

Program-Level Assessment: Annual Report

Program Name (no acronyms): Computer Engineering

Department: Department of Civil, Computer and Electrical Engineering

Degree or Certificate Level: Undergraduate

College/School: School of Science and Engineering

Date (Month/Year): 08/2023

Assessment Contact: Dr. Kyle Mitchell

In what year was the data upon which this report is based collected? AY 21/22

In what year was the program's assessment plan most recently reviewed/updated? Major Update Presently In progress

1. Student Learning Outcomes

Which of the program's student learning outcomes were assessed in this annual assessment cycle? (Please list the full, complete learning outcome statements and not just numbers, e.g., Outcomes 1 and 2.)

(5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

Historical Outcomes:

(d) an ability to function on multidisciplinary teams

(6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

Historical Outcomes:

(b) an ability to design and conduct experiments, as well as to analyze and interpret data

(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

(7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Historical Outcomes:

(i) a recognition of the need for, and an ability to engage in life-long learning

2. Assessment Methods: Artifacts of Student Learning

Which artifacts of student learning were used to determine if students achieved the outcome(s)? Please describe and identify the course(s) in which these artifacts were collected. Clarify if any such courses were offered a) online, b) at the Madrid campus, or c) at any other off-campus location.

(5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

ECE3090 – Project Notebook, the students are required to tag two places they have documented this.

ECE4800 / ECE4810 – Group Meeting Minutes on Project Web Page.

(6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

ECE3151 – Vowel Recognition Report

ECE3090 – Battery Resistance Experimental Report

(7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

ECE3090 – Battery Res: Design Report + Experimental Procedure.

ECE4800 / ECE4810 – Project Notebook, the students are required to tag two-places they have documented this.

All classes assessed were taught as onsite (St. Louis) lab classes with lecture session as necessary. These classes are not offered in Madrid, but will change in the coming years as they implement a CpE program.

3. Assessment Methods: Evaluation Process

What process was used to evaluate the artifacts of student learning, and by whom? Please identify the tools(s) (e.g., a rubric) used in the process and **include them in/with this report document** (do not just refer to the assessment plan).

Each of the artifacts were assessed by two faculty members from the program (due to the programs only having four faculty at the time of review). These assessments were collated and presented to the entire program faculty. The recommendations from these three assessments were discussed by the full program faculty and program improvements developed.

For each of the following assignments assessors are instructed to:

For each indicator, assess three of the presented material. Give each material assessment a score from 1-3 based on the rubric. If the material does not deem to match the rubric then score the material a 1. Observations and recommendations are required for any material scoring a 1, they are recommended for any observations scoring a 2. Observations and recommendations are still welcome for those material scoring a 3.

Note: All rubrics are included at the end of this report.

(5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

Outcome 5 was assessed using a total of 6 samples from 2 assignments. These assignments were the project notebook from ECE 3090 and Group Meeting Minutes on Project Web Page. From ECE 4800/4810

(6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

Outcome 6 was assessed using a total of 6 samples from 2 assignments. These assignments were the Vowel Recognition Report from ECE3151 and the Battery Resistance Experimental Report from ECE3090.

(7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Outcome 7 was assessed using a total of 6 samples from 2 assignments. These assignments were the Battery Resistance Design Report + Experimental Procedure from ECE3090 and the Project Notebook from ECE4800/4810.

4. Data/Results

What were the results of the assessment of the learning outcome(s)? Please be specific. Does achievement differ by teaching modality (e.g., online vs. face-to-face) or on-ground location (e.g., STL campus, Madrid campus, other off-campus site)?

There is no difference in teaching modality as the majority of these classes only have one section.

(5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

There was evidence that students were working as a team. There is still a lack of evidence that the students are setting, working toward and reporting on individual goals.

Outcome 5 Results Summary for ECE 3090 Project Notebook Review – Indicator #1

Reviewer	Team	Rubric Score	Comments
1	1	1	Both of their self-identified entries were for the first meeting of a project, not sure how these entries demonstrate reporting results
	2	1	One of their entries is a report, the other is an assignment The reports back are just statements of done and not a reporting of knowledge.
	3	1	There tasks and reports contain no specifics or details
2	1	1	ECE3090 #1: action items are qualitative rather than quantitative and the reporting on those action items to be too brief if at all (not good).
	2		ECE3090 #2: action items are qualitative rather than quantitative, the reporting on those action items to be too brief if at all (not good).
	3		ECE3090 #3: action items are somewhat quantitative, those action items are reported on in the meetings (somewhat good). ECE3090: Overall it appears that the student knew what this indicator is asking and tagged reasonable locations in their project notebooks.

Outcome 5 Results Summary for ECE 3090 Project Notebook Review – Indicator #2

Reviewer	Team	Rubric Score	Comments
1	1	2	Their tasks need to be more specific, their second Orange tab set given the exact same task to two people.
	2	2	Their tasks are not specific enough
	3	1	One set of tasks is separate the other looks to be one task for the whole group.
2	1	2	N/A
	2		N/A
	3		N/A

Outcome 5 Results Summary for ECE 4800/4810 Project Notebook Review – Indicator #1

Reviewer	Student	Rubric Score	Comments
1	6B	1	The Accomplishments, while listed have no detail. This set of minutes/notes is worthless for documentation The assigned tasks as written are very general, they need to be much more specific. There are a number of people assigned the same task is trouble (i.e. Meeting 4)
	5C	1	There is very little in the way of presenting results. The assigned tasks as written are very general, they need to be much more specific.
	4C	1	There is no detail of Weekly Goals or results.
2	6B	1	ECE4800 JD: action items are somewhat general but reporting is quantitative (fairly good)
	5C		ECE4800 JG: action items are general and not delineated by team member. reporting is weak. (not good)
	4C		ECE4800 SB: action items and reporting virtually non-existent (not good).

Outcome 5 Results Summary for ECE 4800/4810 Project Notebook Review – Indicator #2

Reviewer	Student	Rubric Score	Comments
1	6B	1	For the first several months the tasks were the same for everyone. It was not until semester 2 that the task started to show di- vision of labor. The task statements were still very non-specific.
	5C	2	While the tasks lack specific details, there is evidence that each team member is assigned a different task.
	4C	1	???
2	6B	2	N/A
	5C		N/A
	4C		N/A

(6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

The teams in ECE 3090 seem to be performing well on this outcome. The collected evidence from ECE 3151 seems to be the wrong deliverable and not be where the students discussed this outcome.

Outcome 6 Results Summary for ECE 3151 Vowel Recognition Reports – Indicator #1

Reviewer	Team	Rubric Score	Comments
1	1	1	There is little evidence of procedure, there is nothing that could be followed to reproduce the results. Decision trees are demonstrated, but evidence of their construction is presented.
	2	0	The procedure in the report does not give sufficient detail for someone else to reproduce the results. I see no discussion of using energy bands being defined as part of the tree development.
	3	0	
2	1	2*	In terms of describing a procedure teams went through, no team provided any meaningful explanation. It appeared all the groups simply used trial-and-error. The procedures were not well explained.
	2		
	3		

Outcome 6 Results Summary for ECE 3151 Vowel Recognition Reports – Indicator #2

Reviewer	Team	Rubric Score	Comments
1	1	1	There is evidence that sounds have been analyzed to determine if they can for a classifier, but this was done on speaker basis and not vowel sound basis.
	2	1	There is a discussion of the error rates they achieved, but there is not analysis that demonstrates the vowel sound have been considered individually.
	3	2	There is discussion that energy bands were developed for each vowel, but it is unclear how this was used/combined to generate the tree. The assessment is not with respect to each vowel sound and is presented as a total across all the recordings.
2	1		
	2		
	3		

Outcome 6 Results Summary for ECE 3090 Battery Report – Indicator #1

Reviewer	Team	Rubric Score	Comments
1	1	2	The procedure is a little scarce and has some problematic statements, the Component number differ between their circuits, but it is sufficient after several readings. There are no data tables, but the data to be taken is spelled out in the procedure.
	2	3	The procedure references things before they are presented and does not indicate where to find them The technique is problematic in its data collection approach.
	3	2	Not sure what the note in Step 3 means I do not think Step 5 can be achieved This entire procedure is problematic outside simulation
2	1		Procedures: In many cases the procedures required the experimenter to decide upon resistor and/or capacitor values to use in the experiments. In this sense, the procedure is not well defined. In other cases the procedures did not give blank data tables to indicates exactly what values are to be acquired from the setup. I thought teams #2 and #3 had reasonably well-defined reports but team #1 was lacking. The main deficiency was in the analysis portion of the procedures. Reports: The battery experimental results were lacking in report #1 because no raw data was presented, report #2 gave results but it was hard to determine how they found accuracy, report #3 gave data but there didn't appear to be any accuracy or precision results given as required.
	2		
	3		

Outcome 6 Results Summary for ECE 3090 Battery Report – Indicator #2

Reviewer	Team	Rubric Score	Comments
1	1	2	The data is evaluated for final error, but there was no analysis of how individual data point impacted the final error.
	2	2	The team recognized their results were not successful. They did identify one source that could be a major contributor, but they did not suggest how to improve this measurement.
	3	3	
2	1		
	2		
	3		

Outcome 6 Results Summary for ECE 3090 Battery Report – Indicator #3

Reviewer	Team	Rubric Score	Comments
1	1	1	The procedure was followed, but there is not reflection or suggested improvements, there is no recognition of sources or error.
	2	2	They did not address any of the short comings, but they did identify some of them
	3	2	Was the capacitor measured at frequency? What does 'Both channels need to be set to AC coupling because the DC voltage should be observed by the capacitor', mean If they used a bench scope to measure the voltage across then they introduced error. What is this difference ratio? They did look at their data and decide to take additional frequencies
2	1	2*	
	2		
	3		

(7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

The students seem to be doing an OK job on outcome 7. However we need to better quantify where in the senior design notebook we should expect to find evidence of this outcome.

Outcome 7 Results Summary for ECE 3090 Battery Report – Indicator #1

Reviewer	Team	Rubric Score	Comments
1	1	2	The presentation of the Lit review is not a story but a table of synopsis
	2	1	The presentation of the Lit review is not a story but a table of synopsis. The synopsis stated what was learned, but they did not share this info with the reader. The References in the procedure were not in the document
	3	2	The students do tell a story, but they acknowledge that they were not successful in using references to understand their references. It is not clear where the references are used in this document
2	1	3*	All the design reports demonstrated that teams acquired resources, read them and assessed them for knowledge needed to design the experiment. The main issue is whether the teams were able to correctly apply what they had learned. I think generally speaking it seemed that 2 of the 3 teams understood the basic concepts and applied them correctly. I even think the third team understood the general concepts but they struggled to articulate that in their experimental procedure.
	2		
	3		

Outcome 7 Results Summary for ECE 4800 Project Notebook – Indicator #1

Reviewer	Team	Rubric Score	Comments
1	1		In looking through the notebooks, I saw many places where there were strong indications, if not outright statements, where knowledge was gained through references. Those references were often poorly referenced and I don't think I would be able to find the exact same reference if I tried. It was hard to determine whether that new knowledge was adequately implemented.
	2		
	3		
2	1		
	2		
	3		

5. Findings: Interpretations & Conclusions

What have you learned from these results? What does the data tell you? Address both a) learning gaps and possible curricular or pedagogical remedies, and b) strengths of curriculum and pedagogy.

(5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

Recommendations:

- Students need to learn how to write QUANTITATIVE goals for themselves. This needs to be reinforced in sophomore level classes more through projects, laboratory expectations, and/or in-class learning exercises during typical lecture style courses.
- I think we need a better and more consistent way of giving students feedback. Rather than grading (check marks), I think self-reflection surveys periodically during the semester might help students evaluate themselves. Providing feedback in the form of grading reinforces to the students that the important aspect of design is getting a grade in the class rather than becoming self learners.

- I'm not concerned about how well they did at the beginning of a semester, I care more about whether they "get it" by the end. I don't like the idea of formal meeting minutes. This is simply not done in industry based on my experience and also plays into the "what do I need to do to get a good grade" mindset.
Overall I think teams know how to delineate tasks, however there are too many situations where weak students "hide" behind others by being tasked with the same action item. This needs to be avoided. Again, I think team/self reflection a few times during the semester can help students self-adjust.
- It would appear that the students need examples and lesson on what meeting minutes look like and what their purpose is.
- It would appear that we need to give further guidance in how to de-fine tasks and reinforce the importance of division of labor.

(6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

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- Overall I think teams know how to delineate tasks, however there are too many situations where weak students "hide" behind others by being tasked with the same action item. This needs to be avoided. Again, I think team/self reflection a few times during the semester can help students self-adjust.

(7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

- The students need to learn what a literature review looks like. This is that is tells a part of the experiment story as a story that builds toward the parts of the experiment:
Setup
Procedure
And the like
- We should talk about how this should be done
- Students need to learn that if something is important enough to place in the references list (i.e. material was taken from those sources) than those sources need to be cited around that location in the document
- I think this indicator is satisfied for the most part. I don't have recommendations for this indicator other than maybe we need to have students performing this skill in more lower-level classes.
- I think there are plenty of indications that new knowledge was acquired. But evaluating whether that new knowledge was adequately used was difficult to ascertain from the project notebooks. Perhaps an assessment measure that is more summative, like the posters, might give a better indication whether the knowledge was adequately used.

6. Closing the Loop: Dissemination and Use of Current Assessment Findings

- A.** When and how did your program faculty share and discuss the results and findings from this cycle of assessment?

In a meeting on August 18, 2022, the results of the assessment activities were discussed. The entire program faculty was present at this meeting. The observations and recommendations found during the individual assessments were discussed and used to determine actions.

B. How specifically have you decided to use these findings to improve teaching and learning in your program? For example, perhaps you've initiated one or more of the following:

Changes to the Curriculum or Pedagogies

- Course content
- Teaching techniques
- Improvements in technology
- Prerequisites
- Course sequence
- New courses
- Deletion of courses
- Changes in frequency or scheduling of course offerings

Changes to the Assessment Plan

- Student learning outcomes
- Artifacts of student learning
- Evaluation process
- Evaluation tools (e.g., rubrics)
- Data collection methods
- Frequency of data collection

Please describe the actions you are taking as a result of these findings.

(5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

Ind	Improvements
1	In ECE 4800 Produce guideline that reinforces the type of documentation that belongs in there meeting minutes In ECE 4800 Create a method and rubric to be able to assess (0-3 scale) and comment on lab books (regularly) so that at the end of the semester current performance in lab book keeping can be critiqued for a grade.
2	In ECE 3090 Create an assignment that has them produce a meeting report for their weekly effort on their identified action item - the assignment should have a rubric around what should be in this report (2)
	Develop per course list of assessment driven requirements. Return the indicators to those that were used historically in D and change the assessed location to “notebook material produce in the 4 weeks after spring break”

(6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

Ind	Improvements
1	I think this indicator should require evaluating ECE3090 Experimental procedure and not the report.

2	<p>I think this indicator should require evaluating ECE3090 Experimental procedure and not the report.</p> <p>We need to add experiments to several labs that require students to design part of the lab/experiment:</p> <ul style="list-style-type: none"> • Modify the final project in Digital Design to be one where students have to deiced and document how to proceed with the design process • • Add an procedure to 2103 to have the students capture wave form data from a scope and apply data fitting to the data • Use only a power supply and resistor find the value of a capacitor • • Think about giving broken circuits and having them analyze them and fix them for certain criteria • Think about develop a procedure for finding a parameter (such as max power or time constant) <p>In vowel recognition have them articulate an initial plan with Gantt (division of labor), and document a final procedure and contrast the two</p> <p>There is recognition that experiments in Circuits lab, Electronics lab and probably others do not give insight into the importance of the activity. Our experiments need to have more of a sense of relevance to the real world</p> <p>Add definition to the stand lab report on what the reported format for accuracy, precision should be, i.e. not percent error</p>
3	
	Add senior design back into this, but after the periodic assessment of the notebook is implemented and one of the assessment rubric's quantifies this activity.

(7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Ind	Improvements
1	<p>Beef up the description of what is required for the design report. (Junior Design)</p> <p>Have the students do a survey that ask questions about: does their described method discuss the theatrical method in sufficient detail the people reading the report understand the technical details. (Junior Design)</p> <p>Break indicator into 1:Find - 2:Apply, adjust locations found to better match the indicators individually.</p> <p>The assessment rubric's for the note books from (5) need to include a review of being done in the first semester.</p>

If no changes are being made, please explain why.

7. Closing the Loop: Review of Previous Assessment Findings and Changes

A. What is at least one change your program has implemented in recent years **as a result of previous assessment data**?

In AY20 a change to ECE 3090 was recommended:
Modify the class conversation around review of two notebooks for elements of a good notebook was modified into a written assessment of the two notebooks.

Additionally the students are required to revisit the two notebooks midway through the class to reinforce their understanding of expectations.

B. How has this change/have these changes 7A been assessed?

During the regular review cycle for outcome 5 in AY22 the assessment was performed again.

C. What were the findings of the assessment?

The AY23 assessment showed that one aspect of the outcome had improved while the other had not. The students are still having trouble developing individual tasks and reporting back on their results, or at least they are having trouble documenting this activity.

D. How do you plan to (continue to) use this information moving forward?

A review of the written questions that were developed in response to the AY20 assessment found that they did not address the items that are being looked for in the assessment activity. The written exercise is going to be revised to better emphasize documentation of the items being looked for in the assessment rubric for this outcome.

IMPORTANT: Please submit any assessment tools and/or revised/updated assessment plans along with this report.
IMPORTANT: Please submit any assessment tools (e.g., rubrics) with this report as separate attachments or copied and pasted into this Word document. Please do not just refer to the assessment plan; the report should serve as a stand-alone document.

(5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

Historical Outcomes:

- (d) an ability to function on multidisciplinary teams

Student Outcome (5) assessment indicators and descriptions.

Indicator	Course	Assessment Description
1. Ability to develop weekly goals, followed by presentation of the results of those goals	ECE3090	Project Notebook, the students are required to tag two places they have documented this.
	ECE4800/ ECE4810	Group Meeting Minutes on Project Web Page.
2. Ability to divide tasks amongst the whole group.	ECE3090	Project Notebook, the students are required to tag two places they have documented this.
	ECE4800/ ECE4810	Group Meeting Minutes on Project Web Page.

This outcome refers to an ability for a student to be an effective team member and that the team function in an inclusive manner. The word “effective” refers to an ability to carry out independent work in a timely manner, and to coordinate with other team members in team meetings and otherwise as needed.

Both ECE3090 Junior Design and ECE4810 Senior Design II require that students maintain a legally defensible project notebook. The notebook is to contain notes related to individual design work and also contain properly documented team meetings.

Indicator #1: This refers to a group’s ability to define tasks and goals necessary to perform a design, to complete these tasks and to report the results. This should be evident in team meeting minutes.

- ECE3090 & ECE4800/4810: *Students will demonstrate an ability to develop weekly goals, followed by presentation of the results of performing those goals as evidenced in the project notebooks.*

Indicator #1: This refers to a group’s ability to divide tasks among its members based on ability and workload. If this is done correctly then everyone in the group should have approximately the same workload and everyone should be able to complete the tasks assigned them in a timely manner. This should be evident in the meeting minutes by the relationship between action items identified at each team meeting and the documented work between team meetings.

- ECE3090 & ECE4800/4810: *Students will demonstrate an ability to share appropriate and interrelated information between team members in order to further the overall team design as evidenced in the project notebooks.*

The assessment rubrics are given in the following table

Assessment rubrics for Student Outcome (5).

		Rubric	
Ind	1 = Does not meet Expectations	2 = Meets expectations	3 = Exceeds expectations
ECE3090 & ECE4800/4810			
1	There is little evidence of tasks being identified or results being presented back to the group.	There is evidence that some tasks are being identified, but not on a regular basis, the report back of results from tasks is not happening in a timely manner.	There is evidence that tasks are identified regularly and the results of those tasks are being reported back to the group in a timely manner.

2	The tasks being identified are either not assigned appropriately, or the work is not being performed by the assigned people.	The tasks are being distributed, but a few people are still performing most of the work.	The tasks are being distributed appropriately and the work is being done by the assigned group members.
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(6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

Historical Outcomes:

- (b) an ability to design and conduct experiments, as well as to analyze and interpret data
- implied. (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

The assessment rubrics are given in the following table

Student Outcome (6) assessment indicators and descriptions.

Indicator	Course	Assessment Description
1. Ability to design an appropriate experiment using appropriate parts and instrumentation to meet the requirements and goals of the task	ECE3151	Vowel Recognition Report
	ECE3090	Battery Resistance Experimental Report
2. Ability to analyze data for adequacy, relevancy, and correctness based in fundamental theory.	ECE3151	Vowel Recognition Report
	ECE3090	Battery Resistance Experimental Report
3. Ability to conduct experiments and recognize the accuracy of the results.	ECE3090	Battery Resistance Experimental Report

This outcome refers to an ability to design and conduct experiments with an appropriate goal. The word “ability” refers to, for example, identifying appropriate and readily available equipment, identifying appropriate range of component values, identifying a sequence of procedure steps to achieve a goal, identifying appropriate measurements, identifying appropriate data analysis calculations to achieve a meaningful goal, identifying sources of experimental error, etc.

In summary, it is all the characteristics of a laboratory experiment necessary to enable that experiment to be practically carried out in a suitable laboratory and to draw meaningful conclusions with confidence.

Indicator #1: This indicator refers to an ability to establish an experimental procedure, including identifying specific measurements to acquire, in order to draw meaningful conclusions.

- ECE3151: Student groups are required to acquire a set of training data of the long vowel sounds for each group member. That training data is to be analyzed in the frequency domain to identify unique spectral energy that allows each specific vowel sound to be uniquely identified among the 5 long vowel sounds and among the group members. The specific energy bands in the frequency domain represent the measurements to be acquired.

Students will demonstrate an ability to develop a procedure for analyzing the 5 long vowel sounds across the group members in order to establish energy bands that are useful for discriminating the 5 vowel sounds as evidenced by a technical report.

Students will demonstrate an ability to use the MATLAB development environment to write a computer program as evidenced in laboratory reports.

- ECE3090: Each student group is to establish a process by which the internal resistance of a battery is measured. This process includes establishing an appropriate circuit with appropriate measurements and analysis that leads to a meaningful estimate of the internal battery resistance. This process must include a recognition and specification of the battery test conditions such as battery charge (rechargeable batteries are used), the battery temperature, battery age, etc., that would affect the true value of the internal resistance.

Students will demonstrate an ability to establish an experimental procedure, including identifying specific measurements to acquire, in order to estimate the internal resistance of a battery as evidenced by the battery technical report or the experiment report.

Indicator #2: This indicator refers to an ability to recognize whether the set of acquired measurements are relevant to the question being asked, adequate for drawing meaningful conclusions, and correct. By “relevant” we mean that a particular data has meaning to the question being studied. By “adequate” we mean that the type and quantity of collected data is sufficient for drawing meaningful conclusions with confidence. By “correct” we mean that students can recognize the data collected and the analysis done produces a meaning answer to the question.

- ECE3151: For the long vowel sound experiment, each student group needs to determine whether the vowel sounds recorded are sufficient for developing a useful decision tree.

Students will demonstrate an ability to recognize whether the set of vowel sounds acquired is sufficient for developing a useful decision tree as evidenced by a technical report.

Each student group will need to sift through the vowel metric vectors in order to recognize which metrics are relevant for creating a reliable classifier tree. Some metric vector components do not provide adequate discrimination of vowels and therefore are not relevant to creating a reliable classifier tree while, generally speaking, others will be relevant. The students will analyze their systems ability to process vowel sounds to determine if their selection of components is sufficient or “correct”.

Students will demonstrate an ability to recognize which metric components are relevant for creating a reliable classifier tree as evidenced by a technical report.

- ECE3090: For the internal battery resistance measurement, students need to determine whether the collected data is sufficient for providing reasonable statistical bounds on the true internal battery resistance. This requires some assessment of how much data to collect. The students will compare their measurements with expected values and values published in literature to determine if their process produced a correct result.

Students will demonstrate an ability to determine the adequacy of the battery resistance measurements for the purpose of drawing meaningful conclusions with confidence as evidenced by the battery technical report or the experiment report.

For the internal battery resistance measurement project, students will demonstrate an ability to determine the relevancy of the collected data in order to determine which measurements can lead to meaningful conclusions as evidenced by the battery technical report or the experiment report.

Indicator #3: This indicator refers to an ability to be able to move forward with an experiment in the presence of incomplete knowledge. This could be the selection of instruments or parts based on the expectation of unspecified quantities or the recognition that data collected is accurate without having a comparison data set.

- ECE3090: For the internal battery resistance measurement, student groups are required to carry out the experimental procedure that they developed to measure the internal resistance of a battery. This requires using appropriate engineering tools and, perhaps, appropriate mathematical calculations to obtain a set of values for the internal battery resistance. Those measured values are to be analyzed in the context of some known and objective measure of the internal battery resistance to determine the accuracy of their measurements.

The assessment rubrics are given in the following table

Assessment rubrics for Student Outcome (6).

	Rubric
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Ind	1 = Does not meet Expectations	2 = Meets expectations	3 = Exceeds expectations
ECE3090			
1	The experimental procedure is not sufficiently defined to be repeatable by several people working independently.	The experimental procedure is sufficiently detailed with step-by-step instructions and with appropriate setup illustrations so as to be unambiguous and repeatable. Measurements to be taken may not be fully defined by a blank data table.	The experimental procedure is sufficiently detailed with step-by-step instructions, with appropriate setup illustrations, and with detailed blank data tables so as to be unambiguous and repeatable.
2	There is no evidence that the data collected has been assessed to determine whether it is sufficient for estimating the internal resistance of a battery.	There is evidence that the data collected has been assessed to determine whether it is sufficient for estimating the internal resistance of a battery. This assessment is a simple statement and is not supported with appropriate data illustrations nor numeric measures.	There is evidence that the data collected has been assessed to determine whether it is sufficient for estimating the internal resistance of a battery. This assessment is supported with appropriate data illustrations or numeric measures.
3	There is evidence that the experimental procedure was only marginally followed as described in the procedure. There is evidence that very few sources of procedure and/or measurement errors that occurred were recognized and addressed. There is little evidence that the experimental procedure was reflected upon while taking measurements.	There is evidence that the experimental procedure was mostly followed as described in the procedure. There is evidence that many sources of procedure and/or measurement errors that occurred were recognized and addressed. There is evidence that the experimental procedure was reflected upon and, as needed, improved while taking measurements.	There is evidence that the experimental procedure was closely followed as described in the procedure. There is evidence that nearly all sources of procedure and/or measurement errors that occurred were recognized and addressed. There is evidence that the experimental procedure was reflected upon and, as needed, improved while taking measurements.
ECE3151			
1	There is little evidence that unique energy bands are defined resulting from an experimental procedure or that the procedure that was followed did not result in a effective decision tree to classify the 5 long vowel sounds with a degree of reasonable accuracy.	There is evidence that unique energy bands are defined resulting from an experimental procedure that lead to a decision tree for classifying the 5 long vowel sounds across a group of students. The experimental procedure is not well defined or well articulated to the point where another group could follow the same procedure.	There is evidence that unique energy bands are defined resulting from an experimental procedure that lead to a decision tree for classifying the 5 long vowel sounds across a group of students. The experimental procedure is well defined and well articulated to the point where another group could follow the same procedure.
2	There is no meaningful evidence that the collective set of long vowel sounds (25 sounds/long vowel/student) has been assessed to determine whether it is sufficient for developing a reliable classifier tree.	There is evidence that the collective set of long vowel sounds (25 sounds/long vowel/student) has been assessed to determine whether it is sufficient for developing a reliable classifier tree. This assessment is a general statement	There is evidence that the collective set of long vowel sounds (25 sounds/long vowel/student) has been assessed to determine whether it is sufficient for developing a reliable classifier tree. This assessment is specific to each

		without references to specific data illustrations.	vowel sound and is articulated with appropriate data illustrations.
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(7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Historical Outcomes:

- (i) a recognition of the need for, and an ability to engage in life-long learning

Student Outcome (7) assessment indicators and descriptions.

Indicator	Course	Assessment Description
1. Ability to identify the need for additional knowledge to further a design solution and apply that knowledge correctly.	ECE3090	Battery Res: Design Report + Experimental Procedure.
	ECE4800/ ECE4810	Project Notebook, the students are required to tag two-places they have documented this.

This outcome refers to an ability to acquire knowledge and apply that knowledge to further a design solution. The Computer Engineering program serves to provide an educational foundation for the graduate. When a graduated student enters a school for advanced study or enters industry practice, they will be required to learn new ideas in order to solve problems beyond the specific scope of problems addressed in their undergraduate program. The requires that they develop the skills necessary to acquire new knowledge and apply that knowledge.

There in one indicator associated with this skill. It involves recognizing the need to acquire knew knowledge, and then correctly applying that knowledge to further a design.

Indicator #1: This indicator refers to an ability to identify the need for additional knowledge to further a design solution.

- ECE3090: Students are required to measure the internal resistance of a battery.
Students will demonstrate an ability to identify the need for additional knowledge for the purpose of measuring the internal resistance of a battery as evidenced in the Design Report plus Experimental Procedure.
- ECE4800/ECE4810:
Students will demonstrate an ability to identify the need for additional knowledge as evidenced in the project notebooks at locations indicated by the students.

The assessment rubrics are given in the following table

TABLE 19 Assessment rubrics for Student Outcome (7).

Ind	Rubric		
	1 = Does not meet Expectations	2 = Meets expectations	3 = Exceeds expectations
ECE3090 / ECE 3151			
1	There is little or no evidence that any sources have been identified for the purpose of acquiring new knowledge and no attempt has been mode to apply new knowledge to the design being conducted.	There is evidence that one source has been identified for the purpose of acquiring new knowledge and that knowledge may have been applied incorrectly.	There is evidence that multiple sources have been identified for the purpose of acquiring new knowledge and that knowledge has been applied correctly.