Learning Assessment of Core Outcomes
Suggested Focus 2009-2010: Critical Thinking and Problem Solving

SAC Name: Microelectronic Technology

Contact Name, phone, and email: Shelton Fu, 7620, sfu@pcc.edu

1. **Please describe your plan of action for 2009-2010 Academic Year:**

Assessment part 1 on circuit curriculum was submitted already.

<u>Learning Assessment of Core Outcomes:</u>
<u>Critical Thinking and Problem Solving 2009/2010</u>

SAC Name: Microelectronics Technology (MT)

Contact Name, phone, and email: Shelton Fu, sfu@pcc.edu,

1. **Please describe your plan of action for 2009-2010 Academic Year:**

The MT SAC decided to assess the Critical Thinking and Problem Solving outcome this academic year in two different classes, MT 112 and MT 228. The assessment was done differently in the two classes, as it follows.
MT 112: Although many of our teaching strategies used in all MT classes are targeting the development and enhancement of our students' critical thinking ability, <u>a special lab exercise</u> was designed by the instructor teaching the MT 112 Electric Circuit and Devices II class. Two iterations of the class were offered during winter term , and one during spring term in 2010. Every time the class was offered, the lab was performed by all the students enrolled. The particularity of this lab experiment-used as outcome assessment tool- lays in the fact that no "step by step" directions were presented to the student. Instead, the very limited information was provided was meant to engage their creativity, to make them explore the "new", formulate and articulate totally new ideas, and reason toward an important application of transformers, without any kind of input from the instructor.

2. **When your project is completed, please describe the method(s) you used** *(for example, if you used a rubric, include the rubric and what courses student artifacts were collected from, including the number examined; if you interviewed students in a focus group, list the times, the number of students; etc.)*:

Methods Used in MT 112 class (instructor Dorina Cornea):

- The instructor designed one special project about "TRANSFORMERS" and their applications. With very few explanations, the problem statement was formulated in this way: "**Why not generate, transmit, and distribute the electricity at a voltage of 120V**?"
- The expectations were formulated:

   a. First, try and answer the question from above. You may do any kind of research, talk to your lab partner, read the text book, but do not consult with the instructor during this "investigation phase".
   b. Once you think you have the right answer, devise an experiment based on the equipment and devices that are available in the lab, that will prove correct your point of view. In this phase of the project, please work in groups of two, not more. Present the proper documentation (schematic with proper connections, voltage-current values assigned (estimated), proper use of test equipment like oscilloscope and/or DMM, etc) to your instructor for approval. After receiving the OK, please proceed with the experiment in the lab. You have to prove your theoretical answer through measurements and do a demo to your instructor.
   c. The final demo will be accompanied by a power point presentation containing any pertinent info about the experiment, including conclusions drawn from the entire learning experience.

- The assessment of the student’s performance was done based on the following rubric:

Level 1 Limited demonstration of understanding the problem and has some wrong or very modest ideas about how to answer the questions asked. The student needs full assistance from the instructor or from other class mates in order to do respond to the lab requirements.	**Instructor Comments**
Level 2 Basic demonstration of understanding the problem and has some ideas but is not able to produce a documentation that would lead to the implementation of the lab experiment. Needs a lot of assistance in order to come up with a design.	
Level 3 The student comprehends the problem and is able to come up with clear and creative ideas to prove his point. The student presents a correct solution on paper but struggles implementing it, testing the transformers available, or using the test equipment.	
Level 4 The student quickly comprehends the problem and comes up with clear and creative ideas to prove his point. The student presents a correct solution on paper and implements successfully the schematic using the transformers and the test equipment in a creative but safe and proper way.	
Level 5 The student quickly comprehends the problem and comes up with clear and creative ideas to prove his point. The student presents a correct solution on paper and implements successfully the schematic using successfully the transformers in a creative way, showing intuition and practical sense in using the test equipment. The demonstration of the results of the devised experiment is followed by a clear presentation in front of the class.	

- One copy of each power point presentation along with the score obtained (based on the above mentioned rubric) were collected from every student and saved in a folder in the instructor's office for future reference.

- Statistics of the finalized assessment as of May 2010, more will be available after June 12, 2010:

Total number of students assessed	14*
Total number of sample work saved	12
Results based on the rubric above	Level 2-1 student Level 3-6 students Level 4-2 students Level 5-3 students Average level: **3.58** (maximum level: 5) *(Two students did not turn in the work for assessment.)

3. What did you learn?

MT 112 assessment: The outcome assessment methods especially designed and implemented by the MT SAC did work. Designing them required a considerable amount of time, but considering that they will be reused, we are looking at the entire process as at a good investment.

Although the grade or "level placement" on this assessment did not affect the traditional class grade, all the students seemed to be interested in placing in the higher possible level. The two students who placed on level 5 happen to be the students with the highest level of work experience; not enough data points to be sure about a correlation between work experience and "critical thinking skills" but a high possibility.

4. What changes, if any, are you making or recommending as a result?

Since the design of outcome assessments tools is difficult and time consuming, I am hoping that some of the tools developed by our SAC will have "multiple use", assessing simultaneously two or more outcomes.

5. Follow up in 2010-2011 based on any changes you have made:

Explanation: Each SAC is asked to do some learning assessment activity focused on the above outcome (or other, if appropriate). The idea is that each SAC does something in order to help the college understand how we individually or collectively are helping students to achieve this core outcome.

For Core Outcomes, see: http://www.pcc.edu/resources/academic/core-outcomes/index.html)
For further guidance, see: http://www.pcc.edu/resources/academic/learning-assessment/
(Dates: January 15, 2010: #1 completed; **May 14, 2010: 2-4 completed**)"

Completion:

Assessment part 2 on equipment trouble-shooting is described here. We ask all students in the MT228 class to go through an on-demand performance test—a practical. The Instructor is to set up one error scenario on a Lam Rainbow etcher ahead of time. Students are asked to trouble-shoot and fix the problem.

6. **When your project is completed, please describe the method(s) you used** *(for example, if you used a rubric, include the rubric and what courses student artifacts were collected from, including the number examined; if you interviewed students in a focus group, list the times, the number of students; etc.)*:

MT Troubleshooting Practical Test

Test Description:
Test Time: At the end of MT228 class, which is also usually the end of a student's MT curriculum. Each test can take up to 4~5 hours.
Test format: individual practical exam
Description: Instructor to set up one error scenario on a Lam Rainbow etcher ahead of time. Students are asked to trouble-shoot and fix the problem. The student can access schematics of the etcher. In the 1st part of the test, the student is asked to isolate the problem down to ever smaller blocks of the system using a systematic approach. After the problem is reasonably isolated, the student is given the freedom to solve the problem without following a systematic methodology in the second part.
Step 1: Perform a prescribed task on the etcher during which the student will discover an error. At this point the student will be asked to write down a problem statement.
Step2: Draw a block diagram of the whole system involved in the problem, including all the sub-systems involved and all the components within the subsystems. Instructor can ask the student to identify all possible culprit blocks and describe how they can produce the problem.
Step3: Divide the system in the block diagram into blocks.
Step4: Design an isolation test for each block to see if that block is responsible for the problem. The test needs to be definitive, comprehensive, and as easy as it is to implement. When writing out the tests in the following format:

Test description	Possible outcome	Conclusion

Step5: Prioritize the order of the tests based on the balance between how likely the cause is and how easy it is to implement the test.
Step 6: Implement the tests
Step7: Correctly interpret the test results

After the first round of isolation, more rounds of isolation may be needed. However, students are no longer required to write down the steps. But the instructor can still choose to follow and grade the student in the isolation process.

<u>Grading Guideline</u>:

Proficiency level definition: the overall criterion for qualifying for proficiency is that a student should be able to either solve an easy problem with minimal help from the instructor or solve an intermediate problem with some help, as described in the following chart.

help needed vs. difficulty level	minimal	some (in one out of multiple major blocks)	substantial (more than one out of multiple major blocks)
Easy	P	F	F
Medium	P	P	F

P = pass, F = fail

A further **<u>rubric</u>** is developed as a guideline for grading.

		Excellent	Good	Proficient	Below standard
Systematic Isolation	block diagram	1*,2>90%,3>70%, 4<10%	1, 2>80%, 3>60%, 4 <20%	(1,2,3,4) majority correct; for unfamiliar problems: (1,2,3,4)>50%	
	Division into blocks	1 or 2	1 or 2	(1 or 2) majority correct; for unfamiliar problems: (1,2,3,4)>50%	
	Design of isolation test	1>90%,2>80%,3>80%	1>75%, 2>66%, 3>66%	1 & 2 majority correct; for unfamiliar problems: (1&2)>50%	
	Prioritization of tests	1&2	1OR2	Proficiency not gauged on this category	
	Carrying out test	1	2	3	4
	Interpretation of test result	>90% accurate	>85% accurate	Majority accurate; for unfamiliar problems: >50% accurate	
Safety		No issue	No major issue	Proficiency not gauged on this category	
Identification of cause		Yes, with minimal help	Yes, w/ minor help	Yes, w/ some help (little help in easy problems, some help in medium problems); for unfamiliar problems: <50% help	
Fixing the problem		Yes with some help		Proficiency not gauged on this category	

* See scoring standard table below for explanations.

Scoring Standard Table:

block diagram	Division into blocks	Design of isolation test	Prioritization of tests	Carrying out test
1. Can come up with major subsystems and their relations 2. Can come up with detailed components 3. Can identify all possible culprit blocks and describe how they can produce the problem 4. When identifying all possible culprits, included no irrelevant blocks	1. Division follows natural divisions between subsystems 2. Division facilitates isolation of the problem	1. tests are definitive 2. tests are comprehensive 3. tests are easy to implement * if using data from several rounds of isolation, take the highest score * some blocks are easier than others for iso test design, use the easiest block for grading	1. considered probability of the cause 2. considered the expediency of the test	1. can carry out with minimal help 2. with help only in difficult tests, or in minor details 3. with some help, but only in one out of multiple major parts 4. with help but in more than one out of multiple major parts * When a student is solving a more difficult problem than usual, grader can relax this score by one level, i.e., a 4 becomes a 3, etc.

7. What did you learn?

Learning about the assessment method itself:

1) Need to allocate adequate time for the test, 4~5 hours.
2) Need to keep students' original work for better post mortem analysis.
3) Need to map out factors that cause variability in scores before developing scoring guideline, else scoring will not be consistent. We found variability in this test includes: level of difficulty of the problem, whether the problem is a familiar problem to student or an unseen one, the amount of help/hint students received, round-to-round variability when several rounds of isolation is required, block-to-block variability when several blocks are examined by a student.
4) Grading of Identification of The Cause should take into consideration of degree of isolation. A highly isolated solution should receive partial credit even though the problem is not exactly identified.
5) As it is, the test only measure how fast a student can solve a problem by measuring whether the student is choosing the fastest route at each decision point. Some students took too long to perform a task, such as reading schematics, this in-efficiency is currently not measured.

Assessment of student learning on equipment trouble-shooting:

1) As expected, student competence in this area is on par with results from previous years. The only exception is in the category of isolation test design, where student performance improved. This is probably caused by more coverage of how to utilize redundant/known good systems for testing out a block.

2) Currently, our A and B level students can solve intermediate level problems with some or minimal help but our C level students can not. This means C level students would fail this test. It should be that the C level students can pass the test, the D or F level students should fail the test. This is a significant deficiency.
3) This failure rate among our students is primarily caused by a shift to a higher proficiency level by the instructor. The higher standard was implemented this year. C students would have passed under the old proficiency standard.
4) The shift in the proficiency standard is necessitated by our anticipation of a higher expectation on trouble-shooting skills of our graduates by their employers in the future. In the past, most of our students were hired by Intel. Intel had a different model of utilization of technicians that demands less technical skills than other companies. Now more of our students are hired by other companies.
5) We need to make up this gap between our current student performance level and the raised requirement of our industry partners.

8. What changes, if any, are you making or recommending as a result?

1) Lengthen curriculum hours dedicated to trouble-shooting training.
2) Incorporate training on basic trouble-shooting methodology throughout MT curriculum to reinforce the training. The possible insertion spots are: a) MT121 Lab7 can be a multiple block circuit (counter-decoder-7segment two system cascaded system) trouble-shooting lab. Take out the extensive explorative learning on K-map construction to compensate for the time consumption. B) MT224 DC motor trouble-shooting lab. C) We can dedicate a lot more time in the vacuum class MT223 on systematic isolation methodology of vacuum systems.
3) Some basic requirements such as being able to draw block diagrams of the pneumatic system, pressure regulation system, etc. have to be stated explicitly to students. They also have to be repeatedly tested to reinforce the learning.
4) Repeat canned isolation test designs to students
5) Give students more practice of typical (if not canned) test designs
6) Ask students to go through post mortem learning after each trouble-shooting exercise to capture and reinforce the learning.

9. Follow up in 2010-2011 based on any changes you have made:

Some or all of the above suggestions should be implemented next year.

Explanation: Each SAC is asked to do some learning assessment activity focused on the above outcome (or other, if appropriate). The idea is that each SAC does something in order to help the college understand how we individually or collectively are helping students to achieve this core outcome.

For Core Outcomes, see: http://www.pcc.edu/resources/academic/core-outcomes/index.html)
For further guidance, see: http://www.pcc.edu/resources/academic/learning-assessment/
(Dates: January 15, 2010: #1 completed; May 14, 2010: 2-4 completed)