Citation for Outstanding Early Career Contribution to Engineering Education 2024
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Criterion 1 – Approaches to teaching and the support of learning that influence, motivate and inspire engineering students to learn

Overview of the contribution and its context

I commenced as a lecturer at UOW in January 2020 as my first full time academic position since completing my PhD in 2019. I co-ordinate two of the three subjects in the mechanical design stream of the UOW Mechanical Engineering program. Critical to this program is developing students that have a practical understanding of the world around them and how their decisions as mechanical engineers will shape the projects they are contributing to. This can present challenges for how to replicate or simulate real engineering challenges through projects or experiences in the classroom so that students can be prepared for their future career. My philosophy to education is built around the notion that the best way to learn is by doing and that this can be most effectively achieved through practical real-world projects, hence my practice often lies strongly in the realms of constructionism and experiential learning [1]. I believe that in order for educational experiences to be successful, they must be engaging and encourage the students to think critically about the content and its relevance both to the problem at hand and their future careers. Considering this, my approach as an educator has focused heavily on supporting experiential activities for the students which I provide both through the subjects I coordinate and through a range of extra-curricular activities. As coordinator of the UOW Maker Space and as advisor for the UOW Motorsport Team and Australian Rover Challenge Team I help to provide our students opportunities to gain hands-on experience and put theory into practice.

Fostering student development by stimulating curiosity and independence in learning

I believe the use of active and student-centred learning strategies such as problem-based (PBL) and experiential (ExL) strategies delivered by a passionate and knowledgeable teacher is the best approach [2]. Creating a learning experience that is centred on the students is key to engagement and once the students are engaged, the next challenge is in fostering the students' ability to absorb the subject content on a fundamental level; this can be achieved through real world examples and problems (PBL & ExL) that challenge the students to think critically to solve the problem [3] and also provide them a link to their professional careers through work integrated learning [4]. I have been working diligently to put this philosophy into practice through the development of the UOW Maker Space which I setup in 2022 to enable myself and other educators to have a place where real hands-on experiences can be delivered in the classroom allowing our students to put theory into practice; further it allows our students to continue their learning outside of the classroom by providing free and open access for the students to experiment creatively in a collaborative and supportive environment. This endeavour is supported by strong empirical evidence for the value of 'makerspaces' or 'fabrication (fab) labs' in supporting student confidence and learning outcomes [5] as well as the tremendous attendance the space has received since opening. The space has had close to 5,000 student visits (outside of class) since opening in September 2022 which clearly demonstrates that students feel welcome and value the opportunities the space presents. It also helps support our student teams by providing them access to 3D printing, laser cutting, water jet cutting, and various electrical mechanical tools to enable them to work independently on their projects. Further to this, I am the principal advisor for the UOW Motorsport team and an assistant advisor for the Australian Rover Challenge Team; these programs provide students the greatest opportunity to explore the world of engineering through facing realistic and practical engineering challenges. In advising these teams I challenge the students to put what they have learnt in the classroom into practice and encourage them to explore innovate solutions to the problems they are facing whilst also applying an engineering mindset to the solution process.

Assisting students from equity and other demographic subgroups to participate and achieve success in their courses

Supporting students from diverse and underrepresented groups is extremely important to me although it can be challenging whereby definition there are limited students enrolled in our engineering cohorts from underrepresented groups. As such I have taken the approach to support activities that encourage a more diverse range students to pursue engineering and STEM related careers in the future. I have been able to work towards this through the UOW Maker Space which acts as a hub for outreach activities at UOW with more 30 separate workshops hosted for members of the community including EmpowerHER STEM Summit, AccelerateHER and AccelerateTHEM (MultiCultural Communities of Illawarra), Woolyungah My Future Matters, Recovery Camp, Discovery Days, and many others delivered since 2022. This has the impact of supporting groups that are often underrepresented in STEM particularly women, gender-diverse, and culturally and linguistically diverse groups. It is hoped that these endeavours will help to encourage the participants to pursue STEM careers in the future by providing them with greater confidence and understanding of the careers available.

Inspiring and motivating students through effective educational design and delivery

My approach to learning and teaching that best demonstrates my ability to motivate and inspire students can be seen through two subjects I coordinate (MECH203: Mechanical Engineering Practice and MECH311: Mechanical Engineering Design 2) and my development of the UOW Maker Space. In MECH203 I aim to provide students with a practical understanding of how things are made (manufacturability) to lay a strong foundation of understanding to aid them in their mechanical design endeavours. This is achieved through a combination of ExL and PBL. After completing practical lessons in how to perform the certain tasks for the subject (how to use specific tools and methods), an experiential approach is provided, with students given specific tasks to complete in order to develop the required skill which then leads into a problem-based teaching method where we give students a large and creatively open project to work on for the rest of the semester in small groups. The idea behind this is to trigger students to complete independent and self-directed study towards acquiring and refining knowledge, whilst also allowing the opportunity to discuss new knowledge in group settings as supported by literature [3]. To inspire the students to be as creative as possible, we run this subject in the UOW Maker Space which gives them the opportunity to design, build, and experiment with complete freedom.

"having the freedom to design and build without many limitations, feels like the first actual engineering subject I've taken" (MECH203 2023 Subject Evaluation)

"the hands on learning and practical aspects were the best, also the encouragement of critical thinking and problem solving rather than straight being given the answers was good" (MECH203 2023 Subject Evaluation)

I am fortunate to regularly work on industry-based projects through my research with enables me to bring real world examples into the subjects I teach, to enhance the education and industry readiness of our students. This allows me to include case studies in my subjects based on projects I have worked on or that I am familiar with, to help students understand the real-world applications and impact of the content they are studying. This is clearly demonstrated by student feedback:

"The content and applicability to real–world scenarios. We saw videos and examples of times when bins have failed, or vents for explosions have failed and the repercussions and ways to prevent that from happening" (MECH372 2022 Subject Evaluation)

"I enjoyed the very clear correlation between learning and what I might see in industry – this has been the best example of this in my university career" (MECH372 2021 Subject Evaluation)

Through my approach I have been able to achieve an average teaching evaluation score of 5.60/6 (10 subjects: max 5.81, min 5.33) up to the end of 2023 clearly demonstrating a high level of student satisfaction.

Enabling others to enhance their approaches to learning and teaching

The UOW Maker Space now supports at least 6 subjects each year, with more being added each semester as we grow and develop the facility, which demonstrates the clear impact I am having to enable others to enhance their teaching practice. The development of the UOW Maker Space has also

provided further opportunity to apply my passion and expertise for engineering design to support others through the UOW L.I.F.T program (Women in STEM grant) to provide new resources and services to aid in the education of pre-service and in-service teachers through the School of Education. I provide expertise through the Maker Space for development of new STEM activities and training of the participants. The concept of the collaboration with School of Education academics is that a teacher's confidence, understanding, and skill in STEM activities is intrinsically linked to the effectiveness of STEM delivery in their own classroom practice [6]. For pre-service teachers we have implemented a program to allow education students to gain confidence in STEM activities through structured training in the Makerspace over two weeks leading into a major project for the subject EDSC102 (Science Content Knowledge for Educators) where students are required to utilise the Maker Space in their own time. This program supports over 250 students each year, predominantly women, to gain critical skills and confidence in STEM activities. Further to this we have developed a new "Maker+" program which provides dedicated training in accordance with NSW Education Standards Authority to in-service teachers to build their know-how and confidence in conducting STEM activities for their students. This program comprises of five separate workshops linked to the primary school curriculum with the training and activities developed collaboratively with the School of Education academics. It is expected that these efforts will lead to improvements in the promotion of STEM in primary and secondary education which will flow through to more students taking on the careers in the future.

Developing and/or integrating assessment strategies to enhance student learning

My approach to assessment strategies to enhance student learning is demonstrated through the subject MECH311, where I have developed the subject to focus on the application of theory through practical problems, in the form of a semester long project activity. In this task we do not focus on following a predefined solution method but instead we provide the resources the students need in order to develop their own unique solution to the problem at hand. Recent projects have included the design of agricultural machinery (cultivator, seeder) and different machine tools (lathe, drill press) which represent realistic design challenges incorporating a range of mechanical elements that students have been learning about in their previous subjects. This allows the students to develop a number of desirable skills through the review of background materials, critical analysis, collaboration with team members on a common task, and, of course, problem solving. This results in a student-centred approach where the students work with each other on the assigned task and the teaching staff act to monitor and provide just-in-time support to the students with the goal of building their confidence in solving problems of a complex nature. This approach is designed to prepare students for their professional careers and can be classified as Embedded Work Integrated Learning (WIL). The students clearly grasp the importance of this and value the experience as demonstrated by subject feedback:

"The class involved a real-world application task that allowed project experience which is usually something that is commonly missed in classes. It required in depth analysis of systems connect multiple subjects through multiple years of work together and wasn't individual to this classes content." (MECH311 2023 Subject Evaluation)

"I enjoyed the open–ended nature of the project and the freedom to design. I learned a lot of practical skills that I will definitely be able to apply in my workplace." (MECH311 2023 Subject Evaluation)

Reference List

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