Engineering Mentoring
DREAM • BELIEVE • ACHIEVE

The Handbook on

Assessment Design

2014

McMaster Engineering
Faculty Development Academy

McMaster University
ENGINEERING

The Handbook on Assessment Design was created and developed by Minha R. Ha and Adam Sirutis, as part of the Faculty Development Workshop Series led by Maria Massi. The team wishes to thank the input of faculty members who provided examples and feedback for this document, as well as those who provided facilitation support for related faculty development workshops.

Contents

Dean’s Message

Experiential learning is an integral part of the innovative culture within the Faculty of Engineering. It has been made possible through myriad teacher-learner, teacher-teacher and learner-learner collaborations.

Our Invest for Excellence consensus urges us to construct new and effective learning experiences, which we must conceive for – and also with – our students. We are committed to enhancing a learning environment that is engaging for our students and providing the best possible teaching experiences for our faculty members.

As faculty members, you make so many contributions to enhance teaching and learning. Your hard work, dedication and accomplishments add to the success of our students and the impact that our Faculty has on our world.

Our students’ learning improves as you become better prepared and stay more current with evolving technological advances in teaching. Therefore, please know that I thank each of you personally for taking the time to participate in this professional development workshop.

Ishwar Puri
Dean of Engineering
McMaster University

1. Introduction

Teaching is an artful practice. Instructors design, deliver and evaluate educational methods and tools that dynamically respond to the institutional vision, broader contexts, and the changing cohorts of learners. At a foundational level, the general aims of education are explicitly tied to the outcomes in learners' development – such as self-governance, economic participation, flourishing and citizenship (Brighouse, 2006) – and implicitly to the kind of world they create (Kingwell, 2000). At McMaster University, at least two entities translate the purpose and outcomes expected from engineering education. The Faculty of Engineering carries the mission of pursuing excellence in its teaching, research, service and quality of academic life – with a particular vision for developing engineering practices that help create a sustainable world. Furthermore, the Canadian Engineering Accreditation Board (CEAB) defines 12 graduate attributes expected for development and demonstration before the completion of students' programs in engineering. Both allude to the notion that engineering education involves a dynamic, multidisciplinary and holistic development of young talents as global engineers and citizens.

The reiterative process of teaching and learning, particularly between making instructional (or program) decisions and acquiring (and interpreting) evidence of the learning outcomes, places quality assessment at the centre of continuous improvement in education. Assessment, then, serves at least three purposes for an instructor:

- Monitor student progress in learning, for feedback to both learners and instructors (resulting in decisions to adapt strategies as appropriate), as well as evaluation of pedagogical methods.
- Validate student abilities and attributes upon successful completion of courses/program.
- Align instructor and student expectations on 'success' of particular learning, thus influencing the learning decisions (by students) and teaching decisions (by instructors).

With growing interest in diversifying assessment strategies as fitting to the Faculty's experiential learning strategies and the range of technical and non-technical attributes being developed, the Assessment Design Workshop and this Handbook focus on planning strategies and designing specific assessment instruments. At the course level, this activity is expected to increase constructive alignment between assessment, instructional methods, and intended learning outcomes. At the Faculty level, the workshop serves as a platform to raise the level of shared knowledge base and best practices, driving innovation through collegial peer exchange and collaboration. The quality data generated in the process are expected to contribute to the advancement in the field of engineering education research, out of which learning theories also inform pedagogy. In the end, it is our shared hope that the coherence and diversity of assessment methods in each course (or program) will maximise student learning, through which (at least in part) they become global engineers apt to meet 21st century challenges.

Expected Impact of Excellence in Assessment

1. Improve effectiveness and adequate diversity of assessment strategies
2. Increase quality of data for graduate attributes assessment
3. Enhance teaching and learning strategies
4. Advance theory and practice in engineering education research

Deliverables for the Assessment Design Workshop

1. Assessment plan for the course
2. Rubric development from intended learning outcomes for each assessment instrument
3. Assessment design – Developing prompts and questions

2. Assessment in Engineering

Assessment in engineering begins with the definition of engineering abilities and attributes. The common **graduate attributes (GAs)** as set out by the CEAB and further defined by the Faculty of Engineering provide a common framework for articulating engineering competencies effective across departments. The engineering GAs being assessed at McMaster University are listed below:

- A knowledge base for engineering
- Problem analysis
- Investigation
- Design
- Use of engineering tools
- Individual and team work
- Communication skills
- Professionalism
- Impact of engineering on society and the environment
- Ethics and equity
- Economics and project management
- Life-long learning
- Sustainability

'How do students learn engineering?' is one of the fundamental questions in engineering education research (Streveler & Smith, 2006; Borrego et al., 2008). The expected developmental process in engineering students inevitably informs our teaching decisions and the method of assessment. A constructivist view of learning states that, "as a result of learner activity, learning proceeds cumulatively and changes its structure as it evolves" (Biggs, 2003: 156). Whether assessing engineering ethics or problem analysis, familiarity with current theories of learning and thoughtful reviews of assessment results (including pre-/post-tests, formative/summative) are expected to help set reasonable expectations for student performance at different points of assessment.

Key Issues and Assumptions

There are underlying assumptions that guide different approaches to assessment. The following comparison can provide a useful example (Table 1):

Table 1. Comparison between Unidimensional and Multidimensional Assessment[1]

	Unidimensional assessment	**Multidimensional assessment**
Knowledge and teaching	Assess for the accuracy of correct knowledge. Teach to transmit and help accumulate knowledge.	Assess for the ways of structuring data. Teach to help construct more effective ways of viewing a section of the system or phenomenon.

[1] Developed based on Biggs (2003, pp. 148-150) and discussions in the Faculty of Engineering, McMaster University.

Grading and developmental process	Definition of what earns 100% grade remains the same throughout the learning process. Progress in learning should be directly correlated with increase in the grade (e.g. standardized tests, repeated-attempt assignments).	There is a hierarchy of competencies, i.e. higher level abilities can be qualitatively different from, but subsume, lower level abilities. A student progresses through a continuum of different levels of standards; 100% grade on a higher-level assessment requires more work and complexity than 100% grade on an earlier or lower-level assessment in the program.
Expected range of performance	Each grade level represents some level of uniformity in performance. A normal distribution is expected if students are chosen at random. However, a strict bell curve is NOT expected in many classes, because students are **not** randomly selected, nor their abilities normally distributed. Furthermore, literature supports that ability alone does **not** determine academic attainment, and good teaching tends to override individual differences.	Each grade level can include different forms of student output. Most students are expected to be able to integrate topics and use the obtained knowledge. Tasks or questions can require students to create or apply certain processes without detailed guidance; open-ended problems also accommodate different solutions. Standards for, e.g. reasoning abilities or systematic investigation, apply across varying solutions.
Precision of scale	In deciding which part of learning (qualitative) will count as a unit of mark (quantitative), fair allocation against course objectives and expected level of work can provide a starting point for consideration. Faculty do not treat grades as absolute, but commonly treat borderline cases (49 vs. 50%, or 79 vs. 80%) with appreciation of error or elasticity in scale.	Instructors make holistic judgment on performed competencies (various types and levels) against clear performance criteria. Allocated marks for specific performance criteria are explained in terms of a theory of learning as it applies to the discipline (what is good/more advanced performance and why).
Reliability: (consistency in results & grading)	Stability – same test to the same group at different occasions will give same result independently of who was administering and marking it. Dimensionality – unidimensional, all items measure the same construct. Conditions of testing – each testing occasion conducted under standardized conditions.	Intra-judge reliability – evaluator make the same judgment about the same performance on different occasions. Inter-judge reliability – different judges make the same judgment about the same performance on the same occasion. Dimensionality – test items address all of the course objectives, multidimensional tests. Conditions of testing – reflect individual's optimal learning in the intended application of learning Theory of learning enables consistent judgments.

Validity	Assessment results are validated externally by how well the test result correlates with outside performances.	Assessment results are validated internally by examining how well the scores relate to holistic learning objectives and specific target domains of performance.
Use	Best for **selection** (judging between individuals), comparisons, individual diagnosis, population norms	Best for **development** (judging between performances against criteria), judging effectiveness of learning, usually after instruction

Developing Specific Intended Learning Outcomes

Several frameworks are useful for determining the type of learning outcome being addressed by particular assessment practices. For example, Bloom's and Krathwohl's taxonomies for learning now include levels of competencies in the **cognitive**, **affective**, and **psychomotor** domains (Biggs, 2003), while specific disciplines (e.g. design and technology education, leadership education) have also been defined in terms of **knowledge**, **skills** and **values** (SEAC, 1990; Komives, Lucas & McMahon, 2007). Each course instructor must identify which types and levels of learning are being assessed, make explicit the student performance expectations and criteria, and suitably match assessment strategies.

Table 2. Levels of Competence in Cognitive and Affective Domains

	Cognitive	Affective
Levels of Learning Objectives (Biggs, 2003)	Knowledge Comprehension Application Analysis Synthesis	Receiving Responding Valuing Organisation Characterisation by Value of Value Complex

Table 3. Examples of Learning Objectives in Knowledge, Skills and Values

	Knowledge	Skills	Values/Attitudes
Design and Technology (SEAC, 1990)	Control; energy; materials	Investigation; invention; implementation; evaluation	Technical; economic; aesthetic; moral
Leadership (Komives, Lucas & McMahon, 2007)	Process of change; self and others; citizenship; power; systems; values, justice, care; decision-making; community; group process; relational aspect of leadership	Goal-setting; meaning-making; creative thinking; talent development; listening skills; civil discourse; learning; moral imagination; collaboration; reflection; challenge; feedback	Commitment to social responsibility; equity; recognition of diversity; self-esteem; concern for others' growth; integrity; quality effort; systems perspective

Exercise: The learning objectives in the leadership model in Table 3 are directly linked to the five components of leadership as defined by Komives et. al (2007), where one is: (1) Purposeful, (2) Inclusive, (3) Empowering, (4) Ethical, and (5) Process-oriented. If you were to name the top **3-5 categories of learning and development in your engineering course**, what would they be?

3. Assessment Planning

Decisions on assessment plan at the course level will address, at minimum, the following priorities:

1. Proper method, weighting and time spent on assessments for priority learning outcomes
2. Appropriate content and development opportunities preceding final assessments
3. Opportunities for feedback to be received by students in order to support the learning process

Formative and Summative Assessments

An important function of assessments is the feedback given to the learners and instructors on the learning progress and achievements. Often, the formative assessment activities overlap with learning activities in class – serving as pre- or post-test during instructional sessions. Summative assessments, on the other hand, are opportunities for students to prove the results of their learning, with direct consequences to their academic achievement (i.e. grades). Key distinctions between formative and summative assessments are presented below (Table .

	Formative	**Summative**
Purpose	To know how learning is proceeding	To see how well students have learned To measure student performance against a set of standards (expectations) at the end of a unit
Error in performance	Error acknowledgment leads to opportunity for better understanding	Error signals penalty
Mastery learning	Assessments as integrated part of teaching.	Allow as many tries at the assessment in order to pass the pre-set standard. Common issue: quantitatively defined pre-set criteria work well with surface-oriented students.
'High distinction' vs. 'measured by criteria'	Use student performances against each other to rank. Comparative ranking among peers for high distinction puts a limit to the number of high distinctions awarded. Used for selection.	Criterion-based grading of student performance against intended level of performance. Used for learning.

Self- and Peer-Assessments

Self-directed and active learning requires a certain level of autonomy and shared influence over the learning process among peers. Self- and peer-assessments create a recognised opportunity (with direct relevance to course outcomes, or grades) for students to judge their own competencies or learning progress by guided evaluation of one's own – or others' – work. Taking over the formative role (feedback for development) sets up students to monitor themselves as they learn, making sense of their learning, develop interactional skills for constructive criticism, and developing recognizable standards to measure themselves against (Biggs, 2003; Falchikov, 1995).

While it has been shown that students have, or can develop, an ability to assess themselves or peers with similar conclusions as would be made by an instructor (Ross, 2006), there may require deliberate efforts to train the students to make qualitative judgments against similar standards. It is important to remove possible barriers to effectiveness of self- and peer-assessments. While the detailed language (i.e. instructions, prompts) used in assessment may be developed later in Section 5 of this handbook, the assessment planning stage should include considerations for student familiarity with the assessment format, and fair grading schemes.

Common Assessment Methods: Purpose, strengths and examples

- Case Study
- Debate
- Design Project
- Engineering Journal
- Fixed Answer Problem Set
- Lab Report
- Multiple Choice Question
- Open-Ended Problem (Long answer)
- Oral Exam / Interview
- Position Paper or Analytic Inquiry Report
- Poster Session
- Presentation
- Rating responses
- Self-Reflective Paper
- Short Answer Question
- Simulations
- Summary and Critique

Case study

Case studies are an assessment where students read a real-life case of an engineering problem or scenario, and then discuss the situation and propose solutions. The case can be read before class, and during class it is discussed as a group discussion. Keep in mind that group discussions are less effective in large classroom settings. Or, students can be asked to submit a written response to the case. Case studies measure application, analysis and evaluative skills. Case studies can also test and develop problem solving skills. Short cases are easy to design, but can be difficult to mark. Case studies can be particularly engaging for students, especially as a group discussion, as it connects engineering work in school directly to engineering as a profession.

Type	Case Study
Suggested Length	In-class: 30 minutes per case Take home: 3-5 pages submitted
Expected Prep Time	
Expected Marking Time	15-20 minutes per paper
Suggested Time Allotted to Complete	1 week
Example: Students are responsible to read the case study prior to class. In class, the instructor leads a group discussion on the case. Afterwards, students are required to write a summary including their opinion and/or suggestions on the situation and submit it within 2 weeks. An example of a prompt given for their paper could be: What alternatives do you think this company had when it made the decision to lay-off 1500 workers?	

Design Project

Design projects are large assignments usually spanning anywhere between one month to a term. One example of a project may ask students to research, develop a solution and carry it out. A design project can be done individually, or in a group. This assessment measures knowledge, understanding, application, analysis, evaluation and synthesis. Design projects can develop a student's teamwork and "soft skills" to complement the technical skills, and is a great all-around skill building assessment. Prep and marking time can both be potentially difficult for the instructor. Delegating marks among group members can be especially difficult in group projects, since there are many ways to do this. Projects allow students to experience a more practical learning experience. This is a great assessment type to show students how what they learn in lecture is applied in the real world. Design projects have a good potential for effective use of self and peer assessment throughout the duration of the assignment.

Type	Design Project
Suggested Length	25-50 pages
Expected Prep Time	
Expected Marking Time	1.5-2 hours per project
Suggested Time Allotted to Complete	4-8 weeks
Example: Students are placed into groups of 4. They are given a topic such as: Design an environmentally friendly and economically feasible way to protect steel from corroding in a salt-water environment. It is the responsibility of the group to research the topic and creating a proposal/procedure. Students are given lab time which is supervised by T.A.'s who also instruct students on how to use the equipment. After completing their experimental work, each group submits one final report outlying their project, results analysis and any other relevant information.	

Fixed Answer Problem Sets

A fixed answer problem set present students with question that demands a multi-step process to solve. These problems usually involve applying the knowledge students have learned to produce a solution. This assessment type measures understanding, application and analysis. This is the classic problem-solving assessment. Design of these questions can range from easy to difficult depending on the complexity of the question. Prep time varies depending on the difficulty level. Marking time tends to be fairly quick. Preparation and marking time also varies from fast to slow. Variation between markers is usually low. It is important for students to show their work on this type of assessment so that their process can be evaluated. More challenging problem sets can be especially beneficial for students, as it forces them to try various methods of solving a problem, and discovering their own preferred method through trial and error. This technique can be used in tutorials, take-home assignments, and in exams or midterms.

Type	Fixed Answer Problem Set
Suggested Length	1 page of solutions
Expected Prep Time	
Expected Marking Time	2 minutes per question
Suggested Time Allotted to Complete	Depends on difficulty, 10-20 minutes
The following is an example fixed answer problem as a feature of a physics midterm: A ball is thrown from the top of a 100m building horizontally right at 20 m/s. Find the velocity of the ball at h=5m. (Air resistance is negligible)	

Lab Report

Lab reports are assignments to be completed after a lab is performed. These reports can include their procedure and any relevant information on performing the lab. The report may also require students to answer technical questions, as well as further questions on the material the lab was based on. Lab reports can measure knowledge, understanding, application, analysis and evaluation. These reports help to develop students' technical writing skills. Marking and prep time should be relatively fast since criteria should be well-established. Students should generally be given about one week to complete their report. With this type of assessment, there is good potential for feedback and peer assessment.

Type	Lab Report
Suggested Length	5-10 pages
Expected Prep Time	
Expected Marking Time	15 minutes
Suggested Time Allotted to Complete	1 week
Prior to completing a lab session, students are required to hand in their report by the next lab. In their lab report, they might be responsible for stating the purpose of the lab, the procedure, results and analysis, problems encountered and further questions.	

Multiple Choice Questions

Multiple choice questions prompt students with a question, and provide a variety of possible answers to select, of which only one is correct. Multiple choice questions can measure knowledge, understanding, analysis, and evaluation. Effective multiple choice questions are the most difficult type to design and may demand a lot of preparation time, but are the easiest to mark. It is reliable, fast and easy to analyze and interpret test results. Multiple choice questions can test students on problem solving skills; however, it does not allow the instructor to see the method they used to solve it. Good for immediate self-feedback, practice and determining further questions to professor. Multiple choice is typically used on midterms and exams. A midterm or exam can be entirely based on multiple choice, or, multiple choice can make up only a section of it.

Type	Multiple Choice Questions
Suggested Length	Question length: 1-3 sentences
Expected Prep Time	
Expected Marking Time	2-3 seconds per scantron
Suggested Time Allotted to Complete	1 minute per question
The following is an example of a multiple choice question as a feature of a chemistry midterm: Which of the following is **not** a parameter of the Ideal Gas Law? A) Volume B) Moles C)Temperature D) Mass E) Pressure	

Open-Ended Problem Questions

An open-ended problem requiring judgment is a question proposed to the student where there is no set answer. Students are required to answer a question my giving their opinion on the matter and supporting it with solid arguments with logic and reasoning. This activity can provide an immediate measurement of students' ability to identify, reason and develop arguments towards solution alternatives. These problems measure knowledge, understanding, application, analysis and evaluation. Also gauges the divergent, integrative and convergent thinking. While many other assessment methods utilize open-ended problems, having students reason through and articulate the problem solving process helps demonstrate students' principled methods and deliberation. This assessment type is useful to assess ethical issues in engineering.

Type	Open-Ended Problem Questions
Suggested Length	0.5-1 pages of writing (or 1-2 paragraphs)
Expected Prep Time	
Expected Marking Time	3-5 minutes per question
Suggested Time Allotted to Complete	10-20 minutes per question
The following is an example open-ended problem question that could be featured on a final exam or as a	

stand-alone homework assignment: In your opinion, which power source has more promise? Hydro-electric or wind power? Give 3 arguments to support your choice.

Position Paper / Analytic Report

A position paper (or analytic report) is a paper comparable to an essay. This paper will ask students to give an argument and to support it with sound reasoning. Being able to identify the purpose of the paper, using analytic skills and facts to support their claims is important. Students should be aware who the audience of the paper is. Position papers measure understanding, synthesis and evaluative skills. Good criteria and some training are required to ensure consistency in marking. Students must write appropriately to the intended audience, with clear purpose and thoughtful selection of presented information, and defend their analyses. Writing deliveries of this kind allow students to develop their written communication skills, both technical and creative.

Type	Position Paper
Suggested Length	5-6 pages double spaced
Expected Prep Time	
Expected Marking Time	15-25 minutes per paper
Suggested Time Allotted to Complete	2-3 weeks
Example paper topic: Is the Canadian steel-making industry doing all they can to reduce their greenhouse gas emissions?	

Poster Session

Poster sessions are similar to presentations, but this requires students to design a visually appealing poster to complement their findings. The presentation of their poster is often much shorter and less formal; the poster communicates most of the information. Poster sessions measure knowledge, understanding and possibly evaluation. Poster sessions demand oral communication skills, preparation and organizational skills. Prep time for instructors is relatively low, as is marking time. Students should be given about three weeks to prepare for this assessment. Requires students to present their findings succinctly and clearly, both verbally and visually. This assessment type requires students to evaluate their findings and decide which of it is most important.

Type	Poster Session
Suggested Length	1 poster, 1-3 hour poster fair
Expected Prep Time	
Expected Marking Time	5-10 minutes
Suggested Time Allotted to Complete	3 weeks
Students present their posters in a designated location such as a hallway or foyer. Markers, peers and passers-by can all observe the posters developed. Students stand by their respective posters and briefly explain their work to those interested. Develop a poster based on the research you carried out on the electrical properties of thin films.	

Presentations

Presentations are an assessment type where students verbally present information to the instructor and the class. Usually, visual aids such as PowerPoint are encouraged. This can be done individually or in groups.

Assessment Design

Presentations measure knowledge, understanding and potentially evaluation. Presentations demand oral communication skills, preparation and organizational skills. Prep time for instructors is relatively low, as is marking time. At least two weeks should be given to students to prepare for this assessment. If a rubric is well designed, marking can be fast and reliable. Presentations are also a good opportunity for peer and/or self-evaluation. This is an assessment type that helps to develop the "soft skills" essential to engineering.

Type	Presentation
Suggested Length	10-25 minutes
Expected Prep Time	
Expected Marking Time	Same time as presentation length +/- 2 minutes
Suggested Time Allotted to Complete	2 weeks
In their respective groups, students give a 15 minute presentation on the results of their work in front of their peers and the instructor. Students watching the presentation are given a rubric to fill out and assess the presentation.	

Self-Reflective Papers

A reflective paper is an assessment type where students write a few pages or less on their thoughts. This can be done after a major assessment such as a project, where students are asked to evaluate their own performance individually, their performance as a team member or the performance of others. Reflective papers measure analytical and evaluative skills. They can help develop writing and communication skills through the explanation of their thoughts and opinions. It is an easy assessment to design, but may be difficult to mark. In fact, reflective papers do not absolutely need to be for marks. Students should be given about one week to complete reflective papers if they are to be typed and handed in. They can also be done in class, if they are expected to only be a paragraph or two. Reflective papers are great as a self- and/or peer-assessment technique.

Type	Self-Reflective Papers
Suggested Length	1-3 pages
Expected Prep Time	
Expected Marking Time	10-20 minutes
Suggested Time Allotted to Complete	1 week
This is an example of the topic for a self-reflective paper assigned to students after they completed a group project: How did your group resolve group conflicts? In retrospect, should your group have done anything differently?	

Short Answer Questions

A widely used assessment method in engineering, short answer questions ask students to give a descriptive answer or explanation in a few sentences. Good for measuring knowledge, understanding, analysis, evaluative skills. These can also complement problem solving by prompting interpretation. They are relatively easy to design. Marking is fast compared to full problems, but slower than multiple choice questions. Short answer questions are usually used as a section in midterms and exams. This assessment method allows for quick feedback since each question typically only tests a single idea or concept.

Type	Short Answer Question

Suggested Length	Prompt: 1-3 sentences Answer: 1-2 paragraphs
Expected Prep Time	
Expected Marking Time	1 minute per question
Suggested Time Allotted to Complete	5 minutes
The following is an example of a short answer question featured on a midterm: Explain the advantages of hydrometallurgy over pyrometallurgy.	

Simulations

A simulation is an assessment where students are presented with a design problem where their solution will be tested by a computer program. Simulations are similar to design projects, since they do involve designing a solution, but they do not involve the actual creation of the solution. The student's proposed design will be simulated by a computer program instead. Simulations measure knowledge, understanding, application, analysis, and synthesis. Simulations are a type of assessment that can be especially engaging to the student, since it bridges the theory they learn in school to the application of this knowledge. Reflective questions can also be added on to this type of assessment. Environmental, ethical and economic concerns can also be included as a design consideration.

Type	Simulation
Suggested Length	
Expected Prep Time	
Expected Marking Time	20-30 minutes
Suggested Time Allotted to Complete	2-3 weeks
Students will be put into groups of 3. The following is an example topic for a simulation assessment: Design a gear system for a CD drive. Create an AutoCAD design and run a simulation with software. Students will demonstrate their simulation on computers in the elliptical computer lab to instructor and will answer any questions they may have.	

Summaries and Critiques

Critiques are an activity where students critically evaluate and make suggestions on peer work, performance and given materials. Critiques measure understanding, analysis and evaluation. By writing critiques, students develop soft skills such as their communication skills and constructive criticism and feedback. Students learn how to better give and receive constructive feedback and criticism on their work and the work of their peers. Prep time is fairly quick, but marking time may take a while. Students should be given approximately two weeks to complete and hand in their critique. Critiques can be assigned mid-way through a major assignment, to check progress, and again at the end of the assignment.

Type	Critiques
Suggested Length	2-4 pages
Expected Prep Time	
Expected Marking Time	10-20 minutes per assignment
Suggested Time Allotted to Complete	2 weeks
Students are at the midway mark of a design project assignment and have just submitted a progress report. This progress report will be the subject of this critique assessment. Groups will exchange progress reports and will create a critique report on their peer's work. The following is an example prompt for the critique: Find 3 strong points and 3 weaker points of your peer's paper. Explain your reasoning for each.	

Task: Completing the Assessment Plan and Content Plan Charts

- Identify how or where students can demonstrate expected competencies. Understanding that assessment is also part of learning/instruction, choose which ones will be graded (and how), and which ones will count towards accreditation results.
- Design and name each assessment activity/tool. Alternatively, look at an existing assessment instrument (i.e. complex and large group project) and use the provided Assessment Checklist to identify gaps in intended coverage of attributes.
- Make choices about frequency, weight, depth and breadth of assessments throughout your course. Provide your rationale, for how your decisions best support student learning, as well as obtaining quality data for student performance.
- What instruction or practice opportunities must be given to prepare students for success?

Questions for Peer Feedback on Assessment Planning

- Does the assessment plan support course objectives? (grading what matters)
- Is the plan feasible?
- Will students be able to perform the intended learning outcomes in the given types of assessment?
- How is the plan expected to promote/enhance student learning?
- What are the strengths in this plan? What could be done to improve the plan?

- How do we promote peer learning and academic integrity simultaneously?
- How do we ensure fairness in grading?
- How should the TAs be trained? How do we ensure consistency and efficiency in marking?
- How do we evaluate attributes that are difficult to quantify?
- What should be done in class, what should be done as a take-home?

Assessment Plan Example

Beginning and ending weeks of EP4ES3, Dr. Shinya Nagasaki

Intended Learning Outcomes
#1: Draw from Fukushima Daiichi Nuclear Power Plan Accident to make sense of complexity surrounding energy system issues in terms of sustainability.

#2. Demonstrate a high level of calibre in problem analysis, independent research, critical evaluation, and integration of multidisciplinary expertise or perspectives to investigate a unique energy systems challenge (topic of choice).

#3. Effectively give and draw on peer critique to enhance the quality of analyses (inc. process, reasoning, arguments, assumptions).

Course Schedule	**Week 1/2**	**3/4**	**11/12**	**13/14**
General Themes / Notes	**Inquiry skills, group case study**		**Inquiry Presentations**	
Priority Learning Objectives (match number above)	**#1 #3**	**#1**	**#2 #3**	**#2**
Assessment Type 1: Oral Presentation	**X (group)**		**X (once per student)**	
Assessment Type 2: Group Report (based on Case Study)		**_ _ _ _ _ X[2]**		
Assessment Type 3: Individual Analytic Report		**(Inquiry proposal approved)**		**_ _ _ _ _ X**
Focused graduate attribute indicators		**2.1 3.3 9.1 10.2**	**13.2 9.3 8.1 7.1-7.2**	**11.3-11.4 9.2 10.3 12.1 2.3**
Submitted Data (collected evidence of learning outcome)	**PPT**	**Word document**	**PPT**	**Word document**
Grading Weight	**5% presentation**	**10% report**	**10% presentation**	**40% final paper**
Graded by	**Peer**	**TA**	**Peer**	**TA / Instructor**
Form of feedback provided to students:	**Graded rubric**	**Written comments and mark**	**Verbal comments and graded rubric**	**Graded rubric**

[2] For easy visualisation, underscores were used to represent scheduled instructional sessions. In Week 3/4 period, 'X' marked on the sixth underscore (depicting 3 classes per week) means the group report is due on the last class of Week 4.

4. Rubric Development

Rubrics make explicit the criteria for assessment, as well as the standards that distinguish between good and poor performances in each criterion. Well-articulated standards are expected to improve **consistency in marking**, to clarify **expectations among students** on learning goals, and to enable both the instructors and students to evaluate the **constructive alignment** between instructional and assessment activities. Our faculty have also found that rubrics were very useful in giving **precise feedback** on student performances (especially when there is a time constraint to writing through comments), facilitating **peer evaluation**, and helping students monitor their own level of competence. The following questions may be helpful for clarifying standards in student performance.

Explicating student performance expectations

Exercise 1: Technical content, discipline-specific outcomes

Which specific tasks must be demonstrated by students in order to successfully master the technical problem solving germane to your course?

Exercise 2: Communication, teamwork, management processes

In which processes must students demonstrate aptitude, to be highly effective in their work with the nature of involved tasks and other people?

Exercise 3: Professionalism, sustainability, ethics

What are the expected impact that these attributes would have on the processes and quality of outcomes in the problems germane to your course?

Assessment Criteria	**Key Distinction between Good and Poor Performance**	**Expected Standard (refined)**

Rubric Example 1

Marking Rubric for CE4N04, Dr. Lydell Wiebe

Marking Rubric for CIV ENG 4N04: Steel Structures

Student Name: ____________________

Engineering Calculations: awarded for identifying all relevant equations that must be applied, and for applying them correctly

6 points	5 points	4 points	3 points	2 points	1 point	0 points
All calculations are complete and correct.	Most calculations are complete and correct, but 1 or 2 components of the correct response are missing, or there are some infrequent calculation errors.	The outline of the correct response is generally present, but more than 2 components are missing, or there are frequent calculation errors.	Although the most important components of the correct response are mentioned, the accompanying work is mostly either incomplete or incorrect.	3 or more relevant equations or insights are given, but the most important components of the correct response are not mentioned.	1 or 2 relevant equations or insights are given, but work is almost entirely incomplete or incorrect.	No relevant equations or insights are given.

Engineering Communication: awarded for clearly documenting engineering work

2 points	1 point	0 points
Work is mostly complete, ***and*** all of the following statements apply: • work is always easily legible • organization is logical and clear • all equations and constants are clearly recorded and referenced • sketches clearly illustrate work • all final answers are clearly identified • work is submitted on engineering paper with all pages numbered and fastened together using a staple or paper clip • name, group member number, class, and assignment are given on every page	Major parts of the assignment are missing, ***or*** any of the following statements apply: • work is not always easily legible • organization is sometimes difficult to follow • some equations or constants are not clearly recorded and referenced • some sketches are missing or unclear • some final answers are difficult to identify • work is not submitted on engineering paper, pages are not numbered, or pages are not fastened together using a staple or paper clip • name, group member number, class, or assignment are missing on 1 or more pages	No answer is given, or work is very difficult to read.

Engineering Judgment: awarded for demonstrating understanding of physical principles and giving answers that are consistently both reasonable and safe

2 points	1 point	0 points
All components are answered correctly, conservatively to within an order of magnitude of the correct answer, or identified as unreasonable. All final answers use an appropriate number of significant figures. There are no major conceptual errors and fewer than 3 minor conceptual errors.	Some components are missing, slightly unconservative (within a factor of safety of 1.5), excessively conservative (greater than a factor of 10), or expressed using an unreasonable number of significant figures. All conceptual errors are minor.	No answer is given, there is some unidentified dangerously unconservative (greater than a factor of safety of 1.5) answer, or there is a major conceptual error.

McMaster University
Department of Civil Engineering

CIV ENG 4N04, Fall 2013
2013-08-29

Rubric Example 2

Capstone Project Rubric (partial) in ME4M06, Dr. Marilyn Lightstone & Dr. Mukesh Jain

4M06 (2011-2012), Final Project Evaluation, *Project Code*: ________ , *Date*:__________ , *Supervisor*:______________

Design Progress	***1*** ***(not (demonstrated)***	***2*** ***(marginal)***	***3*** ***(meets expectations)***	***4*** ***(outstanding)***	***Mark (/4)***
Project Management *Management of time and funds*	No useful timeline or budget described; poorly managed project; safety issues	Poor timeline or budget; infrequent meetings; minor safety problems	Plans and efficiently manages time and money; team effectively used meetings; safety considerations are clear	Efficient, excellent project plan presented; detailed budget; potential risks foreseen and mitigated	
Social, environmental, and financial factors *Sustainability in decisions*	No consideration of these factors	Factors mentioned but no clear evidence of impact on decision making.	Incorporated appropriate social, environmental, and financial factors in decision making	Well-reasoned analysis of these factors, with risks mitigated where possible	
Information Management *Identification of need (Req'd) & problem definition*	▪ Client needs not assessed ▪ Problem not defined.	▪ Client needs not *thoroughly assessed*[1]. ▪ Problem not *well defined*[2].	▪ Client needs *thoroughly assessed*[1] ▪ Problem well *defined*[2]	▪ Client needs thoroughly assessed[1]. ▪ Problem well defined[2]. ▪ Unexpected insight into client need.	
Gather Information	▪ No Research. ▪ Lack of critical interpretation of information gathered.	▪ Access and critically interpret resources that are *readily available*[3].	▪ Access and critical interpret resources that are readily available[3] and those that *require initiative to identify*[4].	▪ Access and critical interpret resources that are *readily available*[3] and those that *require initiative to identify*[4]. ▪ Recognize and effectively exploit resources that do not initially appear to be relevant to the problem.	
Generate Concepts	▪ No concept that is *valid*[5].	▪ One concept that is *valid*[5].	▪ Two or more distinct concepts that are *valid*[5].	▪ Two or more distinct concepts that are *valid*[5]. ▪ At least one *valid*[5] concept is an unexpected departure from state-or-the-art	
Decision Making	▪ No decision made or decision is not justified	▪ Decision is justified but not in the context of the problem definition and/or information gathered. ▪ Decision is not objective (e.g. affected by client or student bias)	▪ Decision is objective and justified in the context of the problem definition and information gathered.	▪ Decision is objective and justified in the context of the problem definition and information gathered. ▪ In addition the decision is informed by unexpected insight into the client need and resources that do not initially appear to be relevant to the problem.	
Detailed Engineering	▪ Detailed engineering is either not present or is fundamentally flawed. ▪ The design and engineering analysis involved no references and/or use of applicable standards and codes. ▪ Design journals not maintained at all.	▪ Analysis is not *appropriate*[6]. ▪ Analysis is not *verified*[7]. ▪ *Documentation*[8] does not enable implementation. ▪ *Results of analysis are not applied to the design.* ▪ *Design and analysis has some references to possible standards and codes but no explicit use of them is demonstrated.* ▪ *Design journals poorly maintained and by only some members.*	▪ Analysis is *appropriate*[6]. ▪ Analysis is *verified*[7]. ▪ *Documentation*[8] enables implementation. ▪ Results of analysis are applied to the design. ▪ *Design and analysis has made some use of standards and codes.* ▪ *Design journals maintained regularly showing evidence of good design work by most of the group members.*	▪ Analysis is *appropriate*[6]. ▪ Analysis is *verified*[7]. ▪ *Documentation*[8] enables implementation. ▪ Analysis results are applied to the design. ▪ Analysis based on subject matter that is beyond the scope of the undergraduate curriculum. ▪ Design and analysis makes extensive use of standards/ codes. ▪ Design journals maintained regularly and by all members and showing extensive evidence of detailed design work by all.	

1

5. Assessment Design

Student Perspective on Assessment Quality

The qualities of effective assessment design may be derived from examining student reactions to various assessment qualities. What makes an assessment of a good or poor design?

	Good Design	Poor Design	
	Fair	Too High	Too Low
Type	"The lecture actually matters and I'm learning a lot"	Inappropriate type: frustration/poor results/poor learning	
Weighting	"It's worth my time and effort"	Stress "I'm neglecting my other assignments in order to do well on this one."	Low motivation "Why should I spend my time on this?"
Frequency	"I'm well-prepared and I'm improving"	Stress "Too much work. This is redundant"	Low retention "I'm not sure if I really know the material"
Difficulty	"This is a meaningful challenge, and I feel accomplished"	Stress "I have no idea how to complete this"	Low motivation "This is too easy"
Time	"I'm able to focus, plan and manage"	Low motivation/ procrastination "I'll do it later…"	Stress "I don't think I'll be able to complete this on time!"
Example from experience			

Students can develop negative emotional responses towards the work (e.g. resentment, frustrated, stressed, unmotivated, overwhelmed, overworked or bored) due to a poorly designed assessment. All of these lead to poorer performance from the student and poorer results. On the other hand, students can derive deep satisfaction and motivation for learning with assessment activities that are perceived to be relevant, meaningful, challenging, and attainable (with strategy and work) - also in relation to how instructors are perceived to treat student work.

Adjusting Assessment Plan: Example of Team Project

The following example considers a team project where students were overwhelmed with the overlapping assignments from this course and others. Many teams did very poorly on this assignment. Changes were proposed as the following.

Type: This team project will become an individual project. An individual project allows for simpler organization and avoids the logistics of coordinating other group members' schedules.

Difficulty: Since this is now an individual project and since there will be less time to complete the project, some aspects of the project will be eliminated. This should make it less difficult. Lowering the difficulty will reduce the stress and feeling overwhelmed from overlapping assignments.

Time: Time to complete the assignment will be reduced from term-long to 4 weeks (Week 4 - Week 8).

Assessment Design

Frequency: Frequency will not change, as there is no need for more than 1 project

Weighting: Reduce from 40% to 30% to reflect the decrease in demands of the project.

	Previous Assessment	New Assessment
Type:	Team Project	Individual Project
Weighting:	40%	30%
Frequency:	Once	Once
Overall Difficulty:	Hard	Medium
Time Allotted:	Term-long	4 weeks

As seen above, higher level planning decisions can be made to improve the feasibility and potential effectiveness of the assessment. The grunt work, however, now resides in structuring and developing the assessment. There are specific tasks and expected levels of performance required by each assessment. Providing effective prompts (e.g. questions, background information, instructions) in a deliberate sequence is the first step considered for detailed assessment design.

Instructor's Writing in Assessment

According to Leong (2006), the difficulty level of an assessment has multiple parameters. The following table has 3 of these parameters and how to manipulate them to increase or decrease the difficulty of an assessment:

1. **Content** is the actual subject matter that is being targeted for assessment. Are you purposely choosing to assess the harder or easier material of the course?
2. **Stimulus** is the form in which the assessment information is presented to the student. This includes the wording of a question, the form in which it is presented, the way it is organized, any tables or figures.
3. **Task** is the process that the student must undertake to complete the assessment.

For each assessment instrument being administered (e.g. survey, handout, lab instructions), there is considerable work that goes into communicating to students what they are asked to do, and perform in which sequence or format. The amount of information and guidance given, and the actual tasks prompted, all influence the level of difficulty as well as clarity in assessment.

Exercise 1. Write a multiple choice question (MCQ) that tests for a lower level ability, and another MCQ that tests for a higher level ability. How can the questions and answer options be written to test for target ability, rather than test-taking skill or random choice?

Exercise 2. Write a problem-solving question that tests for a practiced skill, and another question that tests for ability to investigate and explore a new (unfamiliar) situation. What kind of prompts and instructions would be needed to prompt adequate student output (required tasks to completely answer the question)?

Example of Assessment Items Development

Simulation Assignment in EP2E04, Dr. Leyla Soleymani

Previous Version:

Demonstration

You will be graded based on two in-lab demonstrations of your design, simulation and implementation.

a) Design and simulation demonstration will grade your design/simulation based on it meeting the following requirements and your ability in answering the following questions:
   - How do you rationalize choosing the parts used?
   - Does your simulated analog/digital circuit meet the design requirements presented in section 2 of this document?
   - How would you improve your design in you had more resources?
   - How would you redesign your circuit to meet additional specific design requirements?

b) Implementation demonstration will grade your implementation based on it meeting the following requirements and your ability in answering the following questions:
   - Does your implemented analog/digital circuit work properly while meeting the specific design requirements presented in section 2 of this document?
   - What are the observed deviations between the implemented and simulated system?

Revised after Graduate Attribute Mapping and Rubric Development:

Demonstration

You will be graded based on two in-lab demonstrations of your design, simulation and implementation.

a) *Design and simulation demonstration* will grade your design/simulation based on it successfully meeting the basic design criteria (section 2) and your ability in answering questions based on those listed below. In addition, you are required to submit the questionnaire response sheet (available on the course website).

1. How do you rationalize choosing the parts used? What resources did you use in understanding the functionality and specification of each part? Did you take any non-technical considerations in choosing these parts (Health and Safety, Sustainability, Economics)? Elaborate.
2. Does your simulated analog/digital circuit meet the design requirements presented in section 2 of this document? Explain the design process you used in reaching this solution. What are the next steps?
3. What tools (test/measure equipment, displays, …) do you use to test/evaluate your circuit model? Why do you use these particular tools?
4. What practical system/s do you envision your design to be used in? What additional design criteria would your design have to meet for this to be possible?

b) *Implementation demonstration* will grade your implementation based on it successfully meeting the basic design criteria (section 2) and your ability in answering questions based on those listed below.

1. Does your implemented analog/digital circuit work properly while meeting the specific design requirements presented in section 2 of this document? If not, present possible explanations and present a redesign plan.
2. What are the observed deviations between the implemented and simulated system? How would you redesign/reoptimize your circuit to ensure a higher performance?
3. Have a look around the lab and at your colleague's solutions to the same problem? Are all the solutions the same? Explain how and why these solutions defer? Compare and contrast your design solution with the solutions of at least 2 other groups.

Questionnaire Response Sheet

R1. Think about the effectiveness of your team, in how you worked together to produce quality work. What were the strengths and weaknesses in your team dynamics (relationships and individual characteristics) that made it easier or more difficult to achieve top results?

R2. Review your team's responses to the questions (a1-4) asked in the first in-lab demonstrations. What were your key findings about the design process and experience? Were these expected?

6. Evaluation

The main purpose of assessment in educational programs is to enhance learning and teaching quality, which are often mutually reflexive. Several considerations deserve attention in reflecting on the assessment practices and results (below). Discuss with your colleagues on how the following may be relevant themes in your assessment practices, and how your findings inform your continuous improvement in teaching practice:

FAIRNESS

ALIGNMENT

EFFECTIVENESS

LEARNING THEORIES

INTERPRETATION OF RESULTS

TRIANGULATION

Reflection

How is assessment a part of good teaching?

What was learned from reviewing my assessment practices?

What are the remaining challenges for effective teaching and assessment in engineering education?

Additional questions for consideration:

- Does the assessment reward and test for the priority objectives of the course?
- How do assessment methods fit together within the course?
- How useful were existing frameworks/theories for explaining student results, evaluating teaching effectiveness, generating the right type of student performance through assessment design?
- How valid are the resulting data from assessment? For evaluation of teaching effectiveness? For measurement of student abilities? For research on student development?
- What do the results mean? Was anything unexpected?

7. Bibliography

Ahmed, A. & Pollitt, A. (1999). Curriculum Demands and Question Difficulty. *Paper presented at IAEA Conference, Slovenia.*

Ahmed, A. & Pollitt, A. (2007). Improving the Quality of Contextualized Questions: An Experimental Investigation of Focus, *Assessment in Education: Principles, Policy & Practice* **14**(2): 201-232

Biggs, J. (2003). Teaching for Quality Learning at University, 2nd ed. Maidenhead, Berkshire: Open University Press.

Borrego, M., Douglas, E. P. & Amelink, C. T. (2009). Quantitative, Qualitative, and Mixed Research Methods in Engineering Education. *Journal of Engineering Education* **98**(1): 53-66.

Borrego, M., Streveller, R. A., Miller, R. L. & Smith, K. A. (2008). A New Paradigm for a New Field: Communicating representations of engineering education research. *Journal of Engineering Education* **97**(2): 147-162.

Brighouse, H. (2006). *On Education*. New York: Routledge.

Brown, G. A., Bull, J., & Pendlebury, M. (1997). *Assessing Student Learning in Higher Education*, New York, NY: Routledge.

Dochy, F, Segers, M., & Sluijsmans, D. (1999). The Use of Self-, Peer and Co-Assessment in Higher Education: A Review, *Studies in Higher Education* **24**(3): 331-350

Falchikov, N. & Boud, D. (1989). Student Self-Assessment in Higher Education: A Meta-Analysis, *Review of Educational Research* **59**(4): 395-430

Falchikov, N. (1995). Peer Feedback Marking: Developing Peer Assessment, *Innovations in Education & Training International* **32**(2): 175-187

Frey, B.B. (2014) *Modern Classroom Assessment*, London, UK: SAGE Publications

Lane, S., Raymond, M., Haladyna, T.M. & Downing, S.M. (2006). *Handbook of Test Development*, Mahwah, NJ: Lawrence Elrbaum Associastes Inc.

Leong, S.C. (2006). On Varying the Difficulty of Test Items. Paper presented at Annual Conference of the International Association for Educational Assessment, Singapore.

Leydens, J.A.,Moskal, B.M., & Pavelich, M.J. (2013). Qualitative Methods Used in the Assessment of Engineering Education, *Journal of Engineering Education* **93**(1): 65-72

McMahon, M., Simmons, P., Sommers, R., DeBaets, D., & Crawley, F. (2006). *Assessment in Science: Practical Experiences and Education Research*, Arlington, VA: National Science Teachers Association

Moskal, B.M., Leydens J.A., Pavelich M.J. (2002). Validity, Reliability and the Assessment of Engineering Education, *Journal of Engineering Education* **91**(3): 351-354

Olds, B.M., Moskal B.M., & Miller R.L. (2013). Assessment in Engineering Education: Evolution, Approaches and Future Collaborations, *Journal of Engineering Education* **94**(1): 13-25

Ross, J.A. (2006). The Reliability, Validity and Utility of Self-Assessment, *Practical Assessment, Research & Evaluation* **11**(10): 1-13. Available online: http://pareonline.net/getvn.asp?v=11&n=10

Sadler, D.R. (1998). Formative Assessment: Revisiting the Territory, *Assessment in Education: Principles, Policy & Practice* **5**(1): 77-84

Scriven, M. (1996). Types of Evaluation and Types of Evaluator, *American Journal of Evaluation* **17**(2): 151-161

Spurlin, J.E., Rajala, S.A. & Lavelle, J.P. (2008). *Designing Better Engineering Education through Assessment*, Sterling, VA: Stylus Publishing

Streveller, R. A. & Smith, K. A. (2006). Conducting Rigorous Research in Engineering Education. *Journal of Engineering Education* **95**(2): 103-105.

8. Worksheets

- Assessment Plan Sheet
- Course Delivery Plan Sheet (content planning)
- Rubric Development Template
- Assessment Item Development Sheet

Assessment Plan for Course (title / code): ______________________________________

Intended Learning Outcomes (in the order of priority, ideally highest level of learning):

#1.

#2.

#3.

Course Schedule	**1/2**	**3/4**	**5/6**	**7/8**	**9/10**	**11/12**	**13/14**	**Final**
General Themes / Notes								
Intended Learning Outcomes (match number above)								
Assessment Type 1: ________________								
Assessment Type 2: ________________								
Assessment Type 3: ________________								
Assessment Type 4: ________________								
Associated graduate attribute indicators								
Submitted Data (collected evidence of learning outcome)								
Grading Weight								
Graded by whom, and how many hours expected total for class								
Form of feedback provided to students:								

Content Delivery Plan: ___________________________ (Course Code)

Course Schedule	1/2	3/4	5/6	7/8	9/10	11/12	13/14	Final
General Themes / Notes								
Key Learning Objectives or GAs								
Sessions (Focus & Major Activities)								
Key Resources (lecturer, materials, location)								
Completed Required Confirmations (if any)								
Special Notes (in-class assessment, etc.)								

Rubric for: ___________________________________ (Assessment Title)

List the indicators in the order of priority for this assessment. What will distinguish between a superb performance from a poor, or average performance?

Indicators	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6	Q 7	Fails to meet expectations	Marginally meets expectations	Meets expectations	Exceeds expectations

Assessment Items Development: ________________________ (Assessment Title)

Assignment # - Question #	Content or Training:	Prompts / Instructions / Questions:	Associated Graduate Attribute Indicator (if applicable)

Appendix I. Definitions of Common Terms

Assessment: Assessment in the classroom can include a wide variety of activities for students to complete. However, to be considered an "assessment" these activities must provide the instructor with information. With this information, an evaluation on the student can be made. So, in summation, an assessment is an activity that provides the instructor with information with which they can evaluate the student.[3]

Self-Assessment: "Self-assessment refers to the involvement of learners in making judgement about their own learning."[4] Self-assessment is a method to help students reflect on their work, and a method in which the instructor can probe the student's thoughts. Self-assessment can be either qualitative or quantitative, and can either be for marks or not.

Peer-Assessment: "Peer-assessment is a process in which groups of individuals rate their peers."[5] Getting feedback from their peers can be incredibly helpful, as it shows the student how their work and learning level compares. Through peer-assessment, students develop skills such and giving and receiving constructive criticism.

Formative: Formative assessment monitors student learning, provide info to be used as feedback to modify the teaching and learning activities. Formative assessments are a means to provide feedback while teaching and learning is taking place. It is a way for which the instructor to adapt to the learning needs of their students.[6]

Summative: Summative assessment evaluates students learning, measures how much a student has learned. Summative assessments are an evaluation of student learning. They are outcome focused and are for marks.[7]

Interim Assessment: Interim assessments are short tests for immediate feedback given periodically throughout the term. Interim are typically worth marks but this is not a necessity. An example of an interim assignment would be a chapter quiz.

Feedback: Feedback is any information given in regards to performance on a task. Feedback can be either verbal or non-verbal and can be given by an instructor, a T.A., the student's peers and even the student themselves. As an instructor, it is imperative to give students feedback on their assignments, as it is a crucial tool for improvement and reflection. Students can also give feedback to instructors through course evaluations.[8]

Rubric: A rubric is a standard of performance for a defined population. A rubric is typically designed in a table where each row represents a section of the assessment to be marked and each column represents the level of achievement the student accomplished for each section. A rubric is an educational tool designed and used by instructors, and often given to students prior to marking to communicate the instructor's expectations of them.[9]

Scaffolding: In assessment design, scaffolding refers to a way of modeling an assessment by beginning an assessment with relatively easy questions, and increasing the difficulty of the questions as the student progresses through it. This is done to give students confidence early on before facing a more challenging task. An example of this would be a final exam where the first few questions are relatively easy, and the last questions are relatively more challenging.[10]

---

[3] Frey B.B. (2014) *Modern Classroom Assessment*, London, UK: SAGE Publications
[4] Falchikov N. & Boud D. (1989). Student Self-Assessment in Higher Education: A Meta-Analysis, *Review of Educational Research* **59**(4): 395-430
[5] Falchikov N. (1995). Peer Feedback Marking: Developing Peer Assessment, *Innovations in Education & Training International* **32**(2): 175-187
6 Frey B.B. (2014) Modern Classroom Assessment, London, UK: SAGE Publications
7 Scriven M. (1996). Types of Evaluation and Types of Evaluator, American Journal of Evaluation 17(2): 151-161
[8] Sadler D.R. (1998). Formative Assessment: Revisiting the Territory, Assessment in Education: Principles, Policy & Practice 5(1): 77-84
[9] The National Science Education Standards (1996), http://www.nap.edu/openbook.php?record_id=4962&page=75) page 93
[10] Bransford, J., Brown, A., & Cocking, R. (2000). How People Learn: Brain, Mind, and Experience & School. Washington, DC: National Academy Press.

Appendix II. Rubrics Examples from Other Institutions

The following rubrics are selected samples from a larger compilation by Auburn University, Department of Chemical Engineering, downloaded from http://www.eng.auburn.edu/programs/chen/programs/accreditation/assessment-rubrics.html.

Written communication assessment rubric

Topic	Unacceptable (0)	Marginal (1)	Acceptable (2)	Exceptional (3)
Spelling & Grammar	Numerous spelling and grammatical errors.	Several spelling and grammatical errors.	Minor misspellings and/or grammatical errors.	Negligible misspellings and/or grammatical errors.
Content & Knowledge	No grasp of information. Clearly no knowledge of subject matter. No questions are answered. No interpretation made.	Uncomfortable with content. Only basic concepts are demonstrated and interpreted.	At ease with content and able to elaborate and explain to some degree.	Demonstration of full knowledge of the subject with explanations and elaboration.
Organization & Style	Sequence of information is difficult to follow. No apparent structure or continuity. Purpose of work is not clearly stated.	Work is hard to follow as there is very little continuity. Purpose of work is stated, but does not assist in following work.	Information is presented in a logical manner, which is easily followed. Purpose of work is clearly stated assists the structure of work.	Information is presented in a logical, interesting way, which is easy to follow. Purpose is clearly stated and explains the structure of work.
Format & Aesthetics	Work is illegible, format changes throughout, e.g. font type, size etc. Figures and tables are sloppy and fail to provide intended information.	Mostly consistent format. Figures and tables are legible, but not convincing.	Format is generally consistent including heading styles and captions. Figures and tables are neatly done and provide intended information.	Formant is consistent throughout including heading styles and captions. Figures and tables are presented logically and reinforce the text.
References	No referencing system used.	Inadequate list of references or references in text. Inconsistent or illogical referencing system.	Minor inadequacies in references. Consistent referencing system.	Reference section complete and comprehensive. Consistent and logical referencing system.

Data Analysis / Experimental Design Assessment Rubric

Topic	Unacceptable (0)	Marginal (1)	Acceptable (2)	Exceptional (3)
Interpretation of Data	Little to no attempt to interpret data or over-interpreted data	Interpreted some data correctly. Significant errors, omission, or over-interpreted data.	Interpreted most data correctly. Some conclusions may be suspect or over-interpreted.	Data completely and appropriately interpreted. Not over-interpreted.
Effectiveness of Experimental Design and/or Procedures	Very ineffective. Would not allow experimenters to achieve any goals.	Somewhat ineffective. Would allow experimenters to achieve some goals.	Somewhat effective. Would allow experimenters to achieve most goals.	Effective. Would allow experimenters to achieve all goals.
Execution of Procedures	Demonstrated little or no ability to conduct experiments. Did not collect meaningful data.	Demonstrated some ability to conduct experiments. Collected some meaningful data.	Demonstrated adequate ability to conduct experiments. Collected most of the needed data.	Demonstrated superior ability to conduct experiments. Collected all the appropriate data.
Statistical Methods: Error Analysis, Regression, etc.	Statistical methods were completely misapplied or absent.	Statistical methods were attempted. Some methods were applied but with significant errors or omissions.	Statistical methods were attempted. Most methods were correctly applied but more could have been done with the data.	Statistical methods were fully and correctly applied.
Focus of Results and Discussion	No insight. Entirely missed the point of the experiment.	Little insight. Analyzed only the most basic points.	Adequate insight. Missed some important points.	Excellent insight. Results and discussion well focused.

Oral Presentation Rubric

Topic	Unacceptable (0)	Marginal (1)	Acceptable (2)	Exceptional (3)
Organization & Structure	Not possible to understand presentation due to absence of structure.	Difficult to follow presentation due to erratic topical shifts and jumps.	Most information is presented in logical order which is easy to follow.	All information is presented in a logical, interesting and novel sequence, which is easily followed.
Content & Knowledge	No grasp of information. Unable to answer questions about subject.	Uncomfortable with information. Capable only of answering rudimentary questions.	At ease with content and able to elaborate and explain to some degree.	Demonstration of full knowledge of the subject with explanations and elaboration.
Visual Aids & Neatness	No visual aids.	Occasional use of visual aids, however they barely support text or presentation. Several mistakes and/or grammatical errors on slides.	Visual aids are related to text and presentation. Minor misspellings and/or grammatical errors.	Text and presentation are reinforced by the use of visual aids. Negligible misspellings and/or grammatical errors.
Delivery & Speaking Skills	Significant mumbling and incorrect pronunciation of terms. Voice level too low or too high. Monotonous, no eye contact, rate of speech too fast/slow.	Occasional mispronunciation of terms. Little eye contact, uneven rate, only little expression.	Voice is clear and at a proper level. Most words pronounced correctly. Some eye contact, steady rate, excessively rehearsed.	Clear voice and correct, precise pronunciation of terms. Good eye contact, steady rate, enthusiasm, confidence
Presentation Length	Too long of too short. +/- 10 minutes	+/- 6 minutes	+/- 4 minutes	+/- 2 minutes

Ethics, Safety, Society, Environment Assessment Rubric

Topic	Unacceptable (0)	Marginal (1)	Acceptable (2)	Exceptional (3)
Professional Integrity & Ethical Decision Making	No evidence of any appreciation and/or understanding of professional integrity and/or ethics Incapable of answering any questions on the subject.	Serious deficiencies in appreciation and/or understanding of professional integrity and/or ethics. Only rudimentary questions are answered. Not able to elaborate or explain.	Sound understanding of and mostly effective in addressing issues related to integrity and ethics. Most decision and recommendations are supported and can be justified. Some elaboration and explanations given.	Clear and complete understanding of and effective in addressing issues related to integrity and ethics. Decisions and recommendations are supported and discussed along with elaboration and explanation.
Safety & Health Issues	No understanding or appreciation of safety and health related issues.	Serious deficiencies in addressing health and safety issues leading to an unsupported and/or infeasible result.	Sound understanding of health and safety issue. Mostly effective in achieving supported results.	Complete understanding of health and safety issues leading to sound and supported results.
Environmental Aspects	No understanding or appreciation of the importance of environmental concerns/	Environmental aspects are addressed ineffectively with little or no effect on end results.	Sound understanding of environmental aspects. Mostly effective in addressing environmental issues.	Complete understandings of environmental aspects. Effective in addressing of environmental issues leading to a better result.
Public Interest & Societal Impact	No consideration of public interest or societal impact. None or erroneous evaluation of global effects of engineering project/product.	Serious deficiencies in understanding public interest and/or societal impact. Ineffective evaluation of impact of engineering project/product adversely affects result.	Sound understanding of public interest and societal impact. Mostly effective evaluation of engineering project/product impact leads to improved results.	Complete understanding of public interest and societal impact. Effective assessment of engineering project/product impact support and explain results.

Design Project Assessment Rubric

Topic	Unacceptable (0)	Marginal (1)	Acceptable (2)	Exceptional (3)
Design Problem & Boundaries	Little or no grasp of problem. Incapable of producing a successful solution.	Some understanding of problem. Major deficiencies that will impact the quality of solution.	Overall sound understanding of the problem and constraints. Does not significantly impair solution.	Clear and complete understanding of design goal and constraints.
Alternative Designs	Only one design presented or clearly infeasible alternative given.	Serious deficiencies in exploring and identifying alternative designs.	Alternative approaches identified to some degree.	Final design achieved after review of reasonable alternatives.
Use of Computer-Aided Tools	Serious deficiencies in understanding the correct selection and/or use of tools.	Minimal application and use of appropriate tools.	Computer-aided tools used with moderate effectiveness to develop designs.	Computer-aided tools are used effectively to develop and analyze designs.
Application of Engineering Principles	No or erroneous application of engineering principles yielding unreasonable solution.	Serious deficiencies in proper selection and use of engineering principles.	Effective application of engineering principles resulting in reasonable solution.	Critical selection and application of engineering pinciples ensuring reasonable results.
Final Design	Not capable of achieving desired objectives. No implementation of resource conservation and recycle strategies.	Barely capable of achieving desired objectives. Minimal utilization of resource conservation and recycle potentials.	Design meets desired objectives. Moderately effective utilization of resource conservation and recycle potentials.	Design meets or exceeds desired objectives. Effective implementation of resource conservation and recycle strategies.
Process Economics	No or totally erroneous cost estimates presented.	Reasonable cost estimates presented, but no profitability analysis included.	Reasonable profitability analysis presented, but no interpretation of the results.	Effective use of profitability analysis leading to improvement recommendations.
Interpretation of Results	No or erroneous conclusions based on achieved results.	Serious deficiencies in support for stated conclusions.	Sound conclusions reached based on achieved results.	Insightful, supported conclusions and recommendations.