Critical Thinking Trends of Undergraduate Engineering Students ©

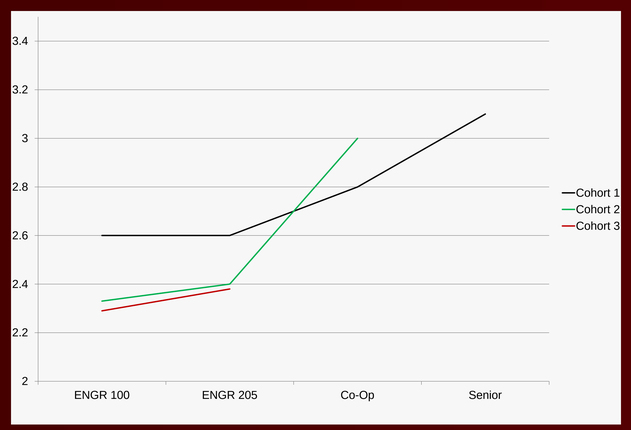
Patricia A Ralston, Ph.D. and Cathy L. Bays, Ph.D.
University of Louisville

This project is supported by the Paul Weber Departmental Award.

ABSTRACT

Faculty in a large, urban school of engineering designed a longitudinal study to assess the critical thinking skills of undergraduate students as they progressed through the engineering program. The Paul-Elder critical thinking framework was used to design course assignments and develop a holistic assessment rubric. The curriculum was re-designed to include deliberate teaching of critical thinking and assessment in at least one key course for every student each year of their undergraduate curriculum. The critical thinking scores for seniors using the holistic rubric were significantly higher than their baseline critical thinking scores as freshmen (p=.004). This case-study can serve as an exemplar for other units, departments, or programs to model or replicate.

CRITICAL THINKING SCORES



PROJECT DESCRIPTION

Background:
Although critical thinking and assessment of critical thinking using rubrics have been discussed in the engineering education literature the studies have primarily related to a single course, not complete curriculum redesign and assessment. Although program assessment of critical thinking has been undertaken in other fields, the only published discussion of program assessment of critical thinking for engineering was the recent work of Eppes et al. (2012).

Purpose:
The purpose of this study was to assess the development of critical thinking skills in undergraduate engineering students. The research question was, “How do the critical thinking skills of undergraduate engineering students change as they progress through the engineering program?”

Design:
The study was a descriptive, longitudinal study of three engineering student cohorts as they progressed through the four year undergraduate program. The study was approved by the university’s Institutional Review Board.

Sample:
Undergraduate engineering students at least 18 years of age as freshmen who would complete the undergraduate engineering program in four years and consented to participate in the study. Cohort 1 n=187, Cohort 2 n=240, Cohort 3=222.

Data Collection:
Freshman: “Introduction to Engineering” case-study that served as the baseline assessment.
Sophomore: “Differential Equations” one-page assignment that required students to answer the question “If you had time to teach only one method to solve differential equations, which method would you pick and why?”
Junior: Cooperative internship report summary which asked students to critically reflect on their primary responsibilities.
Senior: Capstone design projects or other individual written assignments requiring critical analysis.

Conclusion:
Faculty involvement in the creation of critical thinking assignments across the curriculum and assessment of student responses to the critical thinking assignment can strengthen the students’ development of critical thinking abilities.

CRITICAL THINKING RUBRIC

University of Louisville
JB Speed School of Engineering
Holistic Critical Thinking Rubric

Consistently does all or most of the following:

4
Clearly identifies the purpose including all complexities of relevant questions.
Accurate, complete information that is supported by relevant evidence.
Complete, fair presentation of all relevant assumptions and points of view.
Clearly articulates significant, logical implications and consequences based on relevant evidence.

3
Clearly identifies the purpose including some complexities of relevant questions.
Accurate, mostly complete information that is supported by evidence.
Complete, fair presentation of some relevant assumptions and points of view.
Clearly articulates some implications and consequences based on evidence.

2
Identifies the purpose including irrelevant and/or insufficient questions.
Accurate but incomplete information that is not supported by evidence.
Simplistic presentation that ignores relevant assumptions and points of view.
Articulates insignificant or illogical implications and consequences that are not supported by evidence.

1
Unclear purpose that does not include questions.
Inaccurate, incomplete information that is not supported by evidence.
Incomplete presentation that ignores relevant assumptions and points of view.
Fails to recognize or generates invalid implications and consequences based on irrelevant evidence.

REFERENCES

Ralston, P.A. & Bays, C. (In press). Enhancing Critical Thinking Across the Undergraduate Experience: An Exemplar from Engineering. *American Journal of Engineering Education, 4* (2).

Ralston, P., Larson, A., & Bays, C. (2011). *An Assessment of undergraduate* engineering students’ critical *thinking skills guided by the Paul-Elder critical thinking framework. INQUIRY: Critical Thinking Across the Disciplines, 26* (3), 25-32.

Ralston, P. & Bays, C. (2010). Refining a critical thinking rubric for engineering. Conference proceeding for the *American Society for Engineering Education’s Annual Conference and Exposition.*