SCHOLARSHIP OF TECHNOLOGY ENHANCED LEARNING

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Transforming Energy and Pedagogy: An Authentic Learning Example

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Abstract

Engineers ultimately work in multi-disciplinary workplaces, yet degree structures and siloing of subjects typically prevent students from interacting with those outside of their own discipline. As products and technology become increasingly complex, engineers can no longer do design in isolation. Learning designs need to mirror real world complex team projects. In this project we provide an example of how Design-Based Research can be used as a meta methodology to design a learning experience that is implemented through a design-based collaborative student team project. An important part of the design process is to understand the interface with other disciplines of engineering and be able to specify appropriate requirements and verify that those requirements are being met. If these groups of students do not interact while at university, they are ill-prepared to do such design across disciplinary boundaries in the workplace. Moreover, if they are incapable of being able to formally specify *what* they require from other engineers, then they would not be able to verify that the design meets those specifications. This capstone project seeks to address these issues through the following objectives:

- Develop a multi-disciplinary team design project that can be rolled out to two core, candidate subjects in different departments in the Faculty of Engineering and Information Technology (FEIT);
- Develop appropriate learning activities that support the project and promote cohort interaction outside of traditional discipline / departmental boundaries;
- Design relevant feedback and evaluation mechanisms in order to monitor student team progress and gauge the effectiveness of the approach in building cohort, enhancing student graduate outcomes and employability skills;
- Enhance students' communication and project management skills;
- Expose students to real-world engineering practices through the involvement of an industry partner in the scoping and design process.

The project takes a Design-based Research (DBR) (McKenney and Reeves, 2019) approach that aligns with the four stages of DBR that is mirrored in both the design of the learning experience and in the student design project itself:

1. Analysis – problem identification (Threshold Concepts: transdisciplinary collaboration, authentic learning), literature review, establishment of a collaborative learning design team
2. Design prototype intervention (design of authentic learning environment)
3. Evaluation (implementation of prototype with stakeholders – students/industry partner) - Re-Design / Evaluation Iterative Loop
4. Development of Transferable Design Principles for designing authentic (real world) transdisciplinary learning environments in collaboration with industry

Designing a speaker system, which contains electrical and mechanical systems that interact in a complex transfer of energy from electrical to mechanical to acoustic energy, is an inherently multidisciplinary endeavour consisting of both electrical and mechanical engineering concepts. This project will be completed by two capstone teams, one with a mechanical engineering focus and one with an electrical engineering focus, that will closely interact with each other in order to produce a working speaker system that will be tested and evaluated

by an industry partner, creating an authentic learning experience (Herrington et al., 2014).

A particular speaker application will first be chosen by the project teams (e.g. PA speaker, bookshelf speaker, instrument speaker, studio monitor), with corresponding design goals to be determined by the team. Teams will be required to select appropriate speaker drivers, supplied by the industry partner, to form the basis of electrical and mechanical design of the (minimum) two-driver speaker system utilising established design principles (Theile, 1971a, 1971b; Small, 1972, 1973a, 1973b).

The Speaker System Design (Electrical) project team will focus on designing the electrical / electronic side of the speaker system, including modelling, building and testing both passive and active types of crossovers in order to achieve the required performance for the chosen application and consider aspects such as frequency domain performance, power, heat and cost. The electrical project team must interface with the mechanical project team to understand the mechanical characteristics of the enclosure that the speaker is being placed in to design their crossovers.

The Speaker System Design (Mechanical) project team will focus on designing the mechanical / acoustic side of the speaker system, including designing, modelling low frequency response, building and testing a suitable enclosure to minimise vibrations and diffraction and ensure suitable performance characteristics for the chosen application consider aspects such as exterior construction materials, geometry of the design, high frequency diffusion patterns, venting and interior absorption materials to minimise resonances. The mechanical project team must interface with the electrical project team to understand the characteristics of the speaker-driving circuitry to design a suitable enclosure.

The main pedagogical outcomes of the project are to give electrical and mechanical engineering students a real world experience of transdisciplinary collaboration. We will use pre/post student questionnaires and post project focus groups to evaluate the impact of the project on the student learning experience. University ethics consent will be applied for, involving participant consent and information forms, and anonymous data collection.

This presentation will introduce the first two phases of the Design-Based Research project as an example of implementing DBR to design authentic learning – the pedagogical problem analysis, and the proposed prototype educational design capstone project.

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