Science core committee report, test of Knowledge rubric (Learning Outcomes 1.1, 1.2, and 1.3)

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1. See the attached Excel file. We suggest formatting the numerical data as we have done in this file as opposed to the manner suggested by the core council. The physics and astronomy data is somewhat different due to difficulties described below.

2. At this point we did not attempt to randomly select sections due to the difficulty other curricular areas were having with this process. In discussion with colleagues on the social science subcommittee we discovered that they were having two difficulties with this process: 1) getting the instructors of the selected sections to submit artifacts; and 2) getting the instructors to provide useable grading rubrics that corresponded with the rubrics created by the subcommittee. In light of these difficulties and in seeing that this exercise was designed to test the efficacy of the rubrics, we elected to select from among the sections of core courses that were taught by members of the committee during the fall 2015 semester.

In the future when the testing phase is over and the real assessment process begins we will select sections among the core courses by using a random number generator to pick among the offered sections. This approach however does bring up the concern of potentially randomly selecting concurrent courses. Some members of this committee are having difficulty in getting concurrent instructors to submit artifacts and syllabi.

3-6. Each discipline took a different approach to this exercise. We selected different types of artifacts which resulted in the identification of different strengths and weaknesses. Questions 3, 4, 5, and 6 are addressed in each individual section below.

Anthropology

Artifact analyzed for Knowledge 1.1, 1.2, and 1.3: A selection of questions from an exam including multiple choice and fill in the blank questions.

3. Rubric scores and overall exams scores were highly correlated (r = .819), suggesting that the rubric reflected overall student performance and mastery (or lack of mastery) of the subject area.

4. In order to effectively use the rubric, the instructor must identify questions that clearly reflect the learning outcomes or design questions to reflect them. As described below, Earth Sciences took the first approach and had difficulty identifying post hoc which questions were appropriate to use in the assessment. Anthropology took the later approach and used questions specifically designed to address learning outcomes. While this was efficient and worked well it brings up the potential issue of instructors "teaching to the test", especially if these results could potentially be used against instructors in promotion and retention matters.

5. Each set of questions took approximately five minutes per student to assess, for a total time of around two and half hours for this sample of 41 students.

6. The questions selected for Knowledge 1.1 addressed major theoretical concepts that are key to understanding modern human origins. Those for Knowledge 1.2 required explaining the connection between brain size, cultural complexity and development, and access to various food resources. The questions for Knowledge 1.3 involved interpreting site stratigraphy and understanding the applications and limitations of various dating techniques used on fossil materials. All of these concepts correspond to the original proposal for this course to be included in the science core.

Biology

Artifacts analyzed:
Knowledge 1.1: post-assessment exam given toward the end of the course (N = 52)
Knowledge 1.2: laboratory report (N = 24)
Knowledge 1.3: research paper (N = 23)

3. For Knowledge 1.1, the students with higher rubric scores also had the highest grades on the post-assessment exam. For Knowledge 1.2 and 1.3, the rubric scores were derived from scores assigned to the artifacts and therefore are very highly correlated.

4. The rubric is workable. Under the model of assessing the three knowledge areas separately, biology is currently assessing three different artifacts which takes a large amount of time (5 to 15 minutes per artifact per student).

The post-assessment exam could be reworked to cover all three knowledge learning outcomes by having some multiple choice questions but also included short answer and essay questions. However, applying the rubric to such an assessment will take a considerable amount of time

especially with a 90 student class. If each test took 10 minutes it would take 15 hours to complete the scoring. If the assessment was given in a lab section the task could be handled by many individuals which would alleviate the burden on any one individual.

5. Each post-assessment exam took 3-5 minutes to evaluate. The lab report and research paper took 10-15 minutes each.

6. In BIOL 1401, Learning Objective 1.1 was evaluated using the results of a post-assessment. A pre-assessment was given at the beginning of the Fall 2015 semester and the post-assessment was given toward the end of the semester. The same 30 questions were given in each assessment. For purposes of this assessment, each question was assigned a conceptual category. Examples of conceptual categories include macromolecules, evolution, scientific method, and diffusion and osmosis. The category used to evaluate Learning Objective 1.1 was Mendelian and molecular genetics.

Learning objective 1.2 was evaluated using the results from a lab report. In Biology 1401, students were introduced to osmosis and diffusion in the laboratory. Once introduced to the concept, the students, in groups of four, developed a hypothesis, designed an experiment and then conducted the experiment. The final products were a lab report and a presentation.

Learning objective 1.3 was evaluated using the results from a research paper. Each student was to find a reputable paper to read and summarize. The lab section selected to evaluate this was based on having grades available for the summary.

Chemistry

Artifacts analyzed for Knowledge 1.1, 1.2, and 1.3: a lab report and lab quiz.

3. The rubric seemed to work fine with remarkable correlation to the grade on the assignment.

4. It took about 2 minutes to score learning outcome for each student.

5. The artifact addresses these knowledge outcomes adequately.

6. The two artifacts selected both address core principle in chemistry (Learning Objective 1.1). The lab report addressed questions of methods and limitations within the field (Learning Objectives 1.2 and 1.3).

Earth Science

Artifact analyzed for Knowledge 1.1, 1.2, and 1.3: A selection of questions from a multiple choice exam.

3. The rubric scores seemed to match up to the grades the students received on the exam, so it seems to be a fair assessment (r = .781)

4. The biggest problem with scoring this semester is that the it was difficult to assign specific questions to each learning objective. The instructor would have written the exams questions much differently had she known she'd be using this exam to assess these students.

5. The instructor used a multiple choice exam, so it was not time consuming to score one student. It was time consuming to choose the questions to include in this assessment, however, because she did not write the exam with the intention of scoring it using the assessment criteria.

6. The exam used for assessment has questions written for Learning Objective 1.1 that are first principles and major theories in geology. Learning Objective 1.2 had questions about methods of data collection and how we use the data. Learning Objective 1.3 examined the application of these data into understanding the science of geology.

Physics and Astronomy

Artifact analyzed:

Physics courses: A sample of problem questions from exams throughout the semester that covered the learning outcomes

Astronomy: A sample of multiple choice questions from an exam that covered the learning outcomes

3. In all courses, the selected artifacts did not readily break down according to the three learning outcomes. It was difficult to assess these as separate entities. As such, it is difficult to determine how well the rubric worked. Due to this difficulty only Knowledge 1.1 was assessed for these courses.

4. Due to the lack of fit between the learning outcomes and the artifact, the traditional approaches to testing used in these courses may not effectively assess core learning outcomes. It may be necessary to create a separate assignment to use this rubric effectively.

5. It took approximately 10-15 minutes to evaluate each set of problem questions. The multiple choice questions took 3-5 minutes per student.

6. The artifacts selected reflected the learning outcomes proposed for each course in the original science core proposal.

Concerns of the committee:

What are we assessing?

Is it our goal to evaluate student work, that instructors are covering the learning objectives in their courses, or that the artifacts do a good job of assessing the learning objectives? To us this exercise feels as if we are assessing student performance, which is already done via grading within the course. As demonstrated above for anthropology and earth sciences, assigned grades correlate highly with the scores generated by using the rubrics. Instructors are already assessed annually by their department chairs and through student course evaluations. We suggest that this current method is not the best use of limited faculty time and resources. Instead it would be more productive – and considerably less time consuming – to evaluate how well the artifacts used in courses assess the learning objectives. This would require only collecting a few blank artifacts from each selected section, not whole set of student work.

Concurrent courses

How are artifacts are going to be addressed with the concurrent courses, considering the lack of daily supervision due to distance between concurrent instructors and the university?

Division of work

Some programs areas have only one course in the science core; others have four. Enrollments and numbers of sections vary as well. In the future, how can we fairly divide the assessment work so that those programs with multiple, larger courses are not doing 10 times the work of those with fewer sections of smaller courses?

Creation of extra work for instructors

One factor that has not been considered yet is the amount of preparatory work that needs to occur before the rubrics can be applied. To evaluate one section of one course, the following preliminary steps need to occur:

- Selecting a section to be evaluated for each course
- Contacting the instructors to ask for artifacts
- Collecting artifacts
- Redacting student names, instructor names, and other identifying markers from the work

- Creating a key for the artifacts that reflects the scoring scale on the rubric

None of this is reflected in the current or proposed work load policies. This could be particularly burdensome for adjunct instructors, many of whom teach core courses.

Recommendations

It seems that the most efficient way to conduct meaningful, consistent assessment over a span of time is for the instructors of each course to create a single artifact that is used across all sections of a course to evaluate Learning Objectives 1.1, 1.2, and 1.3. This would make the results of the assessment comparable from semester to semester and guarantees that the learning outcomes are being assessed in every section.

However, this generates two possible concerns: 1) interference with instructor autonomy by dictating some of the assignments they must use; and 2) the possibility of instructors "teaching to the test" in order to inflate assessment scores. This last concern would be especially problematic if instructor anonymity in the process is not guaranteed. Even if instructor names are redacted from artifacts, courses that are not offered in multiple sections in a given semester would still be easy to identify. We feel that this second concern particularly emphasizes why we should not be assessing student work but instead assess how well the artifacts are addressing the learning outcomes.

"Understand the theoretical perspective used in one or more of the sciences disciplines"

4 Student shows **sophisticated understanding** of the theories, implications of those theories, concepts, and terminology in completing the assignments of the course.

3 Student can demonstrate **solid understanding** of the theories, implications of those theories, concepts, and terminology in completing the assignments of the course.

2 Student demonstrates **basic understanding** of the theories, implications of those theories, concepts, and terminology in completing the assignments of the course. Performance more based on memorization than mastery of underlying principles. May have difficulty successfully completing some required assignments.

1 Student has **limited understanding of** the theories, implications of those theories, concepts, and terminology of the course. Student has difficulty satisfactorily completing most or all required assignments.

0 Student demonstrates **no or almost no understanding** of the theories, implications of those theories, concepts, and terminology. Student has significant difficulty completing, cannot, or does not complete required assignments.

"Understand observational and experimental methods used in one or more of the sciences"

4 Student understands observational and experimental methods well enough to plan and conduct a simple original research design. Student has **sophisticated understanding** of the concepts, terminology, and procedures for observational and/or experimental methods in the discipline of the course.

3 Student understands observational and experimental methods well enough to successfully complete instructor designed exercises. Student can demonstrate **solid understanding** of the main concepts, terminology, and procedures for observational and/or experimental methods in the discipline of the course.

2 Student demonstrates **basic understanding** of the main concepts, terminology, and procedures for observational and/or experimental methods in the discipline of the course. Performance more based on memorization than mastery of underlying principles. May have difficulty successfully completing some required exercises.

1 Student has **limited understanding** of the main concepts, terminology, and procedures for observational and/or experimental methods in the discipline of the course. Student has difficulty satisfactorily completing most or all required exercises.

0 Student demonstrates **no or almost no understanding** of the main concepts, terminology, and procedures for observational and/or experimental methods in the discipline of the course. Student has significant difficulty completing, cannot, or does not complete required exercises.

"Understand the applications and limitations of the sciences"

4 Student has **sophisticated understanding** of the applications and limitations of the sciences well enough to demonstrate awareness and comprehension of the influence of the discipline on society

3 Student can demonstrate **solid understanding** of the applications and limitations of the sciences well enough to demonstrate awareness and comprehension of the influence of the discipline on society

2 Student demonstrates **basic understanding** of the applications and limitations of the sciences well enough to demonstrate awareness and comprehension of the influence of the discipline. Performance more based on memorization than mastery of underlying applications. May have difficulty successfully completing some required assignments

1 Student has **limited understanding** of the main concepts, terminology, and procedures for applications and limitations in the discipline of the course. Student has difficulty satisfactorily completing most or all required assignments.

0 Student demonstrates no or almost no understanding of the main concepts, terminology, and procedures applications and limitations in the discipline of the course. Student has significant difficulty completing, can not, or does not complete required assignments.

Science Core					
Rubric Tests					
ANTH 1415	**N = 41**				
	score = 3	score = 2	score = 1	score = 0	
Knowledge 1.1	7	12	11	11	
Knowledge 1.2	7	15	16	3	
Knowledge 1.3	21	6	7	7	
BIOL 1401					N =
	score = 3	score = 2	score = 1	score = 0	
Knowledge 1.1	11	26	13	2	52
Knowledge 1.2	9	9	3	3	24
Knowledge 1.3	8	6	8	1	23
[1]					
CHEM 1402 Lab	**N = 14**				
	score = 3	score = 2	score = 1	score = 0	
Knowledge 1.1	9	4	1	0	
	score = 3	score = 2	score = 1	score = 0	
Knowledge 1.2	11	2	1	0	
	score = 3	score = 2	score = 1	score = 0	
Knowledge 1.3	10	3	1	0	
ERSC 1302	**N = 32**				
	score = 3	score = 2	score = 1	score = 0	
Knowledge 1.1	12	17	2	1	
Knowledge 1.2	15	11	5	1	
Knowledge 1.3					

	20	9	2	1	
PHYS 1321/112	**N = 67**				
	score = 3	score = 2	score = 1	score = 0	
Knowledge 1.1	10	30	20	7	
PHYS 1322/112	**N = 40**				
	score = 3	score = 2	score = 1	score = 0	
Knowledge 1.1	11	15	11	3	
PHYS 2321/212	**N = 28**				
	score = 3	score = 2	score = 1	score = 0	
Knowledge 1.1	14	5	4	5	
ASTR 1300/110	**N = 25**				
	score = 3	score = 2	score = 1	score = 0	
Knowledge 1.1	13	8	4	0	

[1] crwilson2: