25TH INTERNATIONAL CONFERENCE ON ENGINEERING AND PRODUCT DESIGN EDUCATION
7-8 SEPTEMBER 2023, ELISAVA UNIVERSITY SCHOOL OF DESIGN AND ENGINEERING, BARCELONA, SPAIN

# SUSTAINABLE PRODUCT DESIGN EDUCATION THROUGH AN APPRECIATION OF THE LOW-TECH

**Ceri ALMROTT**
Technological University Dublin, Ireland

## ABSTRACT
The paper presents a case study on the implementation of Low-Tech development model to teach sustainability in design-led programmes. The author argues that sustainability education should include not only the technical aspects of sustainability theory but also the underlying social aspects. The low-tech approach fits well in design-led modules since it encourages students to consider appropriate technological solutions for design projects while focusing on user behaviour to develop articulate solutions. The study explores the pedagogical approach of the content used to teach the design module and introduces a low-tech design workshop to aid students in implementing learning. The results of the study show that students' understanding of sustainability and low-tech design increased, and they were able to implement mechanical solutions to design problems while considering the social element of their design outputs.

*Keywords: Product design, design education, sustainability, low tech, studio practice*

## 1 INTRODUCTION
Philippe Bihoux, in his 2014 work, *L'Âge des low tech: vers une civilization techniquement soutenable* suggests that developing increasingly high-tech solutions to address the sustainability crisis is a hopeless cause [1]. Instead, an appreciation of energy sobriety and material conservation, as we move to embrace low-tech developments, would yield more impactful results.
Internationally, design courses offer a range of approaches to teaching and embedding sustainability theory amongst their student body. From focusing on behaviour change [2], and imparting knowledge on sustainable design and manufacturing approaches [3] to a focus on developing product solutions which encourage improved product lifespans [4] there are many worthwhile pedagogies which can be imparted to our students.
Low-tech approaches to sustainability require designers to question assumptions held about users' energy needs through the lens of energy sobriety. Their solutions should reduce technological intensity and complexity whilst encouraging a commons approach to the implementation of a solution.
As a method of sustainability education within design-led programmes there is little documentation of this approach being widely utilised although the theory's core ideas of behaviour change through a better understanding of user needs and requirements[5] follow the common practices of User Centred Design that many course programmes map.

## 2 AIMS AND APPROACHES
Many courses are moving toward an integrated model of sustainable education within their programme frameworks rather than standalone sustainability modules [6]. This allows for education systems to not only educate students on the technical aspects of sustainability theory but also the underlying social aspects. This approach allows for a deeper, less superficial understanding of sustainable development. For this reason, it was decided to implement additional sustainability themes into more modules within the programme architecture. The Low-Tech approach fits well within the case study module as students were already being asked to consider non-electrically powered solutions for design projects as well as considering user behaviour to develop articulate solutions. It was decided that module learners should:

- Have an increased understanding of sustainable development.
- Be able to implement mechanical solutions to design problems.

- Be able to consider the social element of their design outputs.

### 2.1 Practice-Based Learning

Practice-based learning for design education is a well-established approach and is often a primary tactic in many design education programmes [7]. It has been noted that it can also be an especially useful approach for comprehending technical systems [8]. These are major themes within the module requirements and so it is a natural pedagogical approach for this type of class. It will be important however to balance the delivery and scaffolding of the sustainability theory within the design-led paradigm that the module structure requires. At this stage in the education cycle students on the programme tend to have shorter time limits for design projects to allow for repeated practice of problem-finding, problem-framing and problem-solving and as such, outcomes are likely to achieve lower levels of resolution. However, there should be plenty of opportunities for students to explore and explain their understanding of the subject matter through their design work.

### 2.2 Technical Content

Students are expected to undertake a large amount of Continuous Assessment work in class and so formal teaching sessions were shorter in length than may ordinarily be expected. This deficit was augmented with additional tailored verbal instructor feedback. Students were presented with several pieces of literature to read and were instructed in the following subject matter through lectures and case studies:

- Introduction to sustainable product development
- The low-tech development model.
- Simple Mechanical Systems

Additionally, video and online resources were provided to students through the Virtual Learning Environment and links to parallel themes in concurrent modules were highlighted to allow students to understand and implement knowledge provided from taught modules in other areas of the programme syllabus.

### 2.3 Low-Tech Workshop

As additional educational activities, an intensive Low-Tech design workshop was developed in two parts to allow students to develop design ideas which were deeply rooted in the low-tech development framework.

The first part of this workshop involved the students undertaking several activities (cause and effect diagramming, ecosystem mapping) and then developing their design ideas using prompts from an ideation card game developed for the workshop. This card game ran for several rounds allowing students to develop responses based on the card prompts which were developed based on the Low-Tech framework.

The second session allowed students to quickly evaluate and prototype their mechanical design ideas through prototyping mechanisms with a simple kit of mechanical components. Students were able to use given components and rapidly prototype their own custom parts to understand the implications of their mechanism design.

## 3 RESULTS

### 3.1 Sustainability Learning

Anecdotally the current generation of students is said to be the most aware cohort ever regarding the climate crisis. To set a benchmark for the understanding of how sustainability considerations were understood within the student body, regarding product development, the class (ordinarily 30 students but for the initial session included some visiting students) was asked to consider the most important consideration when thinking about sustainable design. Thirty-five results were recorded, and they were analysed thematically into the following themes.

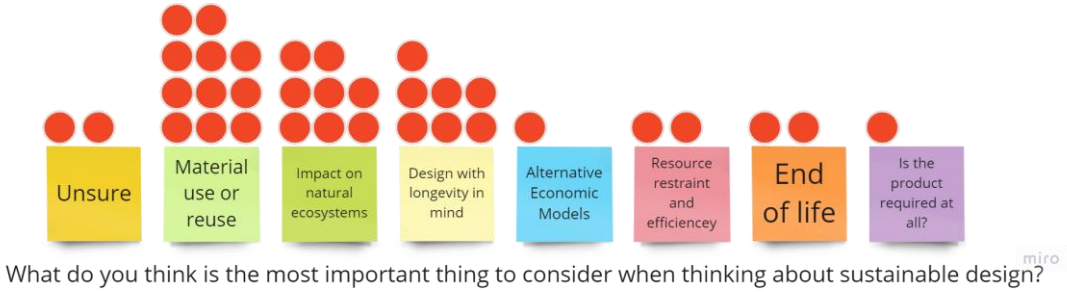


*Figure 1. Thematic grouping of a poll to understand the class's view of important considerations in sustainable design*

The area with by far the most responses related to material use, which is understandable as it is often a central theme in sustainability discussions. This is also related to the broader theme of resource restraint and efficiency. The next largest grouping of responses related to a product's impact on the biosphere with ideas around the life of the product as the third largest theme.

When students were asked to reflect on their understanding of the phrase *low tech design* there were similarly large groupings of responses.

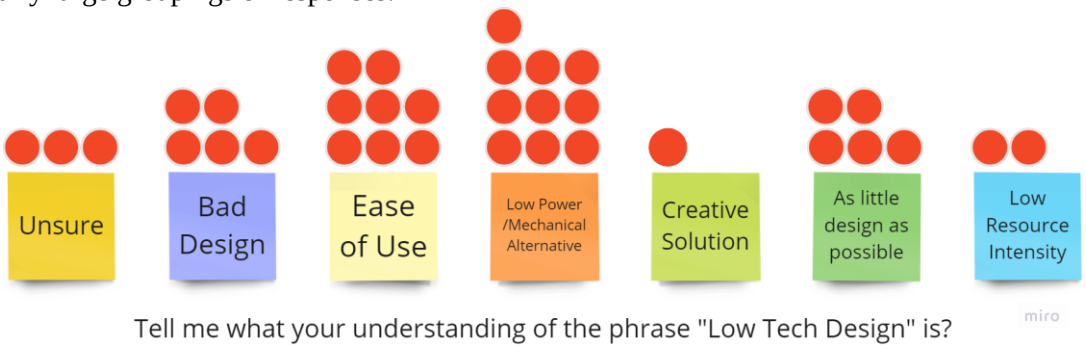


*Figure 2. Thematic grouping of a poll to understand the class's understanding of the phrase low-tech design*

With these groupings, many students understood the phrase to relate to finding mechanical or low-energy solutions, which may have been due to students' prior knowledge of the upcoming design brief. Students also identified the importance of ease of use and *as little design as possible* as important requirements. There was also a markedly high response of students' negative reflections on the phrase and equating it with poor design outcomes.

At the end of the programme of study, students were polled on their understanding of sustainability within a general context and within the more specific realm of product development. Students responded to several statements using a Likert scale to indicate their agreement with a statement. Seventeen students responded to this poll, around 50% of the number who took part in the poll at the beginning of the project.

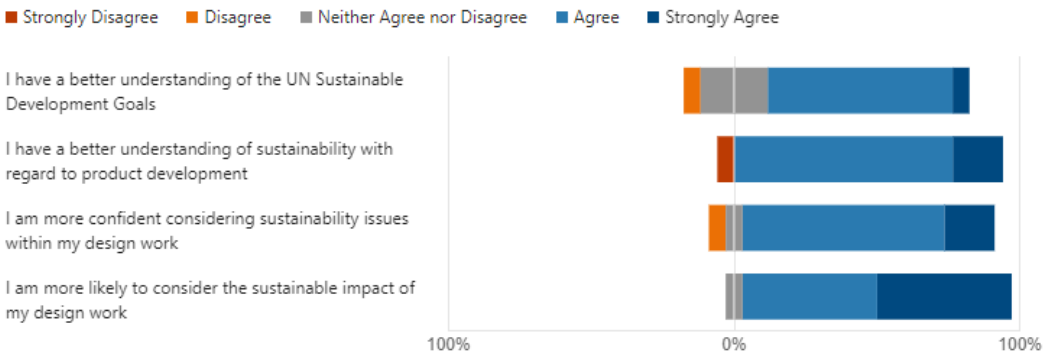


*Figure 3. Results of end-of-course polling to understand student learning around sustainability*

Most students found the programme of study to be positive. Nearly all respondents had a better understanding of the UN Sustainability goals and all bar one felt they had a better understanding of sustainability within the context of product development. More significantly many students were more confident considering sustainability in their ongoing design practice and nearly every student who responded was likely to consider the sustainability aspects of their design concepts moving forward.

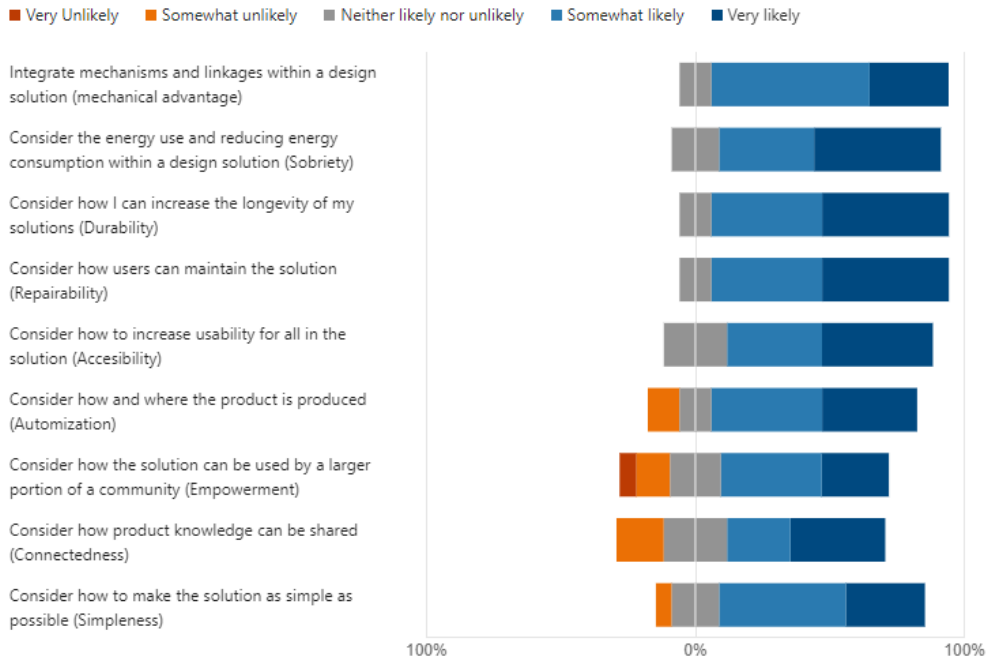


*Figure 4. Likert Graph to understand the adoption of knowledge and competencies around Low - Tech Development*

Overall, the programme of study allowed most respondents to have a high likelihood of implementing many of the Low-Tech method's themes into their future design work. Considerable success was had with students understanding the importance of energy sobriety, durability and repairability which are all important goals.

The themes with the lowest confidence among students were those concerning some of the social elements of the low-tech method. Students were less likely to consider user empowerment and connectedness within future design projects.

## 3.2 Low-Tech Ideation Game

Students spent one 4-hour class session undertaking a serious game to help them develop their design ideas within the Low-Tech framework. Each team was provided with a series of primer tasks based on understanding the product ecosystem for their design space as well as cause-and-effect mapping exercises. The card game posed a series of ideation prompts related to the Low-Tech development method combined with critical thinking prompts in the form of wildcards.


*Figure 5. Low Tech Ideation Game in use*

The workshop session was active, social, and provided a good atmosphere within the studio during the activities. All groups of students engaged well during the workshop and groups finished the session with a large volume of design ideas. When asked to reflect on the session students provided the following feedback.

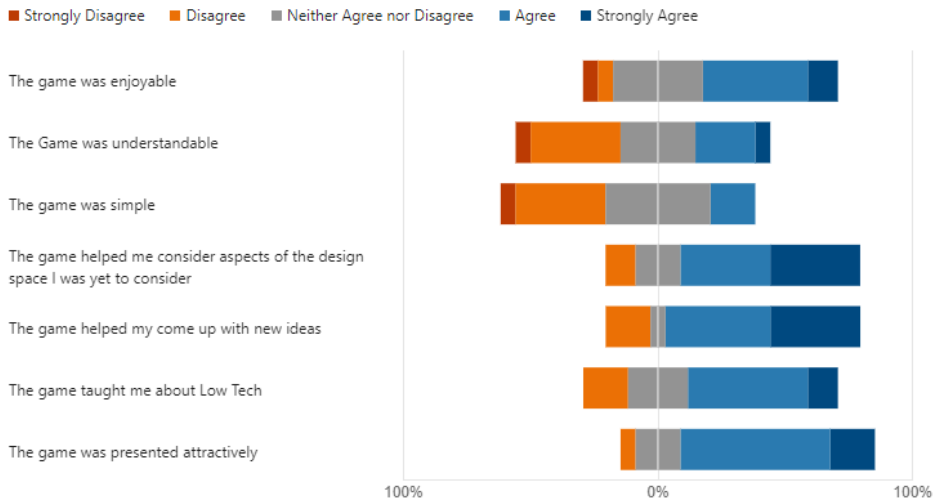


*Figure 6. Feedback on the Ideation Card Game*

Overall, the game was enjoyable but the nature of the game being a prototype was quite evident on the first play-through. Simplicity and understandability received low scores in the Likert response. Initially, the communication around the way the game was to be played was not understood and some groups struggled to understand that they were playing together as a team and not against each other. Additionally, it was found that unplayable hands could be dealt and as such new rules to allow teams to move forward when this happened had to be generated and explained on the fly. This is not surprising considering that it was the first time the game was being played.
The game was however successful in helping respondents consider alternative aspects of their design space, generate innovative ideas and teach some of the aspects of the Low-Tech method.

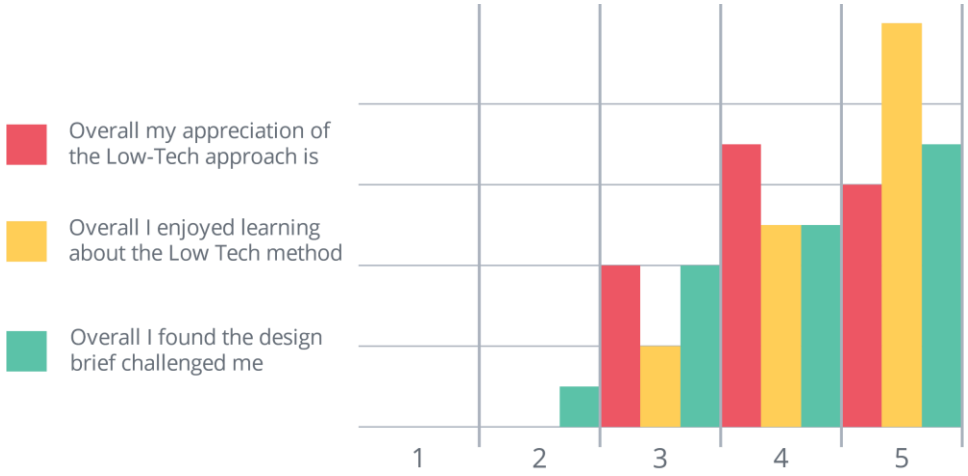


*Figure 7. Feedback from respondents of the exit poll on their impressions of Low-Tech and the design brief*

When asking respondents to rate their experience (5 being high or positive 1 being low or negative) most students found learning about Low Tech development to be an enjoyable activity with the majority having a positive appreciation of the theory. By and large, the design challenge was pitched at the right level. Although most students found it highly challenging, in anecdotal feedback nobody found the difficulty to be detrimental and design project outputs were, for the most part, an improvement on previous projects at this stage of the design education cycle.

## 4 DISCUSSION AND CONCLUSION

Overall, students' experience of the module was overwhelmingly positive and the quality of work that was produced during the class was to a high standard. Students felt that the approach taken was informative and their knowledge of topics related to design for sustainability increased.

Students judged that the methods used improved their comprehension of the more technical aspects of design for sustainability however the social elements were weaker. Within the Low-Tech Development model, the social aspects are a major theme so this should be addressed in future if a well-rounded education in the Low Tech is to be provided. One approach which is common within French-authored literature on the subject is the inclusion of a *territoire* within the design framework [9]. Due to the time constraints of the project, this was not an approach which was implemented within this version of the curriculum but based on the students' feedback it may be of great benefit in allowing students to focus on the social and societal elements of low-tech.

The workshop and card game proved useful to students but did not provide as an enjoyable experience as first intended. It achieved its aims of inspiring alternative approaches and questioning students' assumptions, but the implementation was awkward and at times confusing. Improvements can be made in the instructional material but overall, the rules would benefit from some simplification.

In general, the module achieved its goals of introducing students to Design for Sustainability ideas and the Low-Tech framework operated well within a product design context. All students were able to develop a product concept which involved a mechanical solution (and improved their competency in mechanism design).

## REFERENCES


[1] Bihoiux P. *The Age of Low Tech*, English Tr. Bristol, United Kingdom: Bristol University Press, 2014.

[2] Boks C. and Daae J. Z. "Design for sustainable behaviour in design education," in *Proceedings of the 14th International Conference on Engineering and Product Design Education: Design Education for Future Wellbeing, EPDE 2012*, 2012, no. September, pp. 611–616.

[3] Butt A. T., Causton E. W. and Watkins M. A. "Embedding Sustainability in the Engineering Curriculum: a Complimentary Approach To Performance Engineering and Sustainable Design," in *Proceedings of the 22nd International Conference on Engineering and Product Design Education, E and PDE 2022*, 2022, no. September, pp. 9–14, doi: 10.35199/epde.2022.24.

[4] Green C. "Thinking Beyond the Product Moment: Addressing Issues Around 'Keeping,'" in *Proceedings of the 22nd International Conference on Engineering and Product Design Education, E and PDE 2022*, 2022, no. September, doi: 10.35199/epde.2022.103.

[5] Tanguy A., Carrière L. and Laforest V. "Low-tech approaches for sustainability: key principles from the literature and practice," *Sustain. Sci. Pract. Policy*, vol. 19, no. 1, p., 2023, doi: 10.1080/15487733.2023.2170143.

[6] Ceschin F. and Gaziulusoy I. "Evolution of design for sustainability: From product design to design for system innovations and transitions," *Des. Stud.*, vol. 47, pp. 118–163, Nov. 2016, doi: 10.1016/J.DESTUD.2016.09.002.

[7] McLening C. and Buck L. "Practice based learning approaches in collaborative design and engineering education: A case study investigation into the benefits of a crossdisciplinary practice based learning strategy," *Proc. 14th Int. Conf. Eng. Prod. Des. Educ. Des. Educ. Futur. Wellbeing, EPDE 2012*, no. SEPTEMBER, pp. 661–666, 2012.

[8] Yavuzcan H. G. and Gür V. "View of A Toolkit for Practice-Based Learning of Mechanisms in Industrial Design Education: An Application of a Method Combining Deductive and Inductive Learning," *Des. Technol. Educ. An Int. J.*, vol. 25, no. 3, pp. 47–68, 2020, Accessed: Mar. 06, 2023. [Online]. Available: https://ojs.lboro.ac.uk/DATE/article/view/2781/2903.

[9] Pachoud C., Koop K. and George E. "Societal transformation through the prism of the concept of territoire: A French contribution," *Environ. Innov. Soc. Transitions*, vol. 45, pp. 101–113, Dec. 2022, doi: 10.1016/J.EIST.2022.10.001.