EWU Programmatic SLO Assessment
AY 2014-15 and "Closing the Loop" for AY 2013-14

Introduction:

Assessment of student learning is an important and integrated part of faculty and programs. As part of ongoing program assessment at Eastern Washington University, each department is asked to report on assessment results for *each* program and *each* certificate for *at least one* Student Learning Outcome (SLO) this year. To comply with accreditation standards, the programs must also demonstrate efforts to "close the loop" in improving student learning and/or the learning environment. Thus, this template has been revised into two parts.

Resources:

Check this site for sample reports (created with the previous year's template) by EWU programs and other assessment resources: http://access.ewu.edu/graduate-education/academic-planning/faculty-support/student-learning-assessment/sample-program-slo-assessment-reports

Additional resources and support are available to:

1) Determine whether students can do, know or value program goals upon graduation and to what extent;
2) Determine students' progress through the program, while locating potential bottlenecks, curricular redundancies, and more; and
3) Embed assessments in sequenced and meaningful ways that save time.

Contact Dr. Helen Bergland for assistance with assessment in support of student learning and pedagogical approaches: hbergland@ewu.edu or 509.359.4305.

Use this template to report on your program assessment. **Reports are due to your Dean and to Dr. Helen Bergland (hbergland@ewu.edu), Office of Academic Planning, by Nov. 2, 2015.** (Some Deans have elected to move the deadline up.

Degree/Certificate: BAE

Major/Option: Middle-Level Mathematics
Submitted by: Mathematics Education Committee, with leads Jackie Coomes and Diane Dowd
Date: November 3, 2015

Part I – Program SLO Assessment Report for 2014-15

Part I – for the 2014-15 academic year: Because Deans have been asked to create College-Level Synthesis Reports annually, the template has been slightly modified for a) clarity for Chairs and Directors, and b) a closer fit with what the Deans and Associate Deans are being asked to report.

1. **Student Learning Outcome**: The student performance or learning outcome as published either in the catalog or elsewhere in your department literature.

Understand relationships among quantities, functions, and the analysis of change, and demonstrate a conceptual understanding of and procedural facility with fundamental single variable calculus.

2. **Overall evaluation of progress on outcome:** Indicate whether or not the SLO has been met, and if met, to what level.

__x___*SLO is met after changes resulting from ongoing assessments, referencing assessment results from the previous year to highlight revisions;*
_____*SLO is met, but with changes forthcoming;*
_____*SLO is met without change required*

3. **Strategies and methods:** Description of assessment method and choices, why they were used and how they were implemented.

Students in Math 416: Calculus for Middle Level Teachers were asked to respond to three different questions during spring quarter 2015 regarding their conceptions of function notation graphically and their meaning of f(x+h)-f(x) symbolically and graphically. Their understandings of these will affect their understandings of the average rate of change of a function and the definition of derivative of a function at a point. The first question was presented early in the quarter as an entry task, and asked students to comment on whether or not they would label a graph as *f*, y=f(x), or f(x).

The second question involved explaining the meaning of f(x+h)-f(x) given a particular quadratic function and was presented as an entry task before the difference quotient was introduced. Specifically, the question was: Warm-up: Given that $f(x)=-x^2+2x-5$, write the expression representing: $f(x+h)-f(x)$. What does this expression mean?
Since only one student used a graph in her answer to this question, the third question, given on the final exam, assessed students' meanings of f(x+a)-f(x) graphically and verbally. Specifically,

the question was: Given some function, *f*, and some positive number a, describe the meaning of *f*(x+a)-*f*(x) using words and a graph (you get to make up *f*).

4. **Observations gathered from data:** Include findings and analyses based on the strategies and methods identified in item #3.

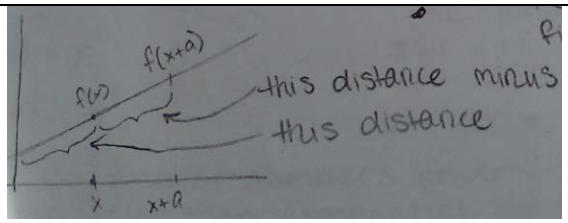
    a. **Findings and analysis:**

	Developing (# of students)	Proficient (# of students)	Exemplary (# of students)
Three tasks on the consistency of graphical and symbolic interpretations of function notation	**10 (83.3%)**	**2 (16.7%)**	**0 (0%)**

In the first assessment, 11 of the 12 students answering the question of how to label a graph responded they would not label a graph of a function as just *f*. The most common reason for not labeling it *f* was that there was not enough information since it consists of only one letter and does not indicate the input variable. This indicates a lack of understanding of the meaning of *f,* and may indicate a lack of understanding of what a function is. A couple of students thought that labeling the graph y=f(x) was redundant, indicating an understanding of the equation as stating an identity rather than a relationship, suggesting a misconception about the meaning of the equal sign in this case. Almost all of the students preferred to label the graph f(x). This appeared to cause difficulties later when we used expressions such as $\frac{f(x+h)-f(x)}{h}$. Students were not able to make the connection between the expression for the slope of a line using x-y-coordinates and the slope of the secants using function notation (i.e. they did not make the connection that the two expressions $\frac{y_2-y_1}{x_2-x_1}$ and $\frac{f(x+h)-f(x)}{(x+h)-x}$ can mean the same thing graphically.) On the second assessment, when asked to find f(x+h)-f(x) for a particular quadratic function, most students correctly evaluated the expression, but in response to 'what does it mean?' 11 of the 12 students responded in ways that showed complete lack of understanding of any *meaning* of the difference. Many said that it was f(h), even when their final expression could be compared to f(h) and shown not to be the same, or described their steps: "In the function f(x), everywhere x appears we add h to it. Then we subtract our original function from f(x+h)."

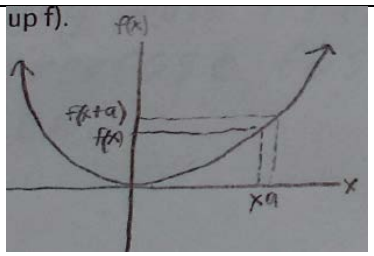
On the second and third assessments students' interpretations of f(x+h)-f(x) graphically and symbolically were inconsistent. On the second question, 11 of the 13 students correctly evaluated f(x+h) other than minor sign errors, and all evaluated f(x+a) correctly by the end of the quarter. However, on both assessments, many students interpreted f(x) and f(x+a) graphically to be the points on the plane rather than the output values of the points (see Figures 1 and 2) although they had clearly described f(x+a) symbolically as the output of *f* at x+a. In the student work shown in Figure 2, the student labels f(x) and

f(x+a) on the y-axis as was modeled in class, but her verbal description indicates that she conceptualizes these as representing points. She also labels the y-axis as f(x) illustrating again the misconception that y=f(x) is an identity. One reason may be that some students arrive at college believing that in higher mathematics, we replace y with f(x).



"f(x+a)-f(x) is used to find the distance between f(x+a) and f(x)."

Figure 1: Interpretation of f(x) and f(x+h) as points



"f(x+a)-f(x) means that we are finding the distance between f(x) at x and f(x+a) at *a*. As *a* becomes infinitely smaller, the point f(x+a) gets closer and closer to f(x)."

Figure 2: Inconsistent use of function notation graphically and verbally

5. **What program changes will be made based on the assessment results?**

   a) Describe plans to improve student learning based on assessment findings (e.g., course content, course sequencing, curriculum revision, learning environment or student advising).

The use of function notation is addressed in the two courses students are required to take before MATH 416, MATH 114 and MATH 311, as well as in MATH 411 (not a prerequisite for MATH 416). Specific changes to the prerequisites might include:
Assessing students' understanding in MATH 114 of the formula for the average rate of change of a function over an interval to better understand how students have developed their understanding of the notation graphically and the consistency of their understandings of the symbolic notation with their graphical understanding of the notation. Specific activities can be developed in MATH 114, MATH 311, and MATH 416 to help students continue to develop an understanding of and use function notation in graphical contexts and prepare to understand the difference quotient. It is likely that students in MATH 141 and MATH 142 will also need more focus on these ideas.

   b) Provide a broad timeline of how and when identified changes will be addressed in the upcoming year.

Faculty from all sections of MATH 114 in Fall 2015 will discuss ways to support development of consistent understandings of function notation graphically, especially in the sections relating to

average rate of change. An end-of-quarter assessment could be used to determine understanding. Further assessment could take place in MATH 311, 141, 142, and 161. We are also considering a different textbook for MATH 114 that does a better job of developing understanding of function notation and its graphical representations.

6. Description of revisions to the assessment process the results suggest are needed and an evaluation of the assessment plan/process itself.

No suggestions since the assessment process worked well.

NEW: PART II – CLOSING THE LOOP
FOLLOW-UP FROM THE 2013-2014 PROGRAM ASSESSMENT REPORT

Working definition for closing the loop: *Using assessment results to improve student learning as well as pedagogical practices. This is an essential step in the continuous cycle of assessing student learning. It is the collaborative process through which programs use evidence of student learning to gauge the efficacy of collective educational practices, and to identify and implement strategies for improving student learning." Adapted 8.21.13 from http://www.hamline.edu/learning-outcomes/closing-loop.html.*

1. **Student Learning Outcome(s)** assessed for 2013-14

Demonstrate conceptual understanding and procedural facility of statistics and probability

2. **Strategies implemented** during 2014-15 to improve student learning, based on findings of the 2013-14 assessment activities.

   In the 2013-14 assessment, over 80% of students achieved a score of at least 3 points (out of 5 possible) on a multi-part task to assess this SLO. For the more than one-third of students who achieved a score of 5, their work included diagrams and computational set-ups that provided evidence of conceptual understanding and procedural facility of the statistics and probability embodied by the task. For this reason, no changes were seen as indicated regarding the content, instruction, or sequencing within the topic itself. This diagnosis was based on the positive overall student results on the task and the number of objectives required for the course.

   Analysis of the work done by students who failed to earn 3 points or to earn full points demonstrated the following errors:

   a. For part (b), students answered with a percentage, rather than applying the percentage they determined to calculate the specific number of items that were expected to have the lifespan indicated in the task.

Faculty in all courses are making greater attempts to focus students on details such as whether they should provide a *percentage* or a *number* of items. Further, an emphasis is being made on distinguishing the specific units being asked for from the very beginning of the first course in this course sequence for elementary teachers. The Common Core State Standards' Standards for Mathematical Practice emphasize K-12 students attending to precision. In our courses for future teachers, we are putting a heavy emphasis on this standard, and using that standard as a way to motivate our students to focus on this important mathematical practice in their own learning and in the learning of their students when they enter the K-12 system.

b. Students based their determination of the probability of the lifespan being less than the designated number of hours on a total of less than 100%. They subtracted from half of 99.95%, rather than from half of 100%. The textbook drawing of a normal distribution highlights the percentages associated with Standard Deviation ranges, and does not highlight the 100% total area under the curve.

The fact that textbook images do not highlight the 100% span is being addressed explicitly in this class. As of Spring 2015, a new textbook was put in use that does not include a drawing of the type that highlights the standard deviation range percentages without focusing also on the entire 100% represented by the area under the entire curve. As other sources of images have been (and continue to be) utilized, the emphasis on recognizing that the 100% span is not highlighted has been and will be explicitly discussed.

c. Attendance was taken in this class. It was observed that students who had not attended class near the end of the quarter when this topic was taught were among those who failed to earn 3 points or full points for this problem.

Mathematics education faculty discussed and implemented ways to emphasize with students the importance of consistent attendance in their courses. It was communicated to majors that, particularly for courses that are in their major (such as MATH 211 for the elementary math majors and elementary / middle level endorsement math majors), the interactive and participatory nature of those courses make it so that the greatest learning takes place by being in class and engaged in learning.

3. **Summary of results** (may include comparative data or narrative; description of changes made to curriculum, pedagogy, mode of delivery, etc.): Describe the effect of the changes towards improving student learning and/or the learning environment.

For students taking the elementary / middle level two-course sequence from which this data was taken, majors are making increased attempts to attend class consistently and to attend to details. An external impetus that has supported these two needs was the Education Department's raising of the grade students must earn in these courses to become a teacher. This new requirement has also helped students be more earnest about coming to class and tending to details in the class.

4. What **further changes to curriculum, pedagogy, mode of delivery,** etc. are projected based on closing-the-loop data, findings and analysis?

The Mathematics Education Committee will submit paperwork to CPAC in November 2015-to restructure the courses for elementary teachers so that the topics of Statistics and Probability can be both taught within one course and be given more time within that one course. At this time, the topic of Statistics is at the end of one course and Probability begins the ensuing course. This divides the natural connection between these two topics and, due to the short time dedicated to the Statistics portion of the first course being at the end of the course it is one that suffers most from end-of-quarter absences.

Some elements of this document have been drawn or adapted from the University of Massachusetts' assessment handbook, "Program-Based Review and Assessment: Tools and Techniques for Program Improvement" (2001). Retrieved from http://www.umass.edu/oapa/oapa/publications/online_handbooks/program_based.pdf