



Guidelines for the Development and Assessment of Program Learning Outcomes

Version 1.0
September 2013

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I. Context: Value of Program Learning Outcomes-Based Assessment

These guidelines describe a step-by-step process to assist faculty across campus with developing and implementing an assessment plan for their programs. The primary goals of engaging in systematic assessment of our academic programs at UCSC are to improve learning and to enhance student success.

Ultimately the quality of our academic programs is the responsibility of our faculty. Faculty are the experts in their fields, and they are in the best position to determine what students in their disciplines should be learning. For that reason we intend assessment on this campus to be faculty driven, locally defined, and program specific.

Assessment has ongoing program improvement as the central goal, and it revolves around faculty defining and articulating standards of performance for student learning in their discipline that are appropriate to the degree. Once these program specific learning outcomes have been established, assessment involves collecting and evaluating credible evidence of student learning, and using that evidence to improve the curriculum, pedagogy, and/or advising, and if necessary to modify and refine the program's learning outcomes.

Engaging in meaningful and regular assessment that directly leads to program improvement makes this approach valuable to both students and faculty, as well as to the institution as a whole.

- a. It allows **students** to understand the major/graduate program as more than a collection of classes; helps them identify their own strengths, weakness, and progress, and helps prospective students select a program of study.
- b. It allows **faculty** to articulate what students are expected to know and the skills they will acquire; to communicate clear expectations to students; to provide a framework for faculty evaluation of the curriculum based on empirical data; and to improve and to measure impact of implemented changes.
- c. It is valuable to the **institution** as it facilitates evaluation of student achievements across programs, and it supports institutional transparency and accountability.

The process described in this document is based on best practices that are being used by faculty across the country, including at prominent research universities, and is consistent with the cycle and requirements of UCSC's program review.

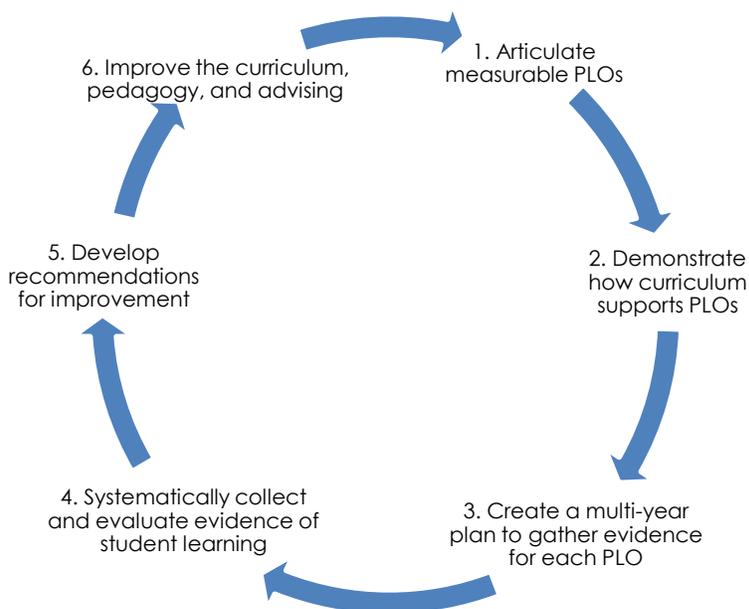
If you have any questions and/or would like to discuss your draft PLOs, curriculum matrix and assessment plans, please contact Dr. Anna Sher, Assistant Director for Assessment by email asher@ucsc.edu or by phone, 459-4302.

II. Overview of the Process: Steps for Conducting Assessment

Systematic assessment of student learning involves a series of discrete steps. This section provides an overview of each of the steps. Subsequent sections provide more detailed instructions, guidelines, and tips for the first three steps, followed by hypothetical examples for both undergraduate and graduate programs.

A systematic approach to assessment is comprised of the following six steps:

1. Articulate a comprehensive, meaningful and measurable set of Program Learning Outcomes (PLOs).
2. Demonstrate how the curriculum supports the PLOs.
3. Create a plan to systematically gather evidence of student achievement of the PLOs.
4. Collect, analyze, and interpret the evidence.
5. Use the resulting information to develop recommendations to improve student learning (including revising the curriculum, teaching and advising methods) and/or to improve PLOs and the methods of assessment.
6. Implement the recommendations.



1. **Program Learning Outcomes (PLOs)** are a set of statements that specify the fundamental knowledge, skills, abilities, and attitudes students will develop over the course of their studies leading to a degree. PLOs are broader and more

comprehensive than learning outcomes associated with individual courses. They should be specific to the program and appropriate to the degree (e.g., BA, BS, Master's, PhD). They can be based on existing program mission statements or goals and objectives, but they should be written from the perspective of what the student will learn. Specific step-by-step instructions and tips for how to write meaningful, comprehensive and measurable Program Learning Outcomes are provided in Section III.

2. **Mapping the curriculum to PLOs.** Once faculty have drafted a set of PLOs the next step is to compare them against the required curriculum. If the PLOs are an accurate and comprehensive reflection of the faculty's expectations about what students should be learning then it follows that the curriculum will support those outcomes, including introducing critical information, and giving students opportunities to practice skills, and ultimately to demonstrate mastery and achievement of the outcomes. Templates for mapping the PLOs to the curriculum are provided in Section IV.
3. **Planning assessment.** Once program faculty have agreed upon their PLOs and mapped them to the curriculum they can create a systematic plan for how to assess their PLOs, including identifying the types of student work, such as exams, projects, papers, etc., that can provide direct evidence that students are learning what the faculty intend, where and when that data will be collected, how it will be evaluated, and how it can be used to inform faculty about their programs. Creating a multi-year plan to evaluate one or two PLOs per year will break assessment into small manageable pieces, and help ensure that it is regularized as part of departmental practices. Ultimately assessment is only useful if it provides meaningful feedback to faculty, students, and other stakeholders, and if the process itself is not overwhelming. Section V provides a detailed discussion of what constitutes evidence in assessment, and guidelines for developing a plan.
4. **Collecting, analyzing and interpreting evidence.** Preparation for an annual assessment study starts with identifying two or more faculty members who will be collecting direct evidence from student work (e.g., who will teach the capstone course that year), evaluating indirect evidence (if student survey data is available for a given PLO), reviewing/revising existing assignments to be used to collect direct data, and articulating specific criteria by which student achievement will be evaluated. Sections VI and VII provide an example for an undergraduate and a graduate program assessment study respectively. Guidelines, workshops and other reference material are being developed to assist faculty with data analysis.

5. **Developing recommendations.** Based on the results of the assessment, faculty may want to make recommendations for improving their programs. Recommendations for improvement may entail revising the curriculum, revising teaching or advising methods, and/or revising PLOs and the methods of assessment.
6. **Using evidence to make changes.** Ultimately the most critical step of the assessment process is to use the findings to regularly evaluate programs, to make programmatic changes, and to demonstrate to students and other stakeholders the meaning and value of the degree. A discussion of a department's PLO assessment process, results, and efforts to improve student learning will be included in the departmental self-study for the program review.

III. Writing Program Learning Outcomes (PLOs)

Defining PLOs begins with the question, “What knowledge, skills and values do faculty in the program expect students to have acquired by the time they graduate?” Program Learning Outcomes are written as a set of statements that specify what faculty expect students in their program to know, be able to do, or be able to demonstrate as a result of successful completion of the program.

Writing Program Learning Outcomes is a critical first step that will guide subsequent steps in the assessment process.

Program Learning Outcome statements should have the following three attributes:

1. meaningful to faculty and students;
2. comprehensive; and
3. measurable.

1. Meaningful to faculty and students—i.e., reflect ...

- Outcomes important to program faculty
- Mission and unique program aspects/goals
- Skills/values students want to acquire
- Knowledge/skills needed for graduate study and/or employment

EXAMPLE OF UNDERGRADUATE PROGRAM LEARNING OUTCOMES

Graduates from the Physics B.S. program will have demonstrated the following:

1. **Physical Principles.** Students will be able to apply basic physical principles—including classical mechanics, electricity and magnetism, quantum mechanics, and statistical mechanics—to explain, analyze, and predict a variety of natural phenomena.

2. **Mathematical Expertise.** Students will be able to translate physical concepts into mathematical language and to apply advanced mathematical techniques (e.g., calculus, linear algebra, probability, and statistics) in their explanations, analyses, and predictions of physical phenomena.

3. **Experimental Techniques.** Students will be able to take physical measurements in an experimental laboratory setting and analyze these results to draw conclusions about the physical system under investigation, including whether their data supports or refutes a given physical model.

4. **Research Proficiency.** Students will be able to formulate personal research questions that expand their knowledge of physics. Students will be able to apply sound scientific research methods to address these questions, either by researching the current literature or developing independent results.

5. **Written Communication.** Students will be able to clearly explain their mathematical and physical reasoning in writing, and

6. **Teamwork Skills.** Students will be able to communicate and work effectively in groups on a common project.¹

2. Comprehensive

A set of PLOs specifies key disciplinary knowledge and skills as well as relevant general skills.

3. Measurable

Each PLO can be demonstrated by students as part of senior research project, thesis, etc.

¹ This set of PLOs was adapted from UC Merced.

PLO attribute #1. When drafting **meaningful** PLOs, it is important to identify outcomes that faculty most care about, and that are meaningful to students in your program as well as to outside constituencies such as employers and other community members.

Guiding questions include:

- What do faculty consider the most important outcomes for their students?
- What are the mission and unique aspects of your program?
- What skills and learning experiences are your students interested in acquiring?
- What knowledge, skills and values are needed for (a) successful transition to graduate studies or (b) finding employment?

To help ensure that PLOs are **meaningful** it is helpful to:

- engage faculty and, if possible, senior students in a discussion about the **key** knowledge, skills, and values students learn in the program;
- prioritize outcomes that faculty consider **life-long** skills and knowledge students should acquire by the time they graduate with a degree;
- identify and revise fuzzy or verbose outcome statements by reviewing each outcome from **the student point of view**: "Will this outcome help students to learn? Will students be clear of my learning expectations with these outcomes?" (Driscoll & Wood 2007: 62);
- review the documentation that may already exist in the program related to goals or expectations for students such as a program description that states the **goals or mission of the program**, syllabi with stated goals, capstone-like experiences where students are asked to show depth of learning.

How to use already existing program-level goals or expectations for students for writing PLOs

If the program has written goals or objectives, or a mission statement, they can be used as a basis for writing Program Learning Outcomes. Goals and objectives may be more general than a set of PLOs, may be written from the perspective of what the program intends to impart rather than what the students are intended to learn, and may or may not be measurable. However, goals can be revised to articulate the expected results of teaching. Table 1 shows how more general program goals can be used to write more specific program learning outcomes.

Table 1
Using general program goals to craft specific program learning outcomes

	Program goals	Program Learning Outcomes <i>that can be evaluated based on a student's senior research project</i>
Students will be able to	... demonstrate familiarity with the major concepts, theoretical perspectives, empirical findings, and historical trends in [psychology, physics, etc.].	a. <u>use</u> of the concepts, language, and major theories of the discipline to account for psychological phenomena. b. <u>apply</u> physical principles to explain, analyze, and predict a variety of natural phenomena.
	... understand and apply basic research methods in [psychology, physics, etc.], including research design, data analysis, and interpretation.	a. <u>design and conduct</u> basic studies to address psychological questions using appropriate research methods. b. <u>take physical measurements</u> in an experimental laboratory setting and analyze these results to draw conclusions about the physical system under investigation
	... communicate effectively.	a. <u>Write effectively</u> following professional writing conventions [in psychology] appropriate to purpose and context. b. <u>clearly explain</u> their mathematical and physical reasoning, in writing [physics].

PLO attribute #2. A **comprehensive** set of program learning outcomes will be different at the undergraduate and graduate levels and should be written at the appropriate level for each of the degrees offered.

A **comprehensive set of PLOs for undergraduate programs** should

- reflect national disciplinary standards;
- include, in addition to the disciplinary knowledge and skills, one or more “general skills” domains such as written communication or critical thinking skills (Table 2).

Because upper-division students continue to develop a range of general education skills in an integrated course of study in their major, PLO statements should also articulate faculty's expectations for such skills as written communication and collaborative skills as relevant to their discipline and the program's curriculum.

Table 2 shows **examples** of PLO statements that fall in the disciplinary domains (knowledge, research/creative skills, professional ethics), followed by UCSC's general education domains that are relevant to a hypothetical example of a psychology major.

Table 2
Institutional Domains for Undergraduate Education at UCSC and examples of Program Learning Outcomes for a "Psychology" major *(not based on the actual UCSC Psychology program)*

Domains	PLOs Students graduating with a BA degree in "Psychology" will be able to
Disciplinary knowledge	<u>use</u> the concepts, language, and major theories of the discipline to account for psychological phenomena
Research, creative or performance skills	<u>design and conduct</u> basic studies to address psychological questions using appropriate research methods
Ethical professional standards	<u>explain</u> ethical issues relevant to psychological research
Examples of general education skills that may be further developed in a major	
Quantitative reasoning	<u>statistically analyze</u> psychological research data
Writing skills	<u>demonstrate effective writing skills</u> following professional writing conventions in psychology appropriate to purpose and context
Oral communication skills	<u>deliver effective oral presentations</u> on psychological topics
Information literacy skills	<u>conduct</u> literature reviews in psychology
Critical thinking skills ²	<u>evaluate</u> research findings and assumptions, including one's own, in exploring a particular psychological topic
Multicultural competencies	<u>incorporate</u> sociocultural factors in development of research questions, design, data collection, analysis, and interpretation
Responsive citizenship, environmental sustainability	<u>evaluate</u> different perspectives on the environment, society and technology as they impact the study of human behavior
Collaborative skills	<u>work with others</u> in a respectful and productive manner

² Skills and attitudes in the broad domain of "critical thinking" can be articulated in many ways specific to the discipline including "skills for textual analysis and interpretation," "capacity for formal reasoning and problem-solving," "appreciation for the arts as ways to create and communicate meaning" (UCSC's Institutional Learning Outcomes).

It is possible that two or more outcomes can be specified within any given domain, but overall it is probably not realistic to have more than 8 PLOs. Table 2 is designed to assist faculty in developing a set of PLOs with a comprehensive scope rather than to limit possible program outcomes to the domains listed in this table.

Developing PLOs with a comprehensive scope is also institutionally useful. When undergraduate programs' learning outcomes cover, or are aligned with more general outcomes, it is possible to aggregate program-level analyses of competencies developed by UCSC graduates across programs and thus conduct an institutional level of assessment.

A comprehensive set of PLOs for graduate programs might include the following domains, depending on the curriculum and mission of the program:

- Fundamental disciplinary knowledge and/or interdisciplinary approach;
- Research skills: experimental, computational, theoretical;
- Scholarship: ability to conduct independent and innovative research (and/or apply an interdisciplinary approach);
- Communication skills in a variety of formats (oral, written) and to expert and non-expert audiences;
- Ethical standards of professional conduct and research;
- Teaching skills;
- Other professional skills such as collaborative skills, ability to write grants and articles for scholarly journals if it is taught by faculty in the department.

EXAMPLE OF DOCTORAL PROGRAM LEARNING OUTCOMES

Graduates of the Quantitative and Systems Biology PhD program will demonstrate:

1. Knowledge and understanding of quantitative (statistical, computational, and model dependent) and high-throughput experimental systems approaches to biological problems, and an ability to conceive, plan, execute and/or interpret the applications of these approaches to research questions.
2. Knowledge and understanding of ethical standards in proposing and executing professional scientific research.
3. Ability to effectively assist in the teaching of science in a classroom environment,
4. Ability to engage in effective communication of original and existing scientific inquiry and results orally and in writing.
5. Ability to undertake and demonstrate original scholarship in specialized areas of biology, including integrative command of historical and current literature and broader scientific context, and identification of open research problems.
6. Ability to execute, complete and defend original research that advances scientific knowledge.³

³ This set of PLOs was adapted from UC Merced.

If a department offers Master's and Ph.D. programs, each program should have a separate set of PLOs with a relevant level of competency and a relevant assessment plan (please see an example in Section VII).

PLO attribute #3. A **measurable** program learning outcome is articulated in a way that clearly indicates/describes how students can demonstrate their learning. This can help students contextualize what they are learning. It also indicates to faculty what evidence they need to collect to evaluate the outcome.

To ensure that PLOs are **measurable**, it is useful to:

- use active verbs and avoid using phrases like “*understand*” and “*know*” without specifying how students can demonstrate their understanding or knowledge.
- use simple language and avoid overly detailed statements.
- be specific. For example, “Students will be able to use the concepts, language, and major theories of the discipline to account for psychological phenomena” is specific compared to the more vague statement, “Students will know the concepts, language, and major theories of the discipline.”
- differentiate between the learning processes and learning outcomes, e.g., “Graduates will complete a thesis” is not a learning outcome.⁴ Also, some outcomes speak about the undergraduate program's overall quality, e.g., “Students will apply and be admitted to graduate school.” However, outcomes like this are not “learning outcomes” defined in terms of knowledge, skills, and values, and should not be included among the PLO statements.
- consider using an “or” to draft an outcome for programs with optional tracks, e.g., “Students will be able to analyze works of art or will be able to create works of art.”
- avoid compound outcomes, that is statements that will require different lines of evidence. A statement “Students will be able to write and speak effectively” contains two outcomes. Sometimes multiple verbs in an outcome can be eliminated if they are redundant or less important.
- consider the type of projects/assignments students are required to do that ask them to demonstrate they can think/act as a physicist, linguist, musician, that is in accordance with their disciplinary training as specified in a PLO. Existing assignments in advanced courses can be used/revised to assess a PLO. In undergraduate programs, senior year projects (papers, research reports, art work) allow students to demonstrate the most advanced level of their skills and knowledge. In graduate programs a qualifying exam, a dissertation proposal defense, and a dissertation provide such opportunities for faculty to measure PLOs.

⁴ The tips on writing quality program outcomes are adapted from ALA's handout by Mary Allen.

IV. Aligning PLOs with the Curriculum: Create a Curriculum Map

Once Program Learning Outcomes have been drafted, the second step in the assessment process is to consider the extent to which each of these outcomes is aligned with the required curriculum. This helps to clarify for the students and for faculty the relationship between what students do in their classes and other core parts of the curriculum, such as field study, theses, qualifying exams, etc., and the faculty's expectations for what students are supposed to learn and be able to do as a result of earning a degree in their program(s). The ultimate purpose is to ensure that students are provided with opportunities to learn and to develop increasing sophistication with respect to each outcome.

What is a Curriculum Alignment Matrix?

A curriculum alignment matrix is required for all undergraduate programs, all masters programs, and is encouraged for doctoral programs. A curriculum matrix is simply a table with one column for each Program Learning Outcome and one row for each required course or activity.

In addition to courses, other required events/experiences may be included. For undergraduates these could include internships, departmental symposium, advising sessions, etc. For graduate programs curriculum alignment matrices may also include the thesis or equivalent project, teaching requirement, research training (lab rotation), and examinations.

An example of the matrix for a hypothetical undergraduate program is shown in Table 3. It is helpful to indicate, where appropriate, the level of competency students are expected to develop. The levels may be differentiated, for example, I=Introduced, P=Practiced, D=Demonstrated, as indicated in Table 3 below. **The courses marked with "D" indicate the opportunities for faculty to gather evidence of student learning.** Table 3 is based on a program with one path to the degree. For a program with multiple paths to the degree courses could be grouped by track.

Table 3
Hypothetical example of undergraduate PLOs that are well aligned with the curriculum

Courses	Program Learning Outcomes (PLOs)					
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6
10 Introduction to Sociology	I	I	I	I	I	I
15 Issues and Problems		I				
30 World Society		I				
100 Statistical Methods	P		P	P		
105 Logic and Methods of Social Inquiry	P		P	P		

Courses	Program Learning Outcomes (PLOs)					
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6
<Upper division course 1>		P		P		P
<Upper division course 2>		D			P	P
Internship					P	D
Capstone Course	D		D	D	D	

A sample PhD program curriculum is shown in Table 4. Faculty indicate with an “X” a specific PLO that students develop in the required components of the program (i.e., courses, written proposals, research products, exams). Marked with an “A” are the program’s required components that ask students to demonstrate their proficiency in a given outcome. Thus the matrix becomes helpful for planning data collection for each outcome. For example, if the faculty plan to assess one or more outcomes based on a dissertation proposal (one of the program requirements), they include it in the matrix with a special marker “A”=assessment evidence collected.

Table 4
Hypothetical example of doctoral PLOs that are well aligned with the curriculum

PhD Requirements	PhD Program Learning Outcomes (PLOs)				
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5
Required course: Research Methods	X		X	X	
Required Course: Theory		X		X	
Seminar Requirements		X		X	
TA training workshop					X
Teaching own section/course					A
Qualifying Exam		X, A		X, A	
Comprehensive Exam	X	X			
Dissertation proposal	X, A		X, A	X	
Dissertation Defense	X, A		X, A	X	

How to create a curriculum matrix

- 1) The best practices approach is to send a curriculum matrix with the drafted PLOs to all faculty members who teach students in courses, fieldwork, workshops and/or engage them in their research projects/serve as thesis advisers. Faculty have the opportunity to indicate which of the outcomes each of their courses address, and at what level (Introduced, Practiced, or Demonstrated). If course objectives/learning goals are specified in syllabi, they can be useful for filling out the matrix, but the course objectives/goals do not need to be identical to the program level outcomes.
- 2) Based on the matrices completed by individual faculty, a program curriculum alignment matrix, as shown in Tables 3 and 4, with one course or other key component of the curriculum per row can be completed.
- 3) The final step shown in Table 3 is to determine that for all or most outcomes, undergraduate students have an opportunity to practice (indicated as "P") and to demonstrate (as "D") their proficiency. The program curriculum matrices are useful for developing an assessment plan. For undergraduate programs, courses marked with "D" provide an opportunity for faculty to collect assessment data. For graduate program, such opportunities are indicated with "A" (Table 4).

The process of constructing the program matrix may reveal the following issues:

- a disagreement among instructors teaching the same course regarding the PLOs this course should address,
- no opportunity for undergraduate students to practice and/or demonstrate a particular PLO,
- one or more required courses do not address any of the PLOs;
- one or more PLOs are not regularly taught by the department faculty either in courses, workshops, or collaborative projects.

This analysis of the PLO-curriculum alignment may serve several purposes, one of which is to introduce the entire faculty to PLOs and engage in a discussion of the PLOs' relationship to courses, assignments, and pedagogy. When faculty discuss how to address the issues they identified in this process of aligning the PLOs with the curriculum, they may want to revise a course syllabus and/or revise program outcomes. By doing this, they engage in assessment that improves the quality of teaching and learning in their program.

Also, the extent to which each outcome is supported by the curriculum (the number of courses in which it is practiced) may provide valuable insights into its relative

importance, as well as into what levels of proficiency can be expected from the graduating seniors that are consistent with the curriculum.

How to use the curriculum matrix to communicate PLOs to students and faculty

Departments are encouraged to publish the curriculum matrix and distribute it to students and faculty. The visibility of PLOs and the program's coherence may be improved by encouraging each faculty member to make explicit connections across courses for the students. For example, at the beginning of the course or unit, a faculty member can remind students what they were introduced to in another course and explain how the current course will have them practice or expand their knowledge. This can reinforce for students the overarching objectives of their program of study, and help them assess their own progress.

V. Planning Assessment

Assessment of Program Learning Outcomes involves collecting and evaluating evidence of whether students are learning what the faculty intend, and at what level. There are two main types of evidence that are used in assessment: direct evidence that evaluates students' actual work using faculty specified criteria; and indirect evidence such as students' self-reported skills, competencies, and learning gains that may be collected on surveys or in other formats. Faculty will need to identify both types of evidence they will use to evaluate each of their PLOs, and make a plan for when and how they will conduct their assessments.

In this section the following are discussed:

- a) Sources of direct evidence
- b) Tools to analyze direct evidence (analytic rubrics)
- c) Why grades and graduation rates are not useful for PLO assessment
- d) Sources of indirect evidence
- e) Formative, summative, and course-level assessment
- f) How to develop a multi-year assessment plan

A. Sources of Direct Evidence

Direct evidence of student learning results from evaluating students' work along a set of criteria determined by the faculty, and aligned with each of the Program Learning Outcomes. A best practices approach is to use assignments that students are already doing as part of a required course or program. Assignments that ask students to approach a real-life situation/task as a person with disciplinary training usually provide better evidence of student competencies than exams. For example, you may consider projects/assignments that ask students to demonstrate they can think/act as a physicist, linguist, musician, that is in accordance with their disciplinary training as specified in a PLO.

Because the goal of assessment is to provide insights into how programs can be improved, assessment focuses on students as a group and is not intended to assess and provide feedback to individual students in the program. (However, it is possible for faculty in relatively small undergraduate and graduate programs to collect evidence from, and provide feedback to all students in their courses and/or programs if they wish).

Three main sources of direct evidence are: embedded assignment, capstone experiences, and portfolios.⁵

⁵ For more information please see Allen 2004: 87; Suskie 2009: 27.

An embedded assignment is a graded assignment that allows measuring a specific PLO and is included in individual course(s) aligned with that PLO. Embedded assessments may use an existing assignment that aligns well with one or more PLOs, a brand new assignment designed by faculty collectively, or a modification of an existing assignment. It can be an essay, laboratory experiment, art work, presentation, game invention, research proposal to address a problem, case study, etc. Such assignments are more meaningful to both students and faculty because they serve as opportunities for students to learn. Whenever possible, it is recommended to collect evidence for assessment across courses taught by multiple instructors (simultaneously or in different quarters), and all instructors should use the same assignment or an analogous assignments aligned with a given PLO.

Moreover, assessment evidence can be collected from a short essay question, a set of multiple choice questions, or problems designed to measure a specific PLO and embedded in the final exam. In graduate programs, all or some problems/parts of the QE can be identified that align with a PLO and assessed.

Capstone experiences (e.g., senior research projects, recitals, exhibitions, Master's thesis, doctoral dissertation) are particularly valuable sources of direct evidence for program assessment because they challenge students to integrate and apply what they have learned over the course of their studies. Senior research or creative projects can provide evidence on more than one PLO such as written communication, critical thinking, information literacy, and research skills.

An individual student portfolio contains several student papers and/or projects. For example, faculty may ask students in their major to keep assignments completed in the course of their senior year for their portfolio. Individual students will assemble/design their portfolios according to the faculty guidelines built around PLOs, that is each selected assignment should demonstrate a student's best performance related to a PLO. Students themselves select their best assignments for inclusion in a portfolio. Each of the selected assignments could, for example, demonstrate one of the following skills: research skills, writing skills, and ability to apply disciplinary knowledge to solve a problem. Faculty may also ask to include an assignment that students found the most challenging and from which they learned the most. Faculty develop criteria to evaluate each PLO using a sample or, in small majors, all of the individual student portfolios. Although electronic media led to creation of "e-portfolios" for program assessment, success of this method depends on engagement of the entire faculty in careful planning, and student interest in creating such portfolios if they are not required for graduation and/or are not helpful for post-graduation job search.

B. Tools to analyze direct evidence: Analytic rubrics

A key advantage of collecting direct evidence is specifying criteria or traits that would indicate student's mastery of a particular skill or knowledge. The criteria are articulated in a rubric that is then used to evaluate student work or performance demonstrating mastery of the PLO. A typical rubric specifies criteria that would indicate four levels of student proficiency: exceeded faculty's expectations, met expectations, almost met expectations, and failed to meet expectations. The data collected using the rubric will inform the faculty about a proportion of students in the program who have met or exceeded their expectations in regard to every PLO. It will also reveal a proportion of students who almost met or failed to meet faculty's criteria for mastering this outcome. Criteria articulated in a rubric will serve as a guide to identifying areas in the curriculum or aspects of learning that need faculty's attention. In order to be useful for program improvement, the criteria should be designed so that not all students "meet expectations." If all students always meet or exceed expectations, the rubric will not be able to provide any guidance for how to further improve the program.

Rubrics can be used for evaluating almost any product or behavior such as essays, research reports, senior theses, works of art, oral presentations, video clips, collaborative work, recitals, dissertations, QE, etc. There are two types of rubrics: holistic and analytic.⁶ In these Guidelines we describe an analytic rubric as the more frequently used type.

An analytic rubric can be designed to evaluate from one to three PLOs. For each PLO it will specify different aspects and criteria used to evaluate a student product. Many rubrics have already been developed, especially for assessing general skills such as writing skills, oral communication, teamwork etc., and can be made available to our faculty as a starting point.⁷ Any rubric designed for assessment can be adapted for grading assignments as well.

In a rubric faculty articulate what is meant by, for example, a PLO statement "Student will be able to deliver an effective oral presentation." Faculty may decide that an effective presentation has three dimensions: organization, content, and delivery. For each of these dimensions, they articulate their expectations for several (usually four) levels of competency. Table 5 shows an example of an assessment rubric—an analytic rubric with three dimensions for assessing oral presentation skills (one PLO).

⁶ For details, see Allen (2004: 138).

⁷ Please contact Dr. Anna Sher (asher@ucsc.edu) for examples of the available rubrics and for strategies to adapt them to specific PLOs.

Table 5
Rubric for Assessing Oral Presentations

	Below Expectations	Almost meets Expectations	Meets Expectations	Exceeds Expectations
Organization	No apparent organization. Evidence is not used to support assertions.	There is some organization, but the speaker occasionally goes off topic. Evidence used to support conclusions is weak.	The presentation has a focus and provides some reasonable evidence to support conclusions.	The presentation is carefully organized and provides convincing evidence to support conclusions.
Content	The content is inaccurate or overly general. Listeners are unlikely to learn anything or may be misled.	The content is sometimes inaccurate or incomplete. Listeners may learn some isolated facts, but they are unlikely to gain new insights about the topic.	The content is generally accurate and reasonably complete. Listeners may develop a few insights about the topic.	The content is accurate and comprehensive. Listeners are likely to gain new insights about the topic.
Delivery	The speaker appears anxious and uncomfortable and reads notes, rather than speaks. Listeners are ignored.	The speaker occasionally appears anxious or uncomfortable, and may occasionally read notes, rather than speak. Listeners are often ignored or misunderstood.	The speaker is generally relaxed and comfortable. Listeners are generally recognized and understood.	The speaker is professional, relaxed, and comfortable and interacts effectively with listeners.

C. Course Grades, GPA, Graduation Rates vs. Direct evidence

A rubric-based assessment yields a different kind of evidence than grades or standardized tests: it is based on very specific criteria collectively determined by faculty teaching in the program and does not involve comparing student performance to one another. This makes a rubric-based assessment criterion-referenced rather than norm-referenced.

Course grades do not provide specific information needed for program improvement, which is the goal of assessment. One cannot determine to what extent students have mastered each of the PLOs based on a course grade distribution or seniors' GPA. Even if a course is designed to address a specific PLO, the course grading system is usually based on much more than demonstration of that particular skill: rather it is based on a gradual attainment of that skill in the duration of the course. Course grades often include other factors such as student in-class participation, attendance, timely submission of homework assignments, etc.

Graduation rates, GRE scores (of graduating seniors), grants and fellowships awarded to students, rates of graduate school admission and job placements provide valuable information about the overall quality of the program and are part of the program review process. However, these data do not provide specific information about student mastery of specific program learning outcomes.

It is possible to combine assessment and grading in embedded course assignments or the QE. Faculty can use a rubric they develop for collecting assessment evidence in grading these assignments. But a rubric can also have a limited focus (on one PLO) and does not have to cover all aspects of the assignment relevant to grading.

D. Sources of indirect evidence

Students' self-reported competencies and skills can provide valuable indirect evidence for evaluating PLOs. UCSC's Institutional Research conducts two student surveys on alternate years: UCUES survey of undergraduates and the UCSC Graduate Student Survey. Additionally, some departments may have their own surveys of students. Indirect evidence may also be collected from student reflection papers and self-evaluations. As with direct evidence, survey questions or an assignment for a reflection paper should be aligned with each of the PLOs.

All undergraduate students at UCSC are invited to participate in the University of California Undergraduate Experience Survey (**UCUES**), an online census survey administered every other year in Spring quarter. The campus-wide response rate is about 34%. In addition to student educational experiences in their major, the survey collects data on students' self-reported competencies and skills. Specifically, it includes:

- understanding of <Physics, Psychology, etc.> as a field of study,
- quantitative (mathematical and statistical) skills,
- analytical and critical thinking skills,
- ability to be clear and effective when writing,
- ability to read and comprehend academic material,
- foreign language skills,

- ability to speak clearly and effectively in English,
- ability to prepare and make a presentation,
- ability to appreciate the fine arts,
- ability to appreciate cultural and global diversity,
- computer skills,
- internet skills,
- library research skills,
- other research skills.

UCSC's Institutional Research prepares major-specific reports that include self-reported competencies and skills for seniors as well as comparative data for seniors in related majors across UC and other UCSC seniors in the same academic division.

The UCUES-based major reports provide indirect evidence on most, but probably not all PLOs in any given program. When planning assessment, it is helpful to review the major-specific UCUES report to identify the PLOs for which indirect evidence is available and those PLOs that are not covered by the UCUES or a department survey. In the case when indirect evidence needs to be collected for one or several PLOs, a couple of survey questions or a reflection essay may be embedded in relevant courses or the capstone experience. Similar to embedded assignments used to collect direct evidence, self-ratings or reflection papers should be administered in the year of the assessment study although they could become a permanent part of the course. In sum, we do not anticipate faculty needing to create an entire survey to collect indirect evidence for undergraduate programs.

The UCSC Graduate Student Survey is an online biennial census survey of all graduate students enrolled in winter or spring quarter. The campus-wide response rate is over 50%. In addition to student educational experiences in their program, the survey collects information on student self-reported level of preparation to engage in the following:

- conduct independent research/scholarship,
- teach undergraduate or graduate students,
- write proposals to obtain funding,
- write scholarly articles for publication,
- adhere to research and/or professional ethics,
- make a presentation to non-academic audiences,
- make a presentation to academic audiences,
- work with people of varied educational levels, and
- work with people from diverse backgrounds.

UCSC's Institutional Research prepares program-specific reports that include self-reported competencies as well as comparative data for other doctoral students in this academic division.

E. Formative, summative, and course-level assessment

Throughout this document we have focused almost exclusively on evaluating student achievement of PLOs at the end of their studies in the program. This approach is called "summative assessment" and is distinguished from "formative assessment" conducted to evaluate student *progress* in the program. If faculty are interested in understanding the student's beginning level and the extent to which students enhance their skills and knowledge by the time of program completion, formative assessment of PLOs can complement summative assessment. If the formative assessment of one or more PLOs is of interest to faculty, it should be part of a multi-year assessment plan for that PLO. In undergraduate programs, direct evidence for formative assessment can be collected in the lower-division courses and/or at the beginning of the upper-division courses. In doctoral programs, formative assessment of PLOs can be done at the QE and summative assessment of the same PLOs at the dissertation defense.

While this document has focused on Program Level Outcomes, some faculty may be interested in evaluating the effectiveness or impact on student learning resulting from changes to the course content, teaching pedagogy, and/or the introduction of learning technologies. Assessment of course-level learning outcomes may be more relevant than the program-level. Course-level assessment follows the same six-step process as for PLO assessment, that is, it starts with articulating course learning outcomes, mapping outcomes against course assignments that help students achieve these outcomes, and identifying specific course assignments in which students can demonstrate their achievement for the purpose of collecting direct evidence. Please note that course learning outcomes should be consistent with one or more PLOs that were identified with that course on the program-level curriculum matrix.

F. How to develop a multi-year assessment plan

Developing a multi-year plan includes identifying the sources of direct evidence that students are learning what the faculty intend, where and when that data will be collected, how it will be evaluated, and how it can be used to inform faculty about their programs. Creating a multi-year plan to evaluate one or two PLOs per year will break assessment into small manageable pieces, and help ensure that it is regularized as part of departmental practices. Ultimately assessment is only useful if it provides meaningful feedback to faculty, students, and other stakeholders, and if the process itself is not overwhelming.

The guidelines for developing a plan are the following:

- A plan specifies an assessment process for each PLO. If several PLOs are assessed at the same time, a separate line of evidence should be collected for each PLO using articulated criteria.
- All PLOs should be assessed within 6 years (consistent with the program review cycle); however, the number of outcomes in any given year and their ordering depend on faculty's interests, capacity and time needed to collect credible data. For example, in small undergraduate programs and most graduate programs faculty may need to collect evidence on a given PLO from senior theses or dissertations over 2-3 years and then analyzed it.
- Evidence of undergraduate and master's students' competencies is collected close to the time of their graduation. In PhD programs it varies depending on the type of PLO. A curriculum matrix would indicate the courses/activities that provide opportunities for faculty to collect evidence of student proficiency in specific PLOs.
- The same type of student work (e.g., senior project, Master's thesis, dissertation proposal) can be used to collect direct evidence for more than one PLO either in the same year or subsequent years.
- Each assessment method should be carefully aligned with a PLO, including the type of assignment, assignment prompt/instructions and criteria (a rubric) used to evaluate student work.
- Student work used to evaluate a PLO should come from courses/sections taught by more than one instructor whenever possible.
- Two or more instructors should be involved in evaluating student work for the assessment purposes.
- While direct evidence can be collected from embedded assignments as part of grading (e.g., during the final exam, QE or oral presentation), samples of student work can be evaluated after students have finished their course of study.
- Names of students and instructors should be removed from sampled student work prior to being read for PLO assessment purposes.

The best practices approach is to plan annual assessment studies focused on specific PLOs. A careful planning is important for each part of the process including preparation for data collection (development of assignment prompts, rubrics) and data collection (sampling and evaluation of student work). Each step should be manageable as well as leading to collection of meaningful and credible data.

For the first year, it is reasonable to select one or two outcomes that faculty are most interested in or concerned about based on the already available evidence (e.g.,

student surveys, faculty experience) or based on recent changes in the curriculum or pedagogy. It might be an outcome that faculty feel most certain that their students are mastering. Another consideration is whether faculty need to design specific assignments to collect relevant evidence for the selected PLO(s): reviewing existing assignments or samples of senior projects could provide valuable insights into what outcome can be evaluated in the first year.

A multi-year assessment plan should describe the following components of the annual assessment studies (also illustrated in Table 6):

1. Year when the study will be conducted
2. Type of direct evidence that will be used for assessment for each PLO (e.g., final paper in an advanced course, exams, oral defense)
3. Type of indirect evidence (e.g., survey questions, focus groups).
4. Faculty to be engaged in adapting/creating assessment tools (assignments, rubrics) and data collection.
5. When evidence will be collected, analyzed and used to develop recommendations.

Table 6
Example/Template for a multi-year assessment plan for a “B.S. program in Physics”⁸

Year	PLO	Type of evidence and its source (note if it needs to be developed)	Population (who will be assessed)	Assessment approach & tools	When evidence will be collected	Analysis, report, recommendations
2013-14	PLO 4 Research proficiency	Direct evidence: Senior thesis	All graduating seniors	Several faculty (thesis supervisors & technical advisors) will assess student proficiency using a rubric to be developed in Winter 2014	Spring 2014	Fall 2014
		Student self-evaluation reported in UCUES Survey	Seniors who responded to survey	Major Report by Institutional Research	2012 & 2014 UCUES	
	PLO 5 Written communication	Direct evidence: Senior thesis	All graduating seniors	Several faculty (thesis supervisors & technical advisors) will assess student proficiency using a rubric to be developed in Winter 2014	Spring 2014	Fall 2014
		Student self-evaluation reported in UCUES Survey	Seniors who responded to survey	Major Report by Institutional Research	2012 & 2014 UCUES	
2014-15	PLO 3 Experimental techniques	Direct evidence: Lab reports	Students enrolled in PHYS 134 in Winter and Spring 2015	2 faculty will assess student proficiency using a rubric to be developed in Winter 2015	Winter & Spring 2015	Fall 2015
		Student self-evaluation reported in an In-class survey (to be created)		Faculty will analyze results of student self-evaluation		

⁸ PLOs are from the example on page 6.

Table 6 (continued)

Example/Template for a multi-year assessment plan for a “B.S. program in Physics”

Year	PLO	Type of evidence and its source (note if it needs to be developed)	Population (who will be assessed)	Approach to data collection & tools	When evidence will be collected	Analysis, report, recommendations
2015-16	PLO 2 Mathematical expertise	Direct evidence: Problems included in final exam	Students enrolled in PHYS 115,116 in Winter and Spring 2016	2-3 faculty will assess select problems using the standards articulated in Winter 2016	Winter and Spring 2016	Fall 2016
		Student self-evaluation reported in UCUES Survey	Seniors who responded to survey	Major Report by Institutional Research	2014 & 2016 UCUES	
2016-17	PLO 1 Physical principles	Direct evidence: Problems included in final exam	Students enrolled in PHYS 110,112 in Winter and Spring 2017	2-3 faculty will assess select problems using the standards articulated in Winter 2017	Winter and Spring 2017	Fall 2017
		Student self-evaluation reported in UCUES Survey	Seniors who responded to survey	Major Report by Institutional Research	2014 & 2016 UCUES	
2017-18	PLO 6 Teamwork	Direct evidence: collaboration in conducting laboratory experiments	Students enrolled in PHYS 134 in Winter and Spring 2018	Faculty will assess student skills based on their own observations and on students' evaluation of their collaborators (rubrics to be developed in Winter 2018)	Winter & Spring 2018	Fall 2018
		Student self-evaluation reported in an In-class survey (to be created)		Faculty will analyze results of student self-evaluation		

VI. Example of a curriculum matrix and a multi-year assessment plan for an undergraduate program

Here is a hypothetical example of a set of PLOs, a curriculum matrix, a multi-year assessment plan, and a description of each annual study.⁹

Program Learning Outcomes (PLOs)

Students graduating with a B.A. degree in Psychology will be able to

- PLO 1. Describe major concepts and theories in Psychology.
- PLO 2. Apply major concepts and theories in Psychology to describe or explain psychological phenomena.
- PLO 3. Design basic research studies in Psychology.
- PLO 4. Statistically analyze psychological research data.
- PLO 5. Explain ethical issues relevant to psychological research.
- PLO 6. Conduct literature reviews in psychology.
- PLO 7. Write papers in APA style.
- PLO 8. Give oral presentations on psychological topics.

Table 7
Curriculum Matrix

Courses	Program Learning Outcomes (PLOs)							
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
10 Intro	I	I	I	I	I	I	I	
20 Statistics			P	P				
100 Research methods	P	P	P	P, D	P			I
101 (biological bases of behavior), 102 (cognitive psychology), or 103 (learning), with a required lab	P	P	P, D		P		P	
110, 112, 115, 116: survey courses in developmental, social, and abnormal psych, and personality theory	P	P			P, D	P	P	
100-level electives	P, D	P, D				P		P
190: senior seminar	D	D	D	D	D	D	D	D

I=PLO is introduced, P=practiced, D=demonstrated.

⁹ This example is based on Mary Allen's ALA handouts.

Table 8
Assessment Plan Template (details of studies are provided below)

Year	Program Learning Outcomes	Type of evidence and its source (note if it needs to be developed)	Population	Approach to data collection & tools	When evidence will be collected	Analysis, report, recommendations
2013-14	PLO 6. lit review (information literacy skills)	Direct evidence: 190 project reports	Random sample of reports across 190 course sections (n=40)	Faculty will develop a rubric to assess the lit review section of the report	Spring 2014	Fall 2014
		Student self-evaluation based on Major Survey questions	Seniors who responded to the survey	Comparative analysis by Institutional Research	Spring 2012 & 2014	
	PLO 7. writing skills, APA style	Direct evidence: 190 project reports	Random sample of reports across 190 course sections (n=40)	Faculty will develop a rubric to assess the research findings section of the report	Spring 2014	Fall 2014
		Student self-evaluation based on Major Survey questions	Seniors who responded to the survey	Comparative analysis by Institutional Research	Spring 2012 & 2014	
2014-15	PLO 3. research design	Direct evidence: 1. Embedded exam questions in 101, 102, and 103 courses 2. 190 project reports	1. All senior students in 101, 102, 103 2. Random sample of reports across 190 course sections (n=40)	Faculty will develop 1. Standards to evaluate exam questions 2. A rubric to assess the research design section of the report	Spring 2015	Fall 2015
		Survey questions embedded in 101, 102, and 103 courses	All senior students in 101, 102, 103 courses	Faculty will analyze results	Spring 2015	
	PLO 4. statistical analysis	Direct evidence: • Embedded exam questions in 100 course • 190 project reports	1. All senior students in 100 2. Random sample of reports across 190 course sections (n=40)	Faculty will develop 1. Standards to evaluate exam questions 2. A rubric to assess the quantitative analysis section of the report	Spring 2015	Fall 2015
		Student self-evaluation based on Major Survey questions	Seniors who responded to the survey	Comparative analysis by Institutional Research	Spring 2012 & 2014	

Year	Program Learning Outcomes	Type of evidence and its source (note if it needs to be developed)	Population	Approach to data collection & tools	When evidence will be collected	Analysis, report, recommendations
	PLO 5. research ethics	Direct evidence: 1. Embedded exam questions in 110, 112, 115, and 116 courses 2. 190 project reports	1. All senior students in 110, 112, 115 or 116 2. Random sample of reports across course sections (n=40)	Faculty will develop 1. Standards to evaluate exam questions 2. A rubric to assess the research design section of the report	Spring 2015	Fall 2015
		Survey questions embedded in 110, 112, 115, and 116 courses	All senior students in 110, 112, 115 or 116 courses	Faculty will analyze results	Spring 2015	
2015-16	PLO 1. describe concepts and theories	Direct evidence: Essay questions embedded in the midterm exams in sample of upper-division courses	All senior students	Faculty will develop a rubric to evaluate essay questions	Spring 2016	Fall 2016
		Student self-evaluation based on Major Survey questions	Seniors who responded to the survey	Comparative analysis by Institutional Research	Spring 2014 & 2016	
	PLO 2. apply concepts and theories	Direct evidence: Essay questions embedded in the final exams in sample of upper-division courses	All senior students	Faculty will develop a rubric to evaluate essay questions	Spring 2016	Fall 2016
		Student self-evaluation based on Major Survey questions	Seniors who responded to the survey	Comparative analysis by Institutional Research	Spring 2014 & 2016	
2016-17	PLO 8. oral communication skills	Direct evidence: 190 project presentations	All presentations across 190 course sections	Faculty will develop a rubric to evaluate oral presentations	Spring 2017	Fall 2017
		Student self-evaluation based on Major Survey questions	Seniors who responded to the survey	Comparative analysis by Institutional Research	Spring 2014 & 2016	

Design details for annual studies in the example assessment plan template (Table 8 above)

2013/14 Study 1. *Information Literacy and Written Communication*

To assess each of the two PLOs (6 and 7), faculty will collect direct and indirect types of evidence. In 190 senior seminar students complete a research project summarized in a formal APA-style research report that includes a literature review, discussion of the research design, relevant research ethics, discussion of findings, and is presented orally.

Faculty will collect **direct evidence** by evaluating two sections of student project reports sampled from the reports completed for 190 seminar. In Winter 2014 faculty teaching 190 seminar will develop **one analytic rubric** with two parts: one part will assess students' information literacy skills as demonstrated in the literature review section of student project reports, and another - their writing skills in the discussion of findings section. As a basis for developing their own rubric faculty will discuss their concerns and expectations related to these PLOs, identify key traits in student work that would allow them to gather meaningful data, and set their standards for evaluating each PLO. They will review the available VALUE rubrics¹⁰ as a starting point for creating their own rubric. They will pre-test the rubric using a small sample of student projects from previous years (to establish face validity).

At the end of the academic year, faculty will randomly select 10 student projects from each of the four senior seminar sections taught in Spring 2014. They will remove students' and instructors' names. Four instructors who taught the seminar will use the rubric to evaluate the two parts of selected reports (literature review and discussion of findings). A random subsample of the 40 student projects will be read by two instructors to ensure inter-rater reliability. Data collected on each outcome will be recorded and analyzed separately.

The second line of evidence, **indirect evidence** will be collected in the major survey in Spring 2014. The campus' Institutional Research administers a survey every other year where students self-report their writing skills, both their current level and starting level at this university. Similarly, students are asked to rate their skills for conducting library research. A major-specific report is provided by Institutional Research that contains the findings for senior Psychology students who took the survey in 2012 and 2014. Faculty will examine self-reported "graduating" levels of two cohorts of seniors and also compare Psychology majors' skills with two groups of seniors who took the survey: their counterparts in similar psychology programs at other institutions, and other Social Sciences majors at the university.

¹⁰ A "VALUE rubric" refers to a set of rubrics for assessment of undergraduate education that contain criteria developed by diverse teams of faculty as part of the AAC&U Essential Learning Outcomes initiative.

Direct and indirect evidence on each outcome will be presented to the undergraduate committee charged with developing recommendations for improvement in teaching these skills and for revisions in the assessment of these skills.

2014/15 Study 2. *Research Methodology*

Faculty will collect two lines of direct evidence for each PLO 3, 4, and 5. One line of direct evidence will be collected using embedded multiple choice questions in final exams. For each outcome, a group of 2-3 faculty teaching the relevant courses will be formed to review the existing final exam questions and identify/develop a set of 5 questions allowing students to demonstrate their mastery of research methodology on the final exam. Each group will determine the standards for four levels of competency on each PLO. For example, for a given PLO, if a student has 0%-33% correct answers, she does not meet expectations; 34%-66% needs improvement; 67% - 86% meets expectations; 87% - 100% exceeds expectations. Data will be collected on each outcome as part of the grading of the final exam; however, it will be recorded and analyzed separately from the exam grades.

The second line of direct evidence will be based on 190 senior project. Specifically, to assess each of the three PLOs related to methodology, faculty will develop **one analytic rubric** and use it to collect evidence from a sample of student projects. The study design will be similar to that used to evaluate PLOs 6 and 7: faculty will randomly select 10 student projects from each of the four senior seminar sections taught in Spring 2015. Instructors who taught the seminar will use the rubric to evaluate the relevant parts of selected reports (research design, ethics, statistical analysis) with names of students/instructors removed.

Indirect evidence for PLO 4 will be collected from the major survey that asks students to self-report their quantitative and statistical skills, both their current and starting levels. A major-specific report is provided by Institutional Research that contains the findings for senior Psychology students who took the survey in 2012 and 2014. Faculty will examine self-reported "graduating" levels of two cohorts of seniors and also compare Psychology majors' skills with two groups of seniors who took the survey: their counterparts in similar psychology programs at other institutions, and other Social Sciences majors at the university.

Indirect evidence for PLO 3 and 5 will be collected in upper-division courses. Faculty will include questions asking students to rate their level of understanding of professional ethical code and their proficiency in designing research studies in Psychology.

Direct and indirect evidence on each outcome will be presented to the undergraduate committee charged with developing recommendations for improvement in teaching these skills and for revisions in the assessment of these skills.

2015/16 Study 3. *Disciplinary knowledge*

Faculty teaching upper-division courses will review existing short essay questions in a midterm and a final exam in a sample of upper-division courses and identify/develop two assignments that would allow students to demonstrate their ability (1) to describe concepts and theories in Psychology and (2) to apply concepts and theories. They will develop **one analytic rubric** to evaluate students' knowledge of and ability to apply these concepts and theories. Instructors will use this rubric to grade the short essay questions. In part, this assessment will be formative because faculty will be looking for evidence of improved understanding between the midterm and the final exam.

Indirect evidence for PLO 1 and 2 will be collected from the major survey that asks students to self-report their understand of Psychology as a field of studies, both their current and starting levels. A major-specific report will provide the survey findings for senior Psychology students who took the survey in 2014 and 2016. Faculty will examine self-reported "graduating" levels of two cohorts of seniors and also compare Psychology majors' skills with two groups of seniors who took the survey: their counterparts in similar psychology programs at other institutions, and other Social Sciences majors at the university.

2016/17 Study 4. *Oral Communication*

To assess PLO 8, faculty teaching 190 seminar will collect direct evidence by using an "oral communication" rubric to evaluate all students' oral presentations during their in-class presentations. They will use a VALUE rubric on Oral Communication as a starting point for developing their own analytic rubric.

Indirect evidence for PLO 8 will be collected from the major survey that asks students to self-report their oral communication skills, both their current and starting levels. A major-specific report will provide the survey findings for senior Psychology students who took the survey in 2014 and 2016. Faculty will examine self-reported "graduating" levels of two cohorts of seniors and also compare Psychology majors' skills with two groups of seniors who took the survey: their counterparts in similar psychology programs at other institutions, and other Social Sciences majors at the university.

VII. Example of a curriculum matrix, assessment plan and analytic rubrics for a graduate program

In graduate programs, assessment is done by faculty usually during the required assignments (such as the QE, first year exam, required course, Master's thesis, or dissertation defense), using specially designed rubrics and is different from assigning a grade.¹¹ Each outcome is assessed separately but several outcomes can be evaluated in a given setting (i.e., QE).

Program assessment at major steps (QE, Master's thesis, dissertation defense) should be derived from existing standards, so that the different levels of achievement in the rubric are based on current criteria used for evaluation. However, the assessment rubric should be seen as separate from the determination of the grade or passing success of the student, as program assessment is aimed at program improvement. In order to be useful for improvement, the criteria in the rubric should be designed so that there will be some students who do not "meet expectations." If all students always meet or exceed expectations, the rubric will not be able to provide any guidance for how to further improve the program.

Completed rubrics (either by committee agreement or by individual committee members) should be collected by the department and evaluated when there are a sufficient number (annual in a larger program, every 2-3 years in a smaller program). The campus may consider integrating assessment in the QE form that is also sent to the Graduate Division.

An example of a complete package is the following hypothetical example for Applied Mathematics and Statistics. The program learning outcomes below are followed by curriculum matrices, PLO assessment plans, and assessment rubrics for a Master's project, a PhD Qualifying Exam, and a PhD dissertation and defense.

¹¹ For more information on recent developments in assessment of doctoral education, please see Maki and Borkowski (2006).

Table 9
M.S. and Ph.D. Program Learning Outcomes

M.S. graduates will demonstrate:

1. Proficiency with the fundamental knowledge in applied mathematics or statistics;
2. Ability to use analytical and computational methods to solve a problem;
3. Ability to apply mathematical or statistical methods to a real-world problem in an application area;
4. Ability to communicate concepts and results to those with or without subject matter knowledge.

Ph.D. graduates will demonstrate:

1. Mastery of the fundamental knowledge in applied mathematics or statistics;
2. Ability to use analytical and computational methods to solve a problem;
3. Ability to apply mathematical or statistical methods to a real-world problem in an application area;
4. Ability to communicate concepts and results to both other experts in the field and to people outside the field;
5. Ability to conduct independent research.

Table 10
Curriculum matrix for both M.S. and Ph.D. programs

	PLO1	PLO2	PLO3	PLO4	PLO5
	Fundamental Knowledge	Analytical Comp Methods	Application	Communicate	Research
AMS 203	x				
AMS 211	x				
Applied Math track:					
AMS 212A	x	x			
AMS 212B	x	x	x		
AMS 213	x	x	x		
AMS 214	x	x	x		
Statistics track:					
AMS 205B	x	x			
AMS 206B	x	x	x		
AMS 207	x	x	x		
AMS 256	x	x	x		
AMS 297/299		x	x	x	x
First-year Exam	A	A			
MS Project			A	A	
PhD Qualifying Exam			A	A	A
PhD Thesis and Defense			A	A	A

X= PLO is being introduced or developed

A=Students demonstrate PLO, and assessment evidence is collected

As shown in Table 11, **assessment in the doctoral program** will start with PLOs 3, 4, and 5. Faculty will collect direct evidence in the course of two years in two settings. The QE (written dissertation proposal and oral presentation) will provide a formative assessment of each of these PLOs, while the thesis document and defense provide a summative assessment of PLOs 3, 4, and 5. Examples of the analytic rubrics are provided on the next page. Indirect evidence for PLO 3 will be collected in a focus group discussion conducted by an analyst from Institutional Research. Indirect evidence for PLOs 4 and 5 is available from the Graduate Student Survey. The survey includes two questions relevant to PLO 4: student evaluation of their preparation to make a presentation to academic and non-academic audiences. Related to PLO 5 are the following four survey items: student evaluation of their preparation to (1) conduct independent research/scholarship, (2) write proposals to obtain funding, (3) write scholarly articles for publication, and (4) adhere to research and/or professional ethics.

In the second study faculty will focus on PLOs 1 and 2, collecting direct evidence as part of the first-year exam which provides an opportunity to evaluate the mastery of the fundamental knowledge, and the ability to use analytical and computational methods (PLOs 1 and 2). Indirect evidence for PLO 1 and PLO 2 will become available from the Graduate Student Survey starting in 2015 when it will include two questions asking students to evaluate their achievement of PLO 1 and PLO 2.

Table 11 shows an **assessment plan for the master's program**. Faculty will evaluate PLOs 3 and 4 based on a written Master's Project using an analytic rubric for a master's level. Indirect evidence for PLO 3 will be collected in a focus group discussion conducted by an analyst from Institutional Research. Indirect evidence for PLO 4 is available from the Graduate Student Survey. The survey includes two questions relevant to PLO 4: student evaluation of their preparation to make a presentation to academic and non-academic audiences. The first-year exam will provide an opportunity for faculty to evaluate students' proficiency with the fundamental knowledge, and the ability to use analytical and computational methods (PLOs 1 and 2). Indirect evidence for PLO 1 and PLO 2 will become available from the Graduate Student Survey starting in 2015 when it will include two questions asking students to evaluate their achievement of PLO 1 and PLO 2.

Table 11
PhD program assessment plan

Year	Program Learning Outcomes	Type of evidence and its source (note if it needs to be developed)	Population	Approach to data collection & tools	When evidence will be collected	Analysis, report, recommendations
2013-15	PLO 3 Application	Direct evidence: 1. QE 2. Dissertation Defense	All students	Analytic rubrics with specified standards for levels at the QE and Dissertation Defense	Fall 2013 through Spring 2015	Fall 2015
		Indirect evidence: Focus group	Advanced students in Spring 2015	A focus group conducted by an outside analyst (from Institutional Research)	Spring 2015	
	PLO 4 Communication	Direct evidence: 1. QE 2. Dissertation Defense	All students	Analytic rubrics with specified standards for levels at the QE and Dissertation Defense	Fall 2013 through Spring 2015	Fall 2015
		Self-evaluation based on Graduate Survey questions	Advanced students - survey respondents	Graduate Student Survey reports by Institutional Research	Spring 2013 & Spring 2015	
	PLO 5 Independent research	Direct evidence: 1. QE 2. Dissertation Defense	All students	Analytic rubrics with specified standards for levels at the QE and Dissertation Defense	Fall 2013 through Spring 2015	Fall 2015
		Self-evaluation based on Graduate Survey question	Advanced students - survey respondents	Graduate Student Survey reports by Institutional Research	Spring 2013 & Spring 2015	
2015-17	PLO 1 Mastery of the fundamental knowledge	Direct evidence: Embedded questions in first year exam	All students	Faculty will identify aspects relevant to PLO 1 and articulate standards	Fall 2015 through Spring 2017	Fall 2017
		Self-evaluation to be included in Graduate Student Survey in 2015	Advanced students - survey respondents	Graduate Student Survey reports by Institutional Research	Spring 2015 & Spring 2017	
	PLO 2 Analytical comp methods	Direct evidence: Embedded questions in first year exam	All students	Faculty will identify aspects relevant to PLO 2 and articulate standards	Fall 2015 through Spring 2017	Fall 2017
		Self-evaluation to be included in Graduate Student Survey in 2015	Advanced students - survey respondents	Graduate Student Survey reports by Institutional Research	Spring 2015 & Spring 2017	

Table 12
M.S. program assessment plan

Year	Program Learning Outcomes	Type of evidence and its source (note if it needs to be developed)	Population	Approach to data collection & tools	When evidence will be collected	Analysis, report, recommendations
2013-15	PLO 3 Application	Direct evidence: MS Project	All students	Analytic rubric with specified standards for MS level	Fall 2013 through Spring 2015	Fall 2015
		Indirect evidence: Focus group	All students	A focus group conducted by an outside analyst (from Institutional Research)	Spring 2015	
	PLO 4 Communication	Direct evidence: MS Project	All students	Analytic rubric with specified standards for MS level	Fall 2013 through Spring 2015	Fall 2015
		Self-evaluation based on Graduate Survey questions	Survey respondents	Graduate Student Survey reports by Institutional Research	Spring 2013 & Spring 2015	
2015-17	PLO 1 Proficiency with the fundamental knowledge	Direct evidence: Embedded questions in first year exam	All students	Faculty will identify aspects relevant to PLO 1 and articulate standards	Fall 2015 through Spring 2017	Fall 2017
		Self-evaluation to be included in Graduate Student Survey in 2015	Survey respondents	Graduate Student Survey reports by Institutional Research	Spring 2015 & Spring 2017	
	PLO 2 Analytical comp methods	Direct evidence: Embedded questions in first year exam	All students	Faculty will identify aspects relevant to PLO 2 and articulate standards	Fall 2015 through Spring 2017	Fall 2017
		Self-evaluation to be included in Graduate Student Survey in 2015	Survey respondents	Graduate Student Survey reports by Institutional Research	Spring 2015 & Spring 2017	

Analytic Rubrics

EVALUATION RUBRIC: Ph.D. Qualifying Examination (Written dissertation proposal and oral presentation)

Student's name _____

Applied Math or Statistics Track (please circle)

Date of the QE _____

Page 1 of 3

This rubric serves two purposes: it (1) collects data on each of the three program learning outcomes for program assessment and improvement, and (2) helps faculty provide students with supplemental feedback.

Collection of the program assessment data: The committee chair should ask the committee members to evaluate the student's achievement of each outcome as described in the rubric. Because the program assessment is focused on each of the listed outcomes and not on the individual student, it is important not to let the evaluation of one outcome influence the evaluation of the others. To facilitate this process, committee members are encouraged to record their evaluation as they are reading student's work and/or listening to the student by circling the appropriate cells and making notes if needed. After the oral presentation, the committee chair leads the discussion and fills in one rubric based on the evaluation that all/most committee members have agreed on. One copy of the rubric is returned to the program manager and another one is submitted to the Graduate Studies Division.

Program Learning Outcome	"Primary traits" that are evaluated	Does not meet expectations	Almost meets expectations	Meets expectations	Exceeds expectations
PLO3: Application of methods to solve problems	Selection of appropriate methods for the problem	Methods identified are insufficient or inappropriate	Methods address most but not all of the parts of the problem, or are not fully appropriate	Methods are appropriate and reasonably likely to produce a useful answer to the problem	Methods are appropriate and original, with significant adaptation to the particular problem
	Proper implementation plan of the methodology	Implementation plan lacks sufficient detail or is incorrect	Implementation plan omits some details or contains items of questionable accuracy	Implementation plan is sufficiently articulated and technically correct	Implementation is partially complete, fully correct, and producing useful preliminary results

Comments

Student's name _____

Program Learning Outcome	"Primary traits" that are evaluated	Does not meet expectations	Almost meets expectations	Meets expectations	Exceeds expectations
PLO4: Communication to both experts and non-experts	Technical communication, appropriate use of terminology	Oral presentation and/or written document lacks sufficient organization and clarity, or uses terminology or symbolic communication incorrectly or inappropriately, or does not communicate at a sufficiently technical level	Occasional problems with the use of terminology or symbolic communication, or the level of communication	Technical language and symbols are used correctly and appropriately, with sufficient technical detail; an expert would fully understand the concepts and most of the implementation	An expert would understand all of the concepts and (given sufficient time) be able to fully reproduce the results
	Understanding by a non-expert audience	Most components of the presentation and written document would not be understood by the outside member of the committee or by other graduate students	Roughly half the components of the presentation and some of the written document would be understood by the outside committee member or by other graduate students	Most components of the presentation and a reasonable amount of the written document would be understood by the outside committee member and by other graduate students	All but a relatively small number of highly technical pieces of the presentation and written document would be understood by the whole audience

Comments

Student's name _____

Program Learning Outcome	"Primary traits" that are evaluated	Does not meet expectations	Almost meets expectations	Meets expectations	Exceeds expectations
PLO5: Ability to conduct independent research	Research plan contains interesting and novel proposed work	The proposal lacks innovative content, or lacks a coherent or realistic plan for success	Ideas are marginally innovative but largely derivative or incremental, or the plan has questionable feasibility	Feasible plan to conduct research; proposed work contains innovative ideas	Feasible and well articulated plan to conduct research; proposed work is highly innovative and has the potential to make a large contribution to the field
	The student shows initiative and self-motivation in developing the research plan	The plan is largely developed by the advisor; the student doesn't exhibit ownership of the proposal	The student largely shows ownership of the proposal, but does not fully understand a piece of the work proposed by the advisor	The plan is jointly developed by the student and advisor with both contributing innovative ideas; the student shows conviction for the proposal during the presentation	The plan is largely developed by the student (with guidance from the advisor) and most innovative ideas originated with the student

Comments

EVALUATION RUBRIC: Ph.D. Thesis Defense (Written document and oral presentation)

Student's name _____

Applied Math or Statistics Track (please circle)

Date of the defense _____

Page 1 of 3

This rubric serves two purposes: it (1) collects data on each of the three program learning outcomes for program assessment and improvement, and (2) helps faculty provide students with supplemental feedback.

Collection of the program assessment data: The committee chair should ask the committee members to evaluate the student's achievement of each outcome as described in the rubric. Because the program assessment is focused on each of the listed outcomes and not on the individual student, it is important not to let the evaluation of one outcome influence the evaluation of the others. To facilitate this process, committee members are encouraged to record their evaluation as they are reading student's work and/or listening to the student by circling the appropriate cells and making notes if needed. After the oral presentation, the committee chair leads the discussion and fills in one rubric based on the evaluation that all/most committee members have agreed on. One copy of the rubric is returned to the program manager and another one may be given to the student.

Program Learning Outcome	"Primary traits" that are evaluated	Does not meet expectations	Almost meets expectations	Meets expectations	Exceeds expectations
PLO3: Application of methods to solve problems	Selection of appropriate methods for the problem	Methods used are insufficient or inappropriate	Methods address most but not all of the parts of the problem, or are not fully appropriate	Methods are appropriate and produced a useful answer to the problem	Methods are appropriate and original, leading to an innovative and useful answer
	Proper implementation of the methodology	Implementation is incomplete or is incorrect	Implementation contains items of questionable accuracy, or was insufficient to achieve a useful answer	Implementation is technically correct and produced a useful answer	Implementation is fully correct and produced results that will have an impact in the subject area

Comments

Student's name _____

Defense, Page 2 of 3

Program Learning Outcome	"Primary traits" that are evaluated	Does not meet expectations	Almost meets expectations	Meets expectations	Exceeds expectations
PLO4: Communication to both experts and non-experts	Technical communication, appropriate use of terminology	Oral presentation and/or written document lacks sufficient organization and clarity, or uses terminology or symbolic communication incorrectly or inappropriately, or does not communicate at a sufficiently technical level	Occasional problems with the use of terminology or symbolic communication, or the level of communication	Technical language and symbols are used correctly and appropriately, with sufficient technical detail; an expert would fully understand the concepts and most of the implementation	An expert would understand all of the concepts and (given sufficient time) be able to fully reproduce the results
	Understanding by a non-expert audience	Most components of the presentation and written document would not be understood by the outside member of the committee or by other graduate students	Roughly half the components of the presentation and some of the written document would be understood by the outside committee member or by other graduate students	Most components of the presentation and a reasonable amount of the written document would be understood by the outside committee member and by other graduate students	All but a relatively small number of highly technical pieces of the presentation and written document would be understood by the whole audience

Comments

Student's name _____

Program Learning Outcome	"Primary traits" that are evaluated	Does not meet expectations	Almost meets expectations	Meets expectations	Exceeds expectations
PLO5: Ability to conduct independent research	Novelty of research	The thesis lacks innovative content	The thesis is marginally innovative but largely derivative or incremental	The thesis contains well analyzed, clearly described, innovative research	The thesis is highly innovative and has the potential to make a large contribution to the field
	Student initiative and self-motivation in completing the research	The thesis follows a plan that was largely developed by the advisor; the student doesn't exhibit ownership of the research	The student largely shows ownership of the research, but does not fully understand a piece of the work done	The thesis contains innovative ideas developed by the student; the student shows conviction for the research during the presentation	Innovative research was largely developed and completed by the student (with guidance from the advisor)

Comments

EVALUATION RUBRIC: MS Project (Written document)

Student's name _____

Applied Math or Statistics Track (please circle)

Today's Date _____

Page 1 of 2

This rubric serves two purposes: it (1) collects data on each of the two program learning outcomes for program assessment and improvement, and (2) helps faculty provide students with supplemental feedback.

Collection of the program assessment data: The committee members should evaluate the student's achievement of each outcome as described in the rubric. Because the program assessment is focused on each of the listed outcomes and not on the individual student, it is important not to let the evaluation of one outcome influence the evaluation of the others. To facilitate this process, committee members are encouraged to record their evaluation as they are reading the student's work by circling the appropriate cells and making notes if needed. Each faculty then submits his/her independently filled rubric to the program manager, or the advisor can submit a jointly agreed rubric.

Program Learning Outcome	"Primary traits" that are evaluated	Does not meet expectations	Almost meets expectations	Meets expectations	Exceeds expectations
PLO3: Application of methods to solve problems	Selection of appropriate methods for the problem	Methods identified are insufficient or inappropriate	Methods address most but not all of the parts of the problem, or are not fully appropriate	Methods are appropriate and produced a useful answer to the problem	Methods are appropriate and contain originality
	Proper implementation of the methodology	Implementation is incomplete or incorrect	Implementation contains one or more parts of questionable accuracy, or was insufficient to achieve a useful answer	Implementation is technically correct and produced a useful answer	Implementation is fully correct and produced results that will have an impact in the subject area

Comments

Student's name _____

Program Learning Outcome	"Primary traits" that are evaluated	Does not meet expectations	Almost meets expectations	Meets expectations	Exceeds expectations
PLO4: Communication to those with and without subject matter knowledge	Technical communication, appropriate use of terminology	Written document lacks organization and clarity, or uses terminology or symbolic communication incorrectly or inappropriately, or does not communicate at a sufficiently technical level	Occasional problems with the use of terminology or symbolic communication, or the level of communication	Technical language and symbols are used correctly and appropriately, with sufficient technical detail; an expert would fully understand the concepts and most of the implementation	An expert would understand all of the concepts and (given sufficient time) be able to fully reproduce the results
	Understanding by a non-expert audience	Most components of the written document would not be understood by someone without subject matter knowledge	Some of the key components of the written document would be understood by someone without subject matter knowledge	The key components of the written document would be understood by someone without subject matter knowledge	All but a relatively small number of highly technical pieces of the written document would be understood by someone without subject matter knowledge

Comments

Appendix

References

Allen, Mary J. 2004. *Assessing Academic Programs in Higher Education*. Jossey-Bass, CA.

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Maki, Peggy L. and Nancy A. Borkowski (eds.) 2006. *The Assessment of Doctoral Education: Emerging Criteria and New Models for Improving Outcomes*. Stylus, VA.

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