

The Implementation and Assessment of Engineering Design

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Synopsis:

As we move more toward constructivist teaching and STEM education students are expected to gain skills in managing projects, the following research was done through implementing a course that teaches this to students. In the International Baccalaureate program this is done through a class called Design, that uses the engineering design cycle to complete projects and document progress. This is about how to implement and assess the course without textbooks or prescribed curriculum. Students' understandings were explored throughout and the data collected addressed specific skills students have obtained in one semester.



Figure 1. Design classes. Top to bottom: How a car works and making a pinewood derby car.

Methodology:

Throughout the course students were asked to use the engineering design cycle to create two different projects. Through their project creation they are expected to create portfolios as their summative assessment documenting what they have learned.

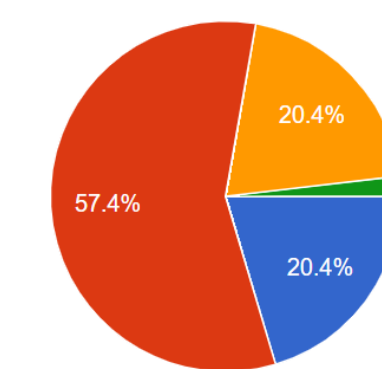
Outside of normal classroom practices the students were asked to complete student checks, where they self assess their ability to perform each design objective. Students also took ungraded pre and post tests matching skills to engineering design cycle objectives. Lastly the students interviewed about what they had learned, and all the skilled addressed in interviews were in a Google Form to see if the other students learned the same skills. Overall finding out if they could learn how to complete this independently.

Conclusion: In the end of the treatment a majority of the students were able to feel confident completing the stages on the engineering design cycle with no or minimal help, but they were still struggling matching skills to sections to the engineering design cycle they belonged to. More explicit instruction about engineering and design skills will be needed as the class continues.



Figure 3. Design classes. Exploring electricity.

Focus questions	Data Source 1	Data Source 2	Data Source 3
Primary Question: How effective is engineering design teaching in having students understand the design cycle?	Student Checks	Design Cycle Pre and posttest	Summative Assessments
Secondary question: What skills do students learn in an engineering design class?	Portfolio Comment Section	Final Interviews	Final Skills Survey



Number Descriptor	Students Perceived Skill Level
4	I completely understand the design cycle and can demonstrate my understanding without a design folder, and I can teach others how to use the design cycle to create and innovate.
3	I completely understand the design cycle and can demonstrate my understanding without a design folder.
2	With the help of my classmates, guardians, and teacher I can effectively demonstrate competency using the design cycle.
1	I will need help and guidance from my teacher to complete a design task and filling out my design folder.
0	What is the design cycle?

Figure 2. Student Check 3. Pie graph measuring student confidence after treatment, (n=54).

Student Confidence:

Evaluating the end of the unit many of the students were confident when using the design cycle. Overall 77.8% of students felt they could complete engineering design tasks without a guided design folder. 22.2% of students still needed support, but 0% felt they have no idea. Confidence was high, but summative assessments showed skills needed to be refined (Figure 2).

Skills Students learned:

- . Research Critically/Citing Sources
- . Coming up With Ideas
- . Explain What You Learned
- . Innovate (Using Old Things/Ideas To Make New Things/Ideas)
- . Organization
- . Thinking Practically
- . Creating a Solution to a Problem.
- . Be Creative/Think Outside the Box
- . Work in Groups/Teamwork
- . Document Progress
- . Blueprinting
- . Time Management
- . Computer and/or Coding Skills
- . Combining Ideas
- . Evaluating Your Work and the Work of Others
- . Building/Crafting Skills
- . Safety
- . Being Frustrated Leads to Learning/Outcomes