# Physics Education Laboratory
# Lecture 13 - Part 1
## Content Knowledge for Thermodynamics

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# Scientific abilities for formative assessment

The term “scientific abilities” describes some of the most important procedures, processes, and methods that scientists use when constructing knowledge and when solving experimental problems. These are not AUTOMATIC SKILLS, but are instead PROCESSES that students need to use REFLECTIVELY and CRITICALLY.

1. an ability to represent knowledge in multiple ways;
2. an ability to design experiments to investigate new phenomena, test hypotheses and solve experimental problems;
3. an ability to collect and analyze experimental data;
4. an ability to devise and test relationships and explanations;
5. an ability to evaluate reasoning and experimental design;
6. an ability to communicate.

# Formative assessment

**Formative assessment** refers to tools that identify misconceptions, struggles, and learning gaps along the way and assess how to close those gaps. It includes effective tools for helping to shape learning, and can even bolster students' abilities to take ownership of their learning when they understand that the goal is to improve learning, not apply final marks… formative assessment occurs throughout a class or course, and seeks to improve student achievement of learning objectives through approaches that can support specific student needs (Trumbull and Lash, 2013)

# Summative assessment

**Summative assessments** evaluate student learning, knowledge, proficiency, or success at the conclusion of an instructional period, like a unit, course, or program. Summative assessments are almost always formally graded and often heavily weighted (though they do not need to be). Summative assessment can be used to great effect in conjunction and alignment with formative assessment, and instructors can consider a variety of ways to combine these approaches.

# Examples of Formative and Summative Assessments

| Formative | Summative |
| --- | --- |
| In-class discussions | Instructor-created exams |
| Clicker questions | Standardized tests |
| Low-stakes group work | Final projects |
| Weekly quizzes | Final essays |
| 1-minute reflection writing assignments | Final presentations |
| Homework assignments | Final reports |
| Surveys | Final Grades |

# Rubrics for assessment - example from ISLE approach (Etkina, 2006)

An assessment rubric is one of the ways to help students see the learning and performance goals, self-assess their work, and modify it to achieve the goals three guiding principles as defined by Sadler:

1) Where are you trying to go? (Identify and communicate the learning and performance goals.)
2) Where are you now? (Assess, or help the student to self-assess, current levels of understanding.)
3) How can you get there? (Help the student with strategies and skills to reach the goal.)

The rubrics contain descriptions of different levels of performance, including the target level. A student or a group of students can use the rubric to help self-assess her or their own work. An instructor can use the rubric to evaluate students' responses and to provide feedback.

- Ability to represent information in multiple ways
- Ability to design and conduct an observational experiment
- Ability to design & conduct an experiment to test an idea/hypothesis/explanation or mathematical relation
- Ability to design & conduct an application experiment
- Ability to communicate scientific ideas
- Ability to collect and analyze experimental data
- Ability to evaluate models, equations, solutions, and claims