

2024-06-17

Refining Transversal Skills Through Engineering Design Projects: A Case for Authentic Assessment

Gerald Gallagher

Technological University Dublin, gerald.gallagher@tudublin.ie

Kevin Delaney

Technological University Dublin, kevin.delaney@tudublin.ie

David Salter

Technological University Dublin

See next page for additional authors

Follow this and additional works at: <https://arrow.tudublin.ie/engschmecon>

 Part of the [Engineering Commons](#)

Recommended Citation

Gallagher, Gerald; Delaney, Kevin; Salter, David; and Chen, Mingzhu, "Refining Transversal Skills Through Engineering Design Projects: A Case for Authentic Assessment" (2024). *Conference Papers*. 86.
<https://arrow.tudublin.ie/engschmecon/86>

This Conference Paper is brought to you for free and open access by the School of Mechanical Engineering at ARROW@TU Dublin. It has been accepted for inclusion in Conference Papers by an authorized administrator of ARROW@TU Dublin. For more information, please contact arrow.admin@tudublin.ie.



This work is licensed under a [Creative Commons Attribution-NonCommercial-Share Alike 4.0 International License](#).

Authors

Gerald Gallagher, Kevin Delaney, David Salter, and Mingzhu Chen

Refining Transversal Skills Through Engineering Design Projects: A Case for Authentic Assessment

Gallagher, Gerald^a Delaney, Kevin^a Salter, David^a Chen, Mingzhu^a

School of Mechanical Engineering, Technological University Dublin, Ireland.^a

Corresponding Author's Email: gerald.gallagher@tudublin.ie

KEY WORDS: [Mechanical Engineering, Engineering Design, Transversal Skills, Authentic Assessment]

ABSTRACT

Transversal skills were typically not the focus of traditional engineering education, where strong technical prowess by students tended to be emphasised in undergraduate and postgraduate study. However, the importance of developing these skills, having application across multiple career trajectories, is becoming a key area of development in engineering education. An engineering design module presented in this work has been refined to act as a vehicle to help students develop and practice these transversal skills while simultaneously reinforcing their abilities in mechanical design. This paper describes how the module has been structured and operationalised, through approximations of practice and authentic assessment, to help the students. For the case study presented, involving group project work spread over two semesters, students were tasked to first design and build a coffee cup weight and temperature measuring device with the design being brought forward and included in a robotic coffee delivery device design during semester two. Feedback from both staff and students indicate that the module structure is advantageous to transversal skill development, with key comments showing considerable reflection on time management, critical thinking, and leadership.

INTRODUCTION

Mechanical engineering is one of the broadest engineering disciplines and graduates must demonstrate strong technical abilities across a broad range of areas. To efficiently apply their technical knowledge to the solution of real-world multi-layered engineering design problems, mechanical engineering students must develop a broad range of skills in addition to this technical knowledge. Such skills, known by various names, have application across a broad range of careers (Goggin et al., 2019). Reflecting this breadth of application, they are commonly called transversal skills and include good communication, time management and organisation, critical thinking, research, and leadership skills. The most effective way to develop and refine these skills is through practice in situations which approximate the experience that students will have after graduation (Larraz et al., 2017). A problem-based

learning engineering design module, developed over the last 15 years, is taken over the two semesters on the third year of a Level 8 Irish National Framework of Qualifications (NFQ) engineering degree in mechanical engineering (Delaney and Nagle, 2019). The degree is equivalent to Level 6 on UK educational frameworks such as the Regulated Qualifications Framework for England and Northern Ireland (Quality Assurance Agency for Higher Education, 2023). The module is designed around authentic assessment used as a catalyst for both technical and transversal student skill set development. The main transversal skills assessed during the module are outlined in Table I.

Table I: Main transversal skills assessed during the module with sample metrics (both observed and assessed)

Communication	Time Management & Organisation	Critical Thinking	Research	Leadership
Verbal	Weekly Deliverables	Design Evaluation	Informed Design	Strategic Decisions
Report Writing	Task Diligence	Troubleshooting	Information Organisation	Delegation
Presentations	Priority Assessment	Design Optimisation	Software and Hardware Evaluation	Conflict Management

AIM AND OBJECTIVES

The aim of the practice was to improve and assess the development of core transversal skills through authentic assessment for mechanical engineering students. To achieve this aim, the main objective was to implement a module structure with deliverables conducive to transversal skill development. This involved designing methods of assessment that indicated both technical and transversal skill improvement and implementing a feedback and reflection process to understand the student response and inform future module changes.

PROBLEM AND INTERVENTION

The general layout of the module involves a two-hour facilitated session every week for 12 weeks across two semesters, starting with an introduction and team building activity, a project briefing, an initial design discussion and a subsequent review with submitted drawings (Delaney et al., 2021). This is followed by multiple design weeks which, after concluding with an intermediate process poster submission, leads to preliminary testing and debugging and the final design test and poster submission.

For the current case study, in the first semester, groups of three to four students were given the task of designing and manufacturing a coffee cup weight and temperature measurement device. Several teaching approaches were applied to encourage students to develop their transversal skills and to reflect on the importance of these skills to the overall success of the project. For example, a strict start time for the two-hour session was avoided to encourage students to realise the importance of self-starting in their groups and for individual students

to develop better leadership and organisational skills. Students were also informed of workshop availability but were required to organise their workshop time independently outside of the session. To expand the experience each group was given the opportunity to work with (a) third year electrical engineering student(s) to emulate the interaction with an external project consultant. This involved the submission of a consultant report to each group which improved the overall design and, perhaps more importantly, also helped make students aware of the importance of communicating with people from different disciplines.

For the second semester, the previous design was incorporated into a robotic coffee delivery device design, with the same teaching approaches applied. As several students undertake Erasmus studies during the second semester, the teams were restructured slightly to help the students experience change and help them improve their resilience. Combined with designing and building a remote-controlled vehicle of a specified size based on the design brief, students were required to incorporate several manufacturing methods into the build. At the end of the semester, the completed vehicles were assessed based on both design features and functionality. Compared to the first semester, the emphasis on hard technical engineering skills in the second semester was significantly increased to align with the program outcomes outlined by the Institute of Engineers Ireland. Figure 1 shows sample student designs based on the first and second semester assignments.

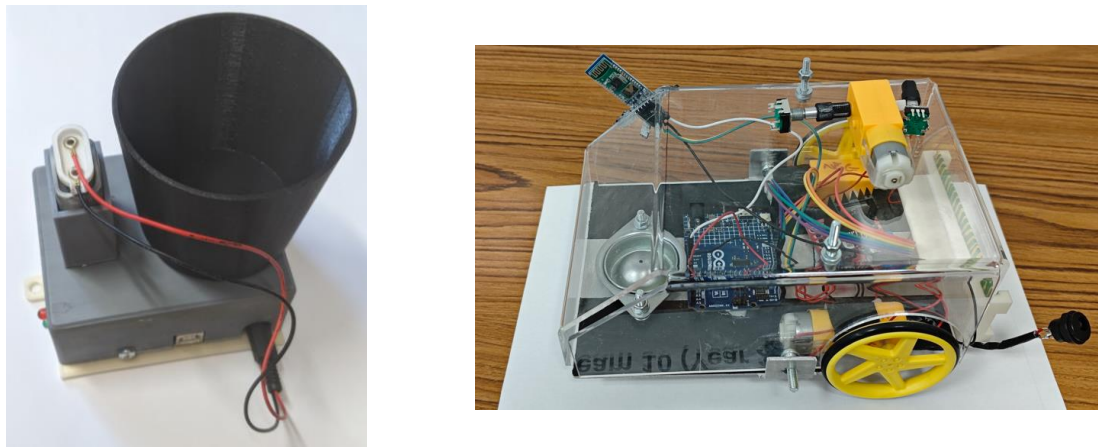


Figure 1: Sample student designs showing a coffee cup weight and temperature measurement device on the left and robotic coffee delivery device on the right.

KEY FINDINGS OR OUTCOMES

It was deemed useful to gather feedback from both staff and students as both viewpoints could be considered for further development of the module structure and content. Table 2 summarises some of the key viewpoints collected at the end of the first semester, with the student feedback generally grouped into transversal skill headings for clarity.

Table 2: Key feedback from staff (left) and students (right)

“Self-starting seemed tough for students”, “Difficult to bring concepts together from different disciplines for design work”, “Some groups flourished, while others found time management and critical thinking to be difficult”, “Beneficial for these skills to be probed and developed at this stage”.	<u>Time Management and Organisation</u>: “Take time to plan”, “Ensure you have enough time to execute idea”, “Create prototype sooner”. <u>Leadership and Communication</u>: “Delegate work better”, “Teamwork was poor”, “Discuss different ideas”, “Confirm resources”. <u>Critical Thinking</u>: “Think outside the box”, “Should have chosen a simpler idea”, “We had too many ideas”, “More testing”. <u>Research</u>: “Should have done more research”, “Rushed into things”.
--	---

DISCUSSION

Preliminary results based on staff and student feedback showed that the module effectively promotes transversal skill development. The development of transversal skills transfers well to both industrial and research-based engineering careers and gives engineering graduates the tools needed for successful careers.

CONCLUSIONS & RECOMMENDATIONS

The module structure was deemed a success as it allows for better transversal skill development than a single semester module. Transversal skills will become more important in interdisciplinary engineering areas while dealing with sustainability problems effectively. Recommendations would be to continue to refine the structure of each stage of the module, and to choose projects that align with research and industry.

REFERENCES

- Delaney, K., Nagle, G., 2019. Problem based learning: A case study from mechanical engineering. <https://doi.org/10.21427/019C-ZX21>
- Delaney, K., Nagle, G., Chen, M., 2021. Gamification of icebreaking activities for mechanical engineering students embarking on a problem based learning module, in: INTED Proceedings, INTED2021. IATED. <https://doi.org/10.21125/inted.2021.2221>
- Goggin, D., Sheridan, I., Lárusdóttir, F., Guðmundsdóttir, G., 2019. Towards the identification and assessment of transversal skills, in: INTED Proceedings, INTED2019. IATED. <https://doi.org/10.21125/inted.2019.0686>
- Larraz, N., Vázquez, S., Liesa, M., 2017. Transversal skills development through cooperative learning. Training teachers for the future. On the Horizon 25, 85–95. <https://doi.org/10.1108/oth-02-2016-0004>
- Quality Assurance Agency for Higher Education, 2023. Qualifications can cross boundaries.