149	45

# EXHIBIT B

# Spring 2016 Assessment Rubric

# MAT040/048 Final Exam

# Solve Linear Equation with Variables on both sides

3 points: Correct answers, good methods.

10) 
$$\chi + 5 - 2(\chi + 5) = 3(2\chi - 4)$$
  
 $\chi + 5 - 2\chi - 10 = 6\chi - 12$   
 $- \chi - 5 = 6\chi - 12$   
 $+ \chi + \chi$   
 $-5 = 7\chi - 12$   
 $+ 12$   
 $1 = \chi$ 

$$\begin{array}{rcl} 11) & 2(\chi - 1) - 3(\chi + 1) = -(2\chi - 1) \\ & 2\chi - 2 & -3\chi - 3 = -2\chi + 1 \\ & -\chi - 5 = -2\chi + 1 \\ & +5 & +5 \\ & & +5 & \\ & & +5 & \\ & & & -\chi = -2\chi + 6 \\ & & & +2\chi & +2\chi \\ & & & \chi = -6 \end{array}$$

2 points: Problem on the left, the student neglected to combine like terms in the 3<sup>rd</sup> step and continued the problem with (-10) but "shows nearly complete understanding".

Problem on the right, student made a calculation error when combining (-5+12). The Student should have gotten +7 instead of -7. Also, the student didn't not move both x terms to same side, instead changed it to a fraction for the final answer.

(v) 
$$\chi_{15} - \chi(\chi_{15}) = 3(\chi_{1-4})$$
  
 $\chi_{15} - \chi(\chi_{15}) = 3(\chi_{1-12})$   
 $\chi_{15} - \chi(\chi_{15}) = 3(\chi_{1-4})$   
 $\chi_{15} - \chi(\chi_{1-5}) = 3(\chi_{1-4})$   
 $\chi_{1-5} - \chi(\chi_{1-5}) = 3(\chi_{1-5})$   
 $\chi_{1-5} - \chi(\chi_{1-5})$ 

Problem on the left, the student neglected to distribute the -3 properly and continued with the problem like that, shows "nearly complete understanding".

Problem on the right, the student distributed the -3 and -1 properly on either side of the equal sign. After that student subtracted terms that are not in the problem.

1points: Instead of combining the like terms first, the student started to move the terms to the other side of the equation. This caused student to get confused and stopped midway through the problem, shows limited understanding.

$$\begin{array}{l} (0) \ \chi + 5 - 2(\chi + 5) = 3(2\chi - 4) \\ \chi + 5 - 2\chi - 10 = 6\chi - 12 \\ + 10 \\ \chi + 5 - 2\chi = 6\chi - 2 \\ + 2 \\ \chi + 2 \\ \chi + 7 - 2\chi = 6\chi \\ - 2\chi = 6\chi \end{array}$$

The student knows to distribute the coefficient and then to combine the like terms on each side, but doesn't know how to proceed further.

$$\frac{11}{2(1-1)-3(1+1)} = -\frac{1}{2(1-1)}$$

$$\frac{2(1-2)-3(1+1)}{-1(1-5)} = -\frac{3(1+1)}{-3(1+1)}$$

0 point: Shows un-sufficient understanding of the problem. The student simply starts moving terms from one side to other without a reason. In the 2nd step student is multiplying 2x+1(which doesn't even exist in this problem) to the right side. In the following steps some terms simply disappears.

### **Solve Systems of Equations**

 $\begin{array}{c} 20 \\ 7(-3y+7)+3y=8 \\ -6y+14+3y=8 \\ -3y=-6 \\ -3y=-7 \\ -3 \\ y=2 \\ x+3(2)=7 \\ y=2 \\ x-6-17 \\ y=-7 \\ y=-7 \\ y=-7 \\ y=-7 \\ y=-7 \end{array}$ 

3 points: Correct answers, good methods.

3 points: different approach (Substitution method) with minor error: -6/-3 should = 2, but student gets -2, but "shows complete understanding of the problem's essential mathematical concepts \* \* \*."

2x + 3y = 8 x + 3y = 7 4 - 3y = 8 x = 7 - 3y -3y = -6 3y = -6 -3y = -6 3y = -2 (7 - 3y) + 3y = 8 y = -2 14 - 6y + 3y = 8 x + 3(-2) = 7 x - 6 = 7 x = 132x+3y=8

2 points: Neglected to multiply right hand side by multiplier (-2) but "shows nearly complete understanding"



also 2 points: Nearly complete understanding – but never goes on to compute value for second variable?

20

1 point: Shows limited understanding. Student knows to try to get "same" coefficient and add to eliminate, but doesn't realize needs opposite sign – critical and major error.



0 points: Just added two equations together. "insufficient understanding"



# Solve Linear Equation with Variables on both sides

3 points: Correct answers, good methods.

3 points (with a little error): The student on the left used a parenthesis for 5 instead of bracket in the interval notation. Student on right inadvertently divided by a 5 and not -5

2 points: The student on the left, divide one side of the inequality by 5 while the other side by -5. Also, student doesn't the invert the in-equality symbol when dividing by - showingsome gaps in understanding.

22) -214 - 5x + 44 - 6 $-5x + 4 \ge -21$ -5× 142-6 -4 -4

1 points: Shows limited understanding. The student started off dividing by the coefficient of the variable being solved for. Student neglects to understand the rule of solving the inequality and order of operations.

$$\begin{array}{c} 23 \\ -13 \leq -2x - 3 \leq -9 \\ -13 \leq -2x + 3 \leq -9 \\ -13 \leq -2x + 3 \leq -9 \\ -13 \geq -2x + 3 \leq -9 \\ -13 \geq 2x - 3 \geq -9 \\ -13 \geq -3 \geq -9 \\ -13 \geq -9 \\ -13 \geq -9 \\ -3 = -9 \\ -3$$

The student starts by clearing the left side of the inequality, rather than solving for *x*.

$$22^{1} - 13 \leq -2x - 3 \leq -9$$
  
-13  $\leq -2x - 3 \leq -9$   
+13  $\leq -2x + 10 \leq -9$   
-10  $= -10 = -10$   
-2x  $\leq 19$ 

0 points: The student on left started dividing by the coefficient of the variable being solved for and then stops. Second student is not following the rules of inequality and is simply moving terms as s/he would like.

$$\frac{22}{-172} - \frac{-2x}{-2} - \frac{3}{-2} - \frac{-7}{-2} = \frac{22}{-2} - \frac{-7}{-2} = \frac{-5x}{-5} + \frac{4}{-2} - \frac{5}{-5} - \frac{-5x}{-5} = \frac{-5x}{-5} - \frac{-5x}{-5} = \frac{-5x}{-5} - \frac{-5x}{-5} = \frac{-5x}{-5} - \frac{-5x}{-5} - \frac{-5x}{-5} = \frac{-5x}{-5} = \frac{-5x}{-5} - \frac{-5x}{-5} = \frac{-5x}{-5}$$

This student started correctly by adding 3 to all three sides but then rather than isolating the variable x eliminated it.

$$\begin{array}{c} 22) -13 \leq -2x -3 \leq -9 \\ +3 & +3 & +3 \\ -16 \leq -2x \leq -6 \\ +6 & +6 & +6 \\ -4 \leq 4 \end{array}$$

# EXHIBIT C

0         1         2         3         Total           Question 10 (M040)         7         19         15         148         189           Question 11 (M048)         1         3         8         32         44	86.24% 90.91%
Question 10 (M040)71915148189Question 11 (M048)1383244	86.24% 90.91%
Question 11 (M048)         1         3         8         32         44	90.91%
Question 16 (M040)         26         6         36         121         189	83.07%
Question 21 (M048)         9         1         4         30         44	77.27%
Question 23(M040)         36         25         45         83         189	67.72%
Question 22 (M048)         7         8         6         23         44	65.91%