

How to Make Future Engineers Critical Thinkers?

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Abstract

Engineering can be broadly defined as the application of scientific principles to create, and manufacture use full products. Rapid advancements in science and technology are giving rise to more innovative techniques and increasingly sophisticated products. Success for today's engineering graduates hinges on their ability to tackle intricate and open-ended problems, coupled with independent and critical thinking skills. Critical thinking (CT) is essentially the analysis of available facts, evidence, observations, and arguments to make informed judgments. Unfortunately, engineering educators often face challenges in nurturing critical thinking among their students. This paper provides an overview of the various issues associated with instructing and assessing CT skills. Various models of critical thinking were explored, including Gibbs' reflective cycle model, Facione's model, Kronholm model, and King and Kitchener's model. Paul and Elder's (P-E) model for critical thinking was found to be the most suitable for engineering. The learning objectives of the courses were adjusted to integrate elements of critical thinking. The instructional strategy, particularly through discussions and interactive sessions, was modified to incorporate critical thinking aspects. The quantitative assessment of CT skills and tasks adds an additional layer of complexity. Assessment plans were revised to align with the updated course learning objectives. Relevant assessment rubrics were modified to include features of critical thinking where necessary. Some noteworthy improvements include classroom exercises for CT assessment, self-assessment of CT skills, CT assessment design, quantification, and summative assessment, taxonomy of CT assessment, and the limitations of standardized CT assessment. This paradigm, focusing on learning experiences related to critical thinking, can be extended to other engineering, science, and non-science courses.

Keywords

Engineering education; critical thinking; CT models; learning objectives; instructional strategy; quantitative assessment.