

Evaluating Engineering Learning: A Comparison Study of Project-Based-Learning

In the heart of Minnesota's Mesabi iron range, a new model for engineering education has been funded and began delivery in January 2010. The IRE (Iron Range Engineering) model is a project-based-learning (pbl) model in which students work with industry on design projects with a focus on producing graduates with integrated technical/professional knowledge and competencies. Students at IRE are upper-division mechanical engineering students most of whom are graduates of Minnesota's community colleges. IRE students do not take classes. 100% of their learning is done in the context of the industry projects.

Since the publication of *Engineer 2020* (and before) there have been numerous calls for a new-look graduating engineer. With guidance from some of the most respected leaders in engineering education, the IRE model has been developed to utilize industry-based pbl, outcome-based assessment, just-in-time interventions, self-directed learning, and emphasis on reflection to graduate engineering practitioners with integrated technical/professional competency.

We believe the beginning of the Iron Range Engineering program presents a tremendous opportunity for evaluation on how engineering learners develop. The overarching intent for this project is to investigate the extent to which students in an entirely project-based curriculum with industry-originated projects acquire knowledge and competencies that repeated national reports have stated to be especially important in the coming decade.

Goal 1: Evaluate cognitive development of students in pbl

Goal 2: Evaluate ability of engineering learners to acquire technical knowledge in pbl

Goal 3: Evaluate ability of engineering learners to acquire professional competencies in pbl

Goal 4: Study impact of PBL environment on student interest-level and motivation to learn.

Goal 5: Share the results of this project with the widest possible audience

We will apply well developed measurement tools, such as the Self-Directed-Learning-Readiness Scale, the National Survey of Student Engagement (NSSE), the TIDEE design assessment system, concept inventories, best-practice portfolios, and others to collect data with respect to the goals.

Intellectual Merit: Educating Engineers: Designing for the Future of the Field, together with other recent research and reports on engineering education, make a compelling case for envisioning engineering education in a new way. The new Iron Range Engineering program will explore a completely different way of approaching engineering education. Some of the characteristics of this new approach are:

- * Primary emphasis is on development of learning outcomes that have been spelled out in national reports, including *The Engineer of 2020*. This emphasis is contrasted with primary emphasis on coverage of topical material that characterizes many of the engineering programs throughout the world.

- * Faculty members in the new program invest heavily in developing abilities of students in the program to assess their development with respect to these outcomes. To support self assessment, faculty members will articulate criteria with which development with respect to these outcomes can be evaluated.

- * All learning activities will be organized around externally-sponsored projects. Each semester, students work on several externally-sponsored projects. Faculty members use the projects as contexts for developing competencies and learning subject matter.

- * Students complete course and graduation requirements by exceeding or meeting levels of competencies with respect to clearly articulated outcomes.

Broader Impacts: Successful completion of this project will provide engineering educators with an understanding of how students learn engineering in project based learning. The results of this study will make visible the extent to which students in engineering pbl develop cognitively, acquire technical competency, acquire professional competency, and the extent to which their motivation to learn is affected. With this data, engineering faculty and administrators will be able to make valid judgments on the efficacy of implementing 100% pbl cohorts within their colleges of engineering. When contemplating the implementation of pbl in cohort models, it becomes obvious that this project has the potential to contribute to a paradigm shift in STEM education.

*Iron Range Engineering – a collaboration between
Itasca Community College and Minnesota State University Mankato*