updated 2020-11-14 05:25 utc by goh kawai

JALT-2020 online conference 2020-11-21 13:25-14:55 JST, room 29, session ID 6

CLIL and STEM Through Building Electronic Circuits

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abstract

This is a case study of a CLIL (content-language integrated learning) STEM (science technology engineering mathematics) task-based course mainly for college freshmen majoring in technical fields such as engineering or science. Students built electronic circuits using breadboards and discrete components, and become able to explain in both L1 and L2 how to construct and operate the circuits. My students had never done these tasks before. My students were familiar with electronics theory but are unaware of actual circuits and components. For example, on an LED (light emitting diode) the positive (also called anode) lead is longer than the negative (also called cathode) lead. By learning how to identify components and build circuits, students balanced their theoretical and practical knowledge. I provided assembly instructions in L1, and similar phrases in L2. After building, testing, and demonstrating kits to classmates, students wrote assembly instructions in L2. Much of the CLIL component of this course was in vocabulary. I exposed students to both L1 and L2 because students need to become bilingual. Much of the STEM component was in practical electronics. Although my results are merely anecdotal and not necessarily generalizable, my experience may assist practitioners seeking course designs or teaching plans for CLIL and STEM.

this poster is for teachers who want to teach:

- STEAM (science technology engineering art mathematics)
- hands-on lab or shop
- with bilingual education or CLIL (content language integrated learning)
- by leveraging existing material

take-away message

- breadboard kits are within the capability of many college freshmen regardless of their area of study
  (not limited to technical students – my humanities majors scored higher than engineering majors)
- flipped learning in L1 and L2 prepares students for in-class pair-work solely in L2
  (1 student says instructions to partner, who builds the kit without reference to written instructions)
- introductory kits come with explanations in L1 or L2, and corresponding L2 or L1 material can be found online (because introductory kits cover basic concepts and techniques that are widely taught worldwide)

upsides (unexpected benefits)

- if students are prepared (via flipped learning) then teachers observe and advise in class
  (circulate among student pairs)
- TAs with technical backgrounds can confidently coach underclassmen (TAs become proficient in L2 by completing flipped learning assignments)
- students trust and respect technical TAs

downsides (required resources)

- need full-color handouts
  (most instructions are color-coded)
- need desk space and lighting
  (components are small and numerous)
- must replace broken components
  (breadboards allow re-use but components fail after multiple uses)

what students learn

- already know
  - electronic theory (mostly book knowledge)
- will learn
  - technical phrases in L2 (hands-on lab)
  - practical circuits in L2 – CLIL
  - bilingual terminology – L1 and L2
  - bidialectal terminology – US and UK differ

most full kits (including breadboard,discrete components, instructions) cost between 700 and 2000 yen depending on complexity

lesson plan

- **before class**
  - preparatory assignment
    (read and hear concepts and tasks explained in L1 and L2)
    (say L2 phrases to use in class)
- **in-class**
  - build kits (pair work, 1 says instructions, 1 builds kit)
  - students demonstrate kits to entire class
  - show demo or slideshow, play with toys
- **after class**
  - review assignment
    (write in L2 assembly instructions and demo explanations)

material available in L1 and L2

consider providing L2 documentation, and asking students to discover L1 version (useful skill; not cheating)