Chart the Course

Identifying the Presence of Technical and Professional Skills in Engineering Syllabi Over Time

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Background

- Many engineering graduates are underqualified in the workforce[1,2]
- Education must remain flexible and versatile to prepare students to meet societal needs for engineering innovation[3,4]
- Engineers require professional skills that build upon their analytical skills to allow them to adapt to new working environments[5]
- Presence of professional skills in Capstone 400 courses[6]

Problem statement: The goal of the study was to identify the extent of professional and technical skill development, as per ABET standards, expressed within courses syllabi over multiple semesters.

"...One study [showed that] civil engineering students' **concern related to the welfare** of the public **decreased over the course of their engineering education**. Some attribute this to the focus on technicality... ABET professional learning outcomes ask engineering programs to **act with social implications in mind**"[7].

Methods

Setting and Participants
- Instructors in two ABET accredited programs in an engineering department at a R1 university in the Midwestern U.S.

Data Collection
- Syllabi from core sophomore and junior level core courses collected from Spring 2019 to Spring 2023

Data Analysis
- Deductively coded information in syllabi based on ABET standards (Table 1 and 2; Fig. 1)
  - "what" instructors would teach in the courses (Table 1, Table 2)
  - Linear regression lines done to test for change
- Establish >= 80% interrater reliability (IRR) for all codes

ABETs		Simplified Definition
Technical skills	ABET1	Computation, STEM principles
	ABET2	Experimental design
	ABET6	Conducting lab experiments
Professional skills	ABET3	Presentation skills
	ABET4	Ethical & professional responsibility
	ABET5	Teamwork
	ABET7	Understanding "why" and "how", learning big picture

Table 1 (left): Definition and categorization of ABET standards

Table 2 (below): Definition of ABET levels

Level	Definition
No Evidence (0)	Not mentioned anywhere
Declared but no evidence (1)	Mentioned but lacks facilitation
Low (2)	5<45% of content or grade
Medium (3)	45<75% of content or grade
High (4)	75<100% of content or grade

Grading:

Homework	10%
Project	10%
Midterm Exams (2)	50%
Final Exam	30%

ABET1 is 90% of the grade, so **ABET1 = 4**
ABET2 is 10% of the grade, so **ABET2 = 2**

Homework: Homework assigned on Tuesday will be due the following Tuesday. Small design projects will be assigned throughout the semester. Design projects are open-ended problems, which may have several answers.

Exams: Two midterm exams will be given during the semester. The dates of the midterms will be announced one week in advance. The final exam will be comprehensive and be given according to the university schedule. The midterm and the final exams will be open book and notes.

Figure 1: Sample of a coded syllabus

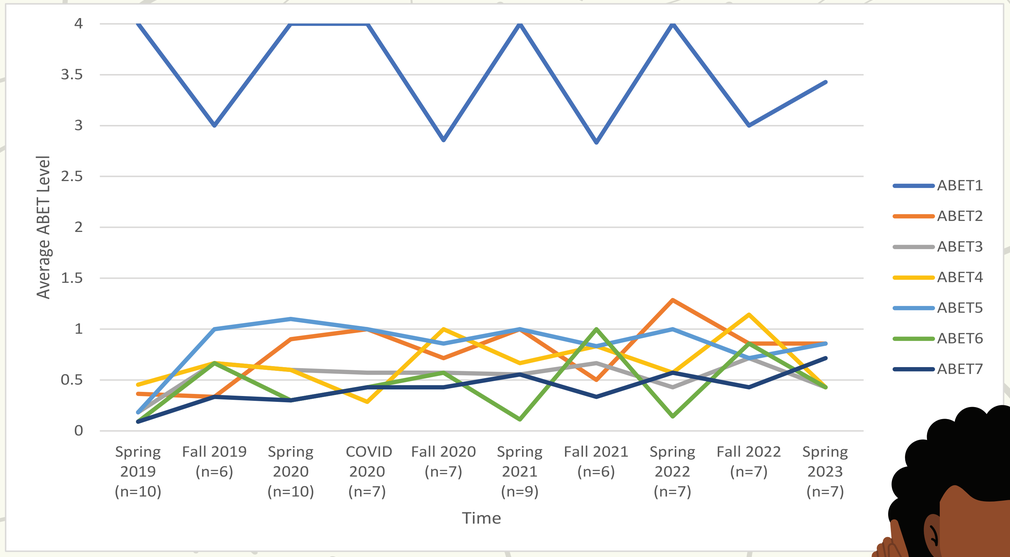

Figure 2: Average ABET Level From Spring 2019 to Spring 2023 (n=77 syllabi)

Results

- ABET1 had highest levels in syllabi
- Average R^2 range from 0.05 - 0.08
  - Only ABET2 R^2 score above 0.2
- ABET1 has weak negative correlation, rest have a very weak positive correlation
  - Not statistically significant changes based on R^2 values
- ABET4 and 5 declined during COVID
- ABET1 and ABET6 alternated peaks

Conclusions and Future Discussion

- Shows need to expose students to culturally relevant problem-solving[7] and professional skills in sophomore and junior level courses

Limitations
- Limited variation in syllabi for IRR
- Focus on only sophomore and junior level core courses in one department

References

1. Miller (2010). "From the Ground up" Rethinking Engineering Education in the 21st Century. Olin College of Engineering.
2. Warsame. (2017). Walden Dissertations and Doctoral Studies.
3. Conlon (2008). European Journal of Engineering Education, 33(2), 151-159.
4. Handel (2022). Monthly Labor Review, U.S. Bureau of Labor Statistics.
5. Bautista (2016). International Journal of Educational Technology in Higher Education, 13(1).
6. Bobbett (2023). 2023 ASEE Annual Conference & Exposition.
7. Drake et al. (2023). Journal of Engineering Education.

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