Annual Report for Assessment of Outcomes 2012-13

Subject Area Committee Name: Mathematics
Contact person: Emiliano Vega (emiliano.vega@pcc.edu)
For LDC/DE: Core outcome(s) assessed: Professional Competence, Critical Thinking and Problem Solving
For CTE: Degree or certificate* assessed: --
*please attach a table showing the alignment of the degree or certificate outcomes with the College Core Outcomes

Note: Information provided in this report may be inserted into or summarized in Section 2C Program Review Outline.

1. Describe changes that have been implemented towards improving students' attainment of outcomes that resulted from recent outcome assessments. These may include but are not limited to changes to content, materials, instruction, pedagogy etc. Please be sure to **describe the connection** between the assessment results and the changes made.

In the 2011-2012 academic year an assessment was done on the outcomes Professional Competence and Self Reflection. Data analysis sessions were held to evaluate the data and to create a list of topics to guide our actions in the 2012-2013 school year in order to improve student learning. Some of the suggested actions generated after the data analysis sessions are listed below:

- Encourage pre-100 students to take a CG 111C course (math study skills) ideally taught by a math instructor
- Add reflection pieces to our CCOGs
- Address concerns with student advising
- Create 5-10 minute lessons on self-reflection and study skills that faculty could easily incorporate in their courses (e.g. activities, videos)
- Disseminate successful ideas already used by our faculty for improving study skills and student-centered learning
- Seek out professional development opportunities for student-centered learning techniques
- Questions relating to student learning as part of faculty online evaluation
- Communicate to students the importance of ideas and concepts rather than rote memorization of procedures

An Action subcommittee of the Mathematics SAC was created to implement changes. With ~200 total members, both full and part time in our SAC, this second group was created to implement changes while the LAS group created the assessment activity, collected the results and made the first analysis of the results and recommendations of what to do to the Action group. At the moment this model works well, it would be ideal to combine the two groups in the future as we become better at designing assessments and implementing changes from the assessment.

The action group met with the goal of creating activities that focus on self-reflection and study skills that faculty could easily incorporate into their own teaching. To do this, the committee collected practices from 25 different instructors that emphasized *Self Reflection* in order to find ways of incorporating more self reflection about mathematics in the classroom setting. (Currently the committee is looking at ways to make

the collected activities available for instructor use. Worksheets are available in a binder in the math department at each campus, but have not been formally distributed.) There is a plan to create a website where the worksheets can be viewed and downloaded. Some examples of the Self Reflection practices collected included:

- Having students grade their own work once a week.
- For partial credit, write a sentence of about each error on a mathematics exam and describe how the error was corrected, for example, "I did not describe the quantity represented by the variable in this problem."
- For Service Learning students, they need to respond to the question, "How were you affected by the experience and how does that compare with your initial expectations?"
- A more detailed example is the *Mathiography* (rooted in Biography), found in Appendix C

For each outcome assessed this year:

2. Describe the assessment design (tool and processes) used. Include relevant information about:

- The nature of the assessment (e.g., written work, project, portfolio, exam, survey, performance etc.) and if it is direct (assesses evidence mastery of outcomes) or indirect (student's perception of mastery). Please give rationale for indirect assessments (direct assessments are preferable).

We administered an assessment consisting of nine mathematics problems to students in all MTH 95 face-to face-classes at Sylvania, Rock Creek, Cascade, SE Center, Newberg, Willow Creek, and Hillsboro Center. The core outcomes of Critical Thinking and Problem Solving, and Professional Competence were measured.

The assessment was a direct measurement of both Critical Thinking and Problem Solving, and Professional Competence. During the Fall 2012 term at a SAC in-service day, full-time and part-time faculty members collaborated to select 10 questions (later reduced to nine for the actual assessment instrument) from our current MTH 95 textbook, which we believe emphasized topics that would be essential for students' success in MTH 111.

a. Since faculty selected problems with content specific to success in MTH 111, we felt this would help assess students Professional Competence in terms of the "knowledge, skills and attitudes necessary to enter and succeed in a defined profession or advanced academic program." More specifically, we wanted to know if the skills we thought students need to be successful in the next class had any uniform representation. (The assessment activity can be found in Appendix B)

b. Additionally some of the questions selected focused on students reasoning with units and meaning of a real-world problem in context, both graphically and non-graphically, before they answered a question. This helped us assess their ability to "identify and investigate problems, evaluate information and its sources" with respect to Critical Thinking and Problem Solving.

- The student sample assessed (including sample size relative to the targeted student population for the assessment activity) process and rationale for selection of the student sample. Why was this group of students and/or courses chosen?

One of the current national discussions in education is about college readiness and whether we are preparing our students for college level classes. Students consistently struggle in MTH 111, the first-college level credit math class, thus we decided to focus on the class students take before MTH 111, MTH 95. Our population of interest for this assessment was only MTH 95 students, which, according to Banner in Week 4 of the Winter 2013 term, there were 1529 students enrolled. The assessment was sent to all instructors at Sylvania, Rock Creek, Cascade, SE Center, Newberg, Willow Creek and Hillsboro, who were teaching MTH 95 in the Winter 2013 term. In total, this was 33 sections of face-to face-classes. We excluded instructors teaching MTH 95 online as this particular assessment was completed by students without access calculator and we could not guarantee online students would refrain from using calculators.

In total 677 students responded across all 33 sections. Since MTH 95 students were our target audience, we felt our sample size was large enough. There is the potential that some students missed class the day the assessment was given or opted out of taking the assessment in class, but we felt the frequency of these events would be low and would not significantly affect our data. (However as Banner reported 1529 students enrolled, we are unsure why our number of responses was not higher since activities were sent to 33 of 35 sections that term.)

- Any rubrics, checklists, surveys or other tools that were used to evaluate the student work. (Please include with your report – OK to include in appendix). Where appropriate, identify benchmarks.

Of the nine questions the LAS had the expectation that:

i. Question #1a and #1b would have a high success rate (75% and up) as the topics are consistently practiced throughout MTH 65 and MTH 95.
ii. Question #5 would have a low success rate (less than 30%) as the wording and problem setup was not ideal even after modifications.
iii. Question #7 would have a low success rate (less than 30%) as the topic may not have been covered yet or only briefly covered at the time of the assessment.

These expectations withstanding, the LAS had felt our students would have an average of five to six questions correct. This was based on typical pass rates for the course. For example, in the 2011-2012 academic year the enrollment pass rate was 62%.

- How you analyzed results, including steps taken to ensure that results are reliable (consistent from one evaluator to another.

Each instructor gave his/her class a short set of directions (found in appendix A) before administering the assessment (found in appendix B). Instructors were welcome to include this assessment as part of a student's grade, but since it was the ninth week of the quarter, it was encouraged to offer the activity primarily as final review.

As the classes completed the activity, the results were put into an envelope and sent to a department administrative assistant at every location and were returned to Emiliano Vega at the Sylvania campus to

distribute to a subcommittee of SAC members to grade. To maintain instructors' privacy, the administrative assistants notated envelopes so that instructors could have the material back upon completion of the assessment if desired.

There was no need for a rubric since when grading the assessment it was agreed that student responses should be marked as correct or not correct and that no partial credit given. Instead of partial credit or using a rubric, we focused on notational differences in answers to make sure the members of the SAC who were grading were consistent in scoring correct vs. incorrect. After short discussions an email was sent to all SAC members who were grading to "normalize" the notational differences.

- e.g. Question #1b in the activity asks students to "Solve when $f(x) = 0$". The equation has three solutions. There are multiple ways to display the solutions (such as $x = -1,\ x = -3,\ x = 4$, or $-1, -3, 4$, or $x \mid x = -1, -3, 4$, or $-1, -3, 4$.

Due to the number of different instructors giving the assessment and different acceptable notations that students could use, we accepted all answers that had the correct solutions regardless of notation. This allowed us to have reliable and consistent grading from instructor to instructor.

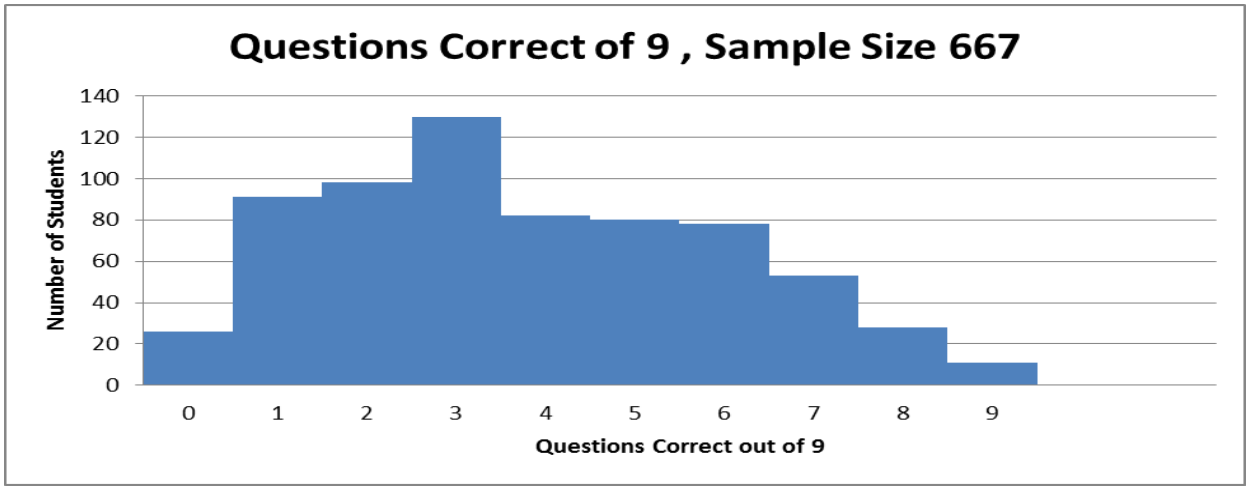
3. Provide information about the results (i.e., what did you learn about how well students are meeting the outcomes)?
   - If scored (e.g., if a rubric or other scaled tool is used), please report the data, and relate to any appropriate benchmarks.
   - Results should be broken down in a way that is meaningful and useful for making improvements to teaching/learning. Please show those specific results.

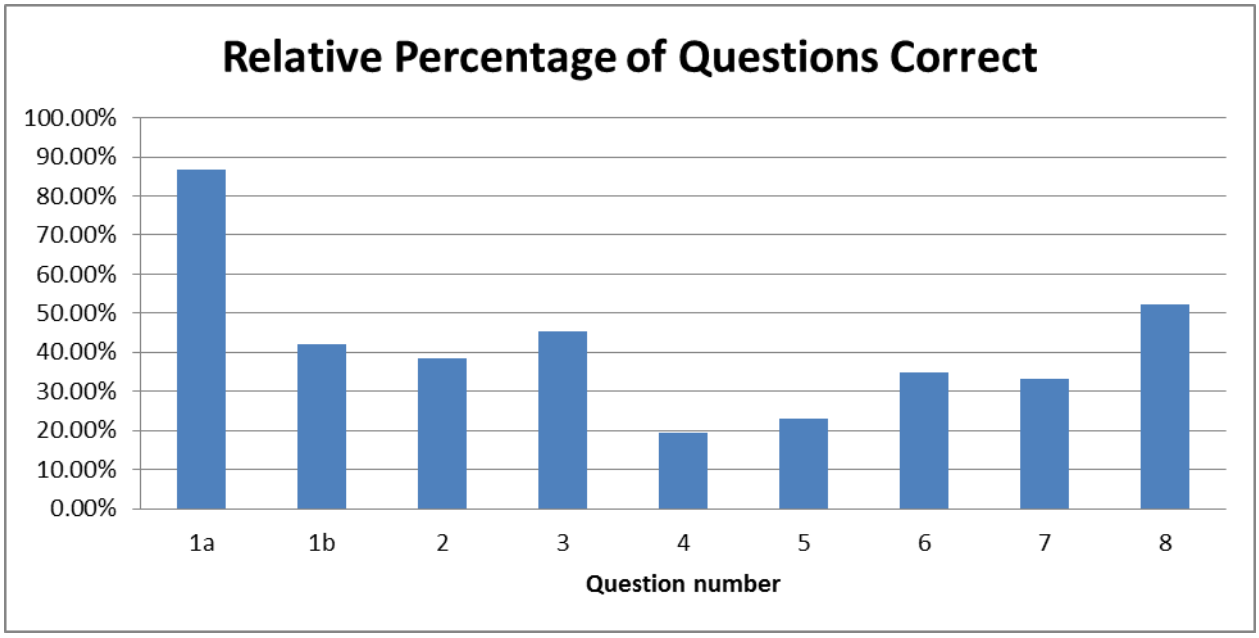
Our assessment consisted of nine questions. After all submissions were graded, the average score was approximately 3.8 out of nine. On a class-to-class basis the average had a low of 1.7 out of 9 to a high of 5.4 out of 9. We were unsure of why the average of all classes was so low; nonetheless we found it alarming. Did students not take the activity seriously since most instructors did not assign points to it? Would it have been better to give it with the final exam when most students were prepared for a mathematics assessment? The data collected is given below:

Average score out of 9 per class from low to high		
	Sample Size	Average
Class #1	33	1.8
Class #2	9	1.9
Class #3	14	2.1
Class #4	22	2.7
Class #5	29	2.9
Class #6	36	3.0
Class #7	19	3.1
Class #8	30	3.3
Class #9	32	3.4
Class #10	25	3.5
Class #11	11	3.5
Class #12	22	3.6
Class #13	24	3.6
Class #14	25	3.7
Class #15	12	3.8
Class #16	14	3.9
Class #17	16	3.9
Class #18	19	3.9
Class #19	11	3.9
Class #20	26	4.0
Class #21	18	4.0
Class #22	24	4.0
Class #23	17	4.1
Class #24	15	4.1
Class #25	10	4.4
Class #26	24	4.7
Class #27	31	4.7
Class #28	31	5.0
Class #29	8	5.1
Class #30	15	5.3
Class #31	25	5.3
Class #32	25	5.4
Class #33	5	6.4

Sample size from low to high		
	Sample Size	Average
Class #1	5	6.4
Class #2	8	5.1
Class #3	9	1.9
Class #4	10	4.4
Class #5	11	3.9
Class #6	11	3.5
Class #7	12	3.8
Class #8	14	3.9
Class #9	14	2.1
Class #10	15	5.3
Class #11	15	4.1
Class #12	16	3.9
Class #13	17	4.1
Class #14	18	4.0
Class #15	19	3.9
Class #16	19	3.1
Class #17	22	3.6
Class #18	22	2.7
Class #19	24	4.7
Class #20	24	4.0
Class #21	24	3.6
Class #22	25	5.4
Class #23	25	5.3
Class #24	25	3.7
Class #25	25	3.5
Class #26	26	4.0
Class #27	29	2.9
Class #28	30	3.3
Class #29	31	5.0
Class #30	31	4.7
Class #31	32	3.4
Class #32	33	1.8
Class #33	36	3.0

Average of all classes, sample size 33
3.79





While it is encouraging to see a high percentage of students being able to do question #1a (applying function notation to a graphical representation of a function and using an input to find an output), we were not encouraged to discover that many were unable to apply the opposite idea in question #1b (using an output to find input(s)), since the topics are always done together. Question #3 involves rewriting a rational expression, a topic that received a significant amount of time in MTH 95; to have more than 50% of the surveyed students miss this item was disappointing. Question #2 involves linear functions, another topic that is explored in MTH 60, 65 and 95; again almost 60% of the surveyed students missing this question was disappointing.[1]

[1] The Mathematics SAC has already taken action on these results. At the May SAC meeting a standing committee was formed to take a critical look at the alignment of the four pre-college level mathematics courses currently offered. Since linear functions is an essential understanding for any college-level mathematics courses, we recognize that we need to do a better job supporting the development of students' understanding of this topic.

Based on these data, some questions that the SAC members would like to evaluate at some point (if possible) are:

i. Are there questions missed uniformly across all classes? Do some questions have a higher incorrect frequency in certain classes and what would be the cause?
ii. For questions that had multiple solutions/answers, can we focus on why students found some solutions/results and why not others?
iii. Does class location of time, night or day, have an affect on the results? (This is likely not possible while maintaining privacy for instructors.)

4. Identify any changes that should, as a result of this assessment, be implemented to help improve students' attainment of outcomes. (These may include, but are not limited to, changes in curriculum, content, materials, instruction, pedagogy etc).

Upon completion of our analysis of the activity the Learning Assessment Subcommittee will give suggested changes to the Action Subcommittee from this year's assessment work (and possibly last year's) to the Math SAC for discussion in Fall Quarter 2013.

Below is a list of possible discipline-level changes created from this year's data analysis. The Learning Assessment Subcommittee shared these actionable items with the SAC at our last SAC meeting of the academic year.

Potential actionable items to improve student learning:

a. Change the MTH 95 CCOG to specifically address in the "intended outcomes" if solutions are reasonable.

   i. At the moment the addendum for the course states, "*As much as p* real-world contexts *ossible, instructors should present functions that model real-world problems and relationships to address the content outlined on this CCOG."* This could be made more explicit as there is no mention of addressing the reasonableness of a solution(s) when working with real-world contexts. Adding this to the course outcomes could be beneficial to students.
   ii. To further this, instructors could develop activities for students to analyze another's mathematical work and assess both the reasonableness of the strategy and result. This would help students towards achieving the Professional Competence outcome.

b. Create a minimum skills test for MTH 95. This could be administered online or as a paper version. If given online, results could also be used by faculty (possibly students if given online so they can see results) to assess students' professional competence and potentially self-reflection. A question could be added on the minimum skills test as to whether they feel prepared for the next course (MTH 111).

c. At a more global level we should have discussions about the delivery of course content in way that support both full time and part time faculty, which could possibly include:

   i. The potential for curriculum materials to be utilized by all instructors across all PCC campuses and locations. This could begin as a small piece of content for specific sections with which students have the most difficulty.
   ii. Have a "super" committee for MTH 20/60/65/95 to align the outcomes in the precollege mathematics curriculum. This would help make a smooth transition between all classes with important topics and

themes constantly revisited throughout the precollege curriculum, better preparing students for college-level mathematics.

iii. The integration of new curriculum materials perhaps in coordination with the CTE mathematics course development to address Critical Thinking and Problem Solving for all students. This could serve as way to highlight the CTE programs to students while also drawing on applications from these programs into the non-CTE mathematics classes.

5. Reflect on the effectiveness of this assessment tool and assessment process. Please describe any changes to assessment methodology that would lead to more meaningful results if this assessment were to be repeated (or adapted to another outcome). Is there a different kind of assessment tool or process that the SAC would like to use for this outcome in the future? If the assessment tool and processes does not need to be revised, please indicate this.

We had discussed the potential of giving the same assessment again during the first week of the Spring 2013 term to all MTH 111 classes at all campuses (MTH 111 is the next course in the general mathematics sequence after MTH 95). This would allow us to have a snapshot of students who progressed from MTH 95 to MTH 111 and if their skill set had increased, decreased or remained approximately the same. We decided against this activity, as it simply would have been too labor intensive.

It is possible that students may not have tried their best on the assessment since it did not affect their grades in any way. In the future it would be ideal to add assessment questions, perhaps two or three, to the MTH 95 final for all classes and simply not count them in a student's score and repeat the assessment for an entire academic year to search for patterns and trends.

Although most of the questions on the assessment are almost directly from our current MTH 95 textbook, there was concern that we need to focus more on student work and their conceptual thinking and not simply right or wrong in order to assess what students know. As indicated earlier, for this activity we focused on correct or incorrect results for the assessment. Some in our group felt this would not help solve our students' content issues and that perhaps in the future we need a smaller assessment that will let us:

i. Look beyond correct/incorrect results

ii. Build in components that let us critically evaluate our students' <u>thinking</u> and reasoning on the problems. This arose when discussing question #4 where many felt it was difficult to find WHERE students made a mistake in reasoning: was it the fractional exponents? The negatives? The division?

iii. Assign partial credit for explanations and work as opposed to no credit unless it is correct. E.g., correctly finding two out of three solutions/answers vs. question left blank. This arose in question #7, which had four parts. Some felt that we should have investigated more and found a way to assign partial credit to students who did three parts correctly but made an error on the fourth.

iv. Search for trends in conceptions or misconceptions that students may have for concepts we deem essential to succeed in MTH 111

APPENDIX A

MTH 95 Assessment Talking Points

The Mathematics Learning Assessment Subcommittee (Math LAS) is a subcommittee of the Mathematics SAC. The subcommittee is charged with developing and administering assessments of student learning around college and course outcomes.

This year we are examining the transition from MTH 95 to MTH 111. The subcommittee, using feedback from members of the Mathematics SAC, have developed an assessment that includes eight problems linked to our CCOG, which we believe represent skills essential to success in college algebra. We are asking all MTH 95 instructors to administer this assessment during Week 9 or 10 of Winter term. The assessment should take no more than 30 minutes.

- The goal of this assessment is to learn how well ***we*** are preparing students for college-level mathematics. If our MTH 95 students demonstrate difficulty with these problems, then ***we*** will take a critical look at our pre-college mathematics sequence.

- This assessment will provide an opportunity for uncovering topics to be reviewed before the comprehensive final exam. You are welcome to make a copy of your students' work on this assessment to use to prepare a review.

No instructor name will be attached to a student's responses or the results of the assessment. The goal of the assessment is to assess how the mathematics faculty fares in terms of preparing students for college algebra. However, if you are interested in the results from your class, you – and only you – may have access to these data.

You are welcome to assign a point value to this assessment. If you decide to use the assessment as part of the course grade, please make a copy of your students' work on the assessment. Otherwise when all done, put the assessments back into the envelope they came in and give them to the department secretary. Again, <u>no instructor name will be attached to a student's responses or the results of the assessment</u>

Directions for administering the assessment will be provided with the assessment.

Here is a suggested script for introducing this assessment to the students in your section(s) of MTH 95:

"The mathematics instructors at PCC are interested in learning about how well we are preparing students for college algebra (MTH 111). We are asking all MTH 95 students to complete 8 problems that *we* think are important to success in MTH 111. We understand that not all MTH 95 classes are the same and that different instructors may spend more time on some topics and less on others. Just do what you can on these problems today. We hope that working on these problems is an opportunity for you to start reviewing for you final exam."

APPENDIX B

Name:_____

- Please do all your work on scratch paper but only write your final results on this page.
- **NO Calculator**. Show ALL YOUR WORK on the scratch pages and turn them in as well!
- Please staple your scratch paper to this page when you are done!

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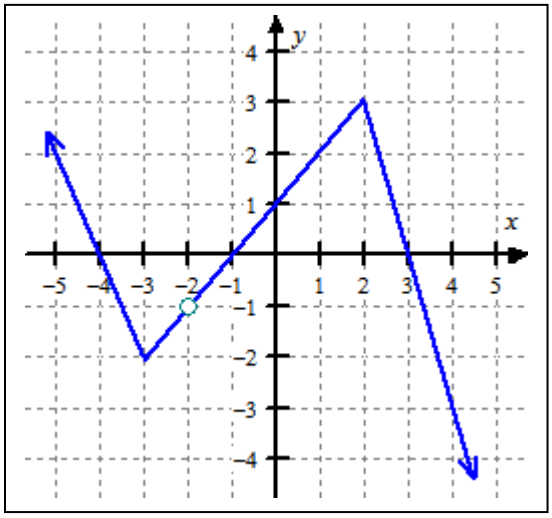
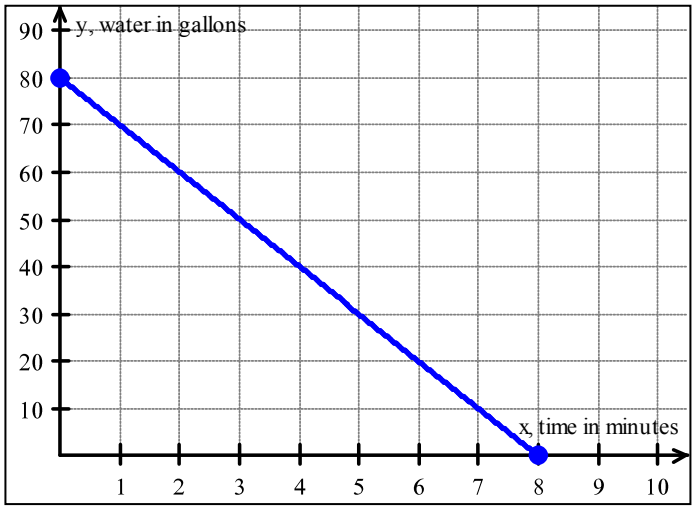
1. The graph of $y = f(x)$ is given at right.



a. Evaluate $f\ \ 2$. **Answer:**_____

b. Solve when $f\ \ x\ = 0$. **Answer:**_____

2. The graph shows the amount of water y in an 80-gallon tank after x minutes have elapsed. Find the slope-intercept form of the equation of the line.



Answer:_____

3. Simplify $\dfrac{4x - 12}{2x - 6}$. **Answer:**_____

4. Simplify $\dfrac{k^{1/2}\ ^{-3}}{k^{2}\ ^{1/4}}$. **Answer:**_____

5. The function T gives the amount of time it takes a car to exit a parking lot if x cars are able to exit the lot each hour. The equation that defines the function T is $T(x) = \dfrac{1}{x-80}$. How many cars should be able to exit each hour if it takes a car 0.5 minutes to exit?

Answer:_____

6. Simplify $\dfrac{\frac{1}{a}-\frac{1}{b}}{\frac{1}{b}}$.

Answer:_____

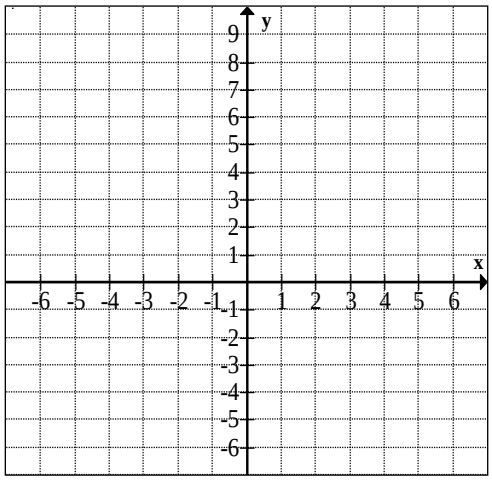
7. For the function given below, find the vertex, the x-intercept(s), and the y-intercept and draw a graph on the coordinate plane given to the right.

$$f(x) = -x^2 + 4x + 5$$

Answer: vertex: _____.

Answer: x-intercept(s): _____.

Answer: y-intercept: _____.



8. Solve the following equation by any method:

$$3x^2 - 12 = -12x$$

Answer:_____

APPENDIX C

MATHIOGRAPHY (Created by Daniel Castleton) MTH 95 – Fall 2012

Take some time to reflect upon your past education in mathematics, and on a separate sheet of paper, write a few paragraphs (no more than a page) that identify some of your thoughts about your mathematics background. This assignment should include:

- *A little about yourself; where you're from, hobbies, etc. Include as much or as little as you like. Also let me know if you go by a nickname.*
- *The math courses you have taken from high school until now.*
- *Last school you attended and your major/program (if you've declared one) or academic interests, as well as how far you need to go in math.*
- *Any important experiences (i.e., specific teachers, classes, moments of enlightenment, etc.) that have affected your knowledge of math or feelings toward math.*
- *Anything you think I should know about you or your learning style that will help you succeed in this course (Do you like to see difficult examples worked out? Group work? Interpretive dancing to demonstrate concepts, etc.)*