The Role of Authentic Assessments in Multi-displiniary Design and Build Modules for Enhancing Student Employability

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***Abstract*— This innovative practice full paper provides an in-depth analysis of the Design and Build (D&B) module, which utilises cross-programme grouping method, within UK undergraduate engineering programmes, showcasing a unique approach to authentic assessment. It elucidates the module's significant impact on enhancing student employability and interdisciplinary collaboration, offering a novel model that integrates real-world challenges and teamwork into the academic curriculum. The distinctiveness of the D&B module lies in its branched structure, which not only reinforces technical and soft skills but also promotes innovation and practical application of knowledge.**

The primary aim of such modules is to enhance student employability through the development of technical expertise, problem-solving abilities, and teamwork skills. Additionally, it seeks to foster innovation and the practical application of theoretical knowledge, preparing graduates to meet the dynamic demands of the engineering industry.

The study's findings reveal that the D&B module significantly contributes to student employability by enhancing technical competencies, soft skills, and the ability to engage in innovative problem-solving. Graduates from the programme demonstrate a high degree of readiness for the professional environment, showcasing the effectiveness of the module in bridging the gap between academic learning and industry requirements.

Keywords— Employability; Multidisciplinary; Student experience; Authentic Assessment

I. INTRODUCTION

The field of engineering is in constant evolution, driven by rapid technological advancements and the increasingly complex challenges of a globalised world. In this dynamic environment, the gap between traditional academic training and the practical skills demanded by the industry has become a critical concern within engineering education. Traditional curricula often emphasise theoretical knowledge and analytical skills, which, while foundational, may not suffice to equip students for the multifaceted challenges they will encounter in professional settings.

Recognising this gap, educators and academic institutions have been urged to innovate and adapt their teaching methodologies to better prepare students for the realities of the engineering profession. This need is particularly pronounced in Higher-Education (HE) institutions, where engineering programmes are expected not only to provide rigorous theoretical training but also to cultivate practical, problem-solving, and interpersonal skills that are essential in the workplace.

The Design and Build (D&B) module was developed as a core component of three undergraduate engineering curriculums. The module is grounded in the principles of authentic assessment, which argues that learning is most effective when students are engaged in tasks that mirror the complexity and ambiguity of real-world scenarios. Authentic assessment challenges students to apply their theoretical knowledge in practical settings, thereby bridging the educational gap between theory and practice.

The module's instructional approach is designed around a two-phase project that simulates real engineering challenges. The initial phase involves discipline-specific training, while the second phase

requires interdisciplinary teams to integrate their work into a cohesive system. This design rationale is rooted in the pedagogical principle of authentic assessment, which emphasises learning through doing and reflects the complexity of real-world engineering tasks.

This approach specifically addresses these challenges by integrating multidisciplinary teamwork, real-world problem-solving, and continuous feedback into a cohesive educational experience. By simulating real engineering challenges and requiring interdisciplinary collaboration, the module not only enhances technical skills but also develops the soft skills—such as communication, teamwork, and innovation—that are crucial for modern engineers.

This paper presents an in-depth analysis of the D&B module, examining its impact on student employability and its capacity to foster a deeper understanding and application of engineering principles. Through this study, we aim to demonstrate the effectiveness of the practical module in enhancing the preparedness of graduates for the professional environment, thereby contributing to the ongoing discourse on the need for innovation in engineering education.

II. LITERATURE REVIEW

The shift towards more practical and application-based learning in engineering education is robustly documented within academic literature. This section reviews existing educational practices, underscores identified gaps, and contextualises the approach of the D&B module, demonstrating how it aligns with and advances current educational theories.

Assessment design in HE has vastly evolved over the years and the concept of making assessments 'authentic' has been widely discussed in literature. To depict the idea of authenticity, the authors in [1] described few characteristics which makes an assessment authentic such as: challenging, produces an outcome in the form of a product and ensure transfer of knowledge. The study in [2] described authenticity in assessment as a transformation from usual examination and tests to a more complex and comprehensive assessment of knowledge of higher order skills. The significance of authenticity in learning/assessment in enhancing the learning experience has been covered in a number of studies, including [3], illustrated the aspect of authenticity through experiential learning in engineering education. The vast majority were based on the typical implementation of Kolb's theory of experiential learning, where engineering theory and application meet in a rigorous, 'hands-on' team work experience[4][5]. Assessment design in HE is more comprehensive now with the inclusion of problem-based learning, critical thinking, communication, collaboration and reflection. These are the key attributes expected from graduates in computing, so designing authentic assessments to capture these less tangible attributes at the heart of modern core computing modules [2]. The modules delivered in the engineering programmes provides an opportunity for students to gain experience of analysing real-world problems and designing and implementing solutions to those problems. The delivery incorporates tools and technologies aimed at producing professional quality solutions to real world problems. Assessments are designed purposefully to help students gain professional experience and practice with the most up-to-date technologies, along with an understanding of core computer science concepts. This enables an easier transition into industry and commerce as a graduate professional.

Literatures such as [6] and [7] discussed students' weaknesses in technical strength and feeling of unprepared for employment and insecure when they enter in the professional world. The main cause of these problems is because they are not provided with the opportunities to feel the challenges of real-world problems when assessed, thereby making students passive learners only. In this regard, designing authentic assessments for science and engineering students becomes more crucial.

In this study, the literature review focused on the following aspects:

A. Traditional vs. Innovative Educational Practices

Traditional engineering education has predominantly focused on theoretical and analytical skills, often to the detriment of practical application. Dym et al. [8] highlight that while these traditional methods are essential for establishing foundational knowledge, they frequently fall short in preparing students for the practical demands of the engineering profession. Conversely, innovative educational practices such as project-based learning and integrated curricula have been demonstrated to significantly enhance student engagement and learning outcomes by simulating real-world engineering tasks. Prince and Felder [9] provide evidence that such methods not only improve understanding but also increase student motivation and self-efficacy.

B. Experiential Learning and Authentic Assessment

Kolb's Experiential Learning Theory [4] posits that the process of learning is enhanced when students actively experience content knowledge and subsequently reflect on these experiences. This theory underpins the recent shift towards authentic assessment strategies in education, which aim to assess students' abilities to apply their knowledge in new and varied contexts [3]. Such principles can be addressed by involving students in real-world engineering projects and requiring them to navigate complexities commonly encountered in professional settings.

C. The Role of Interdisciplinary Collaboration

The importance of interdisciplinary training in engineering education has increasingly been recognised,

as today's engineers frequently face challenges that span multiple disciplines. Borrego and Newswander's research in [10] underscores that interdisciplinary approaches not only foster a broader understanding of complex issues but also enhance students' abilities to work effectively in diverse teams. In our study, the module embodies this approach, requiring collaboration among students from various engineering specialisations, thereby reflecting the complex professional environments they are likely to encounter post-graduation.

D. Bridging the Gap Between Education and Industry

It is well agreed that there is a growing need for the necessity to closely align educational outcomes with industry expectations. The publication authors of [11] critically explores the 'skills gap' observed in engineering graduates, highlighting the imperative need for educational institutions to adapt their curricula to include more practical skills training. Such adaptations are crucial for incorporating skills such as project management, teamwork, and problem-solving into engineering education, thereby effectively bridging the divide between academic learning and the demands of the industry.

III. METHODS

The D&B module is a fundamental component of the engineering curriculum, contributing to the final programme Awards. The module unfolds in two distinct phases:

Phase 1: Hands-on Training

In the initial week, students receive specialised hands-on training tailored to their respective programmes, where Telecommunication Engineering (Telecom) programme students focus on electronic systems design, E-commerce (E-commerce) programme students engage in web authoring and database management, and Internet of Things (IoT) programme students delve into neural network training and inference.

Phase 2: Interdisciplinary Collaboration

Students are randomly grouped with peers from other specialisations to foster interdisciplinary collaboration. Each team, consisting of 10 or 11 students, integrates their respective prototypes to construct a functional system. The teams are approximately balanced in a 3:5:3 ratio among E-Commerce, Telecoms, and IoT students.

This phase places a strong emphasis on innovation and the practical application of knowledge. Students are encouraged to initiate, apply their theoretical knowledge practically, and collaboratively tackle engineering problems. They gain invaluable experience working across disciplines and enhance their understanding of the various facets of a comprehensive design project, including hardware, website development, and artificial intelligence.

During this phase, formative peer assessment takes place, wherein students evaluate each other's contributions and exchange innovative ideas to refine their projects.

The module concludes with the students presenting their design ideas and demonstrating the final system as a group. Academic Assessors scrutinise the quality of their work and the evidence of effective teamwork, providing practical and summative feedback on their skills and collaborative efforts.

To evaluate the effectiveness of the module, a survey was conducted among 69 participants of the D&B module to evaluate its effectiveness in enhancing practical skills and preparing engineering undergraduates for professional challenges. The survey represented two sets of Likert-scale questions focusing on the effectiveness of the group project and the perceived benefits of the project in terms of real-world application and skill integration. Responses were categorised as positive, neutral, or negative.

A. Study Design

This study employs a mixed-methods approach to evaluate the effectiveness of the D&B module, a pioneering practice within undergraduate engineering programmes. This module integrates authentic assessment and interdisciplinary collaboration to enhance employability skills, aiming to bridge the gap between theoretical knowledge and practical application.

B. Participants

The participants included 69 undergraduate students enrolled in the D&B module across various engineering disciplines. The selection aimed to reflect a diverse array of experiences and perspectives, thus enhancing the robustness of the study findings.

C. Data Collection

Data were gathered through a structured survey, comprising Likert-scale questions to assess students' perceptions of their development in skills such as teamwork, communication, and problem-solving. The survey also included open-ended questions to provide qualitative insights into students' experiences, particularly focusing on the application of theoretical knowledge in practical scenarios.

D. Data Analysis

Quantitative analysis: Descriptive statistics were used to quantify the distribution of positive, neutral, and negative responses, offering a clear measure of the module's impact on student perceptions.

Qualitative analysis: Thematic analysis was employed to identify prevalent themes in the open-ended responses, enhancing the quantitative findings and highlighting areas for future enhancement.

IV. RESULTS

This section analyses the results attained from the questionnaires handed to the students:

Quantitative Outcomes

TABLE I. summarises the outcome from the questionnaire. A total of 71 responses, two of which were discarded as they were clear outliers and did not pass the qualifying criteria. In summary, the results confirmed the following:

A. Effectiveness of the Group Project (Fig. 1):

a) Application of Engineering Concepts:

81% of students reported positively on applying design and building concepts to realistic scenarios, demonstrating the module's efficacy in simulating real-world challenges. 13% of students expressed negative experiences, and the remaining students remained neutral.

b) Teamwork and Communication Skills:

75% indicated an enhancement in communication and teamwork, crucial for effective multidisciplinary collaboration. 13% of students responding negatively, and the remaining ones were neutral. The negative response was mainly attributed to the fact that some students did not like working with weaker team members and wished to choose their partners.

c) Integration of Skills:

84% of students confirmed that the module effectively challenged them to integrate various skills like research, analysis, and presentation, while only 9% responded negatively.

d) Feedback and Improvement:

77% appreciated the feedback on projects, which facilitated tangible improvements in their design and building capabilities. 7% of students expressed negative response, and the remaining ones were neutral. The negative responses were mainly attributed to the association of weaker marks for some project members which impacted the team as a whole.

B. Benefits of the Group Project

a) Real-world relevance:

70% responded positively, indicating that tasks provided practical exposure to professional practices, despite a 19% negative response which could indicate a perception of irrelevance among some students.

b) Application of knowledge and skills:

74% felt positively about using learned concepts to solve real problems, with 12% providing negative feedback.

c) Integration of multiple skills

83% saw a positive integration of diverse skills, while 10% perceived it negatively.

d) Multiple perspectives:

75% appreciated the encouragement to consider user needs, functionality, and design principles, with 10% negative response.

C. Real-World Relevance and Job Preparation:

Remarkably, 99% of participants acknowledged the module's activities as highly effective in preparing them for future job applications, evidencing the module's alignment with professional standards and industry requirements.

Qualitative Insights

Key themes from the qualitative data included a strong appreciation for the real-world relevance, enhanced readiness for professional environments, and a robust endorsement of the continuous feedback mechanism integral to the module. Students frequently highlighted the module's role in boosting their confidence and practical skills, directly aligning with industry expectations.

Discussion

The results underscore the D&B module's effectiveness in enhancing employability skills through its innovative design and application. The overwhelmingly positive response across various competencies highlights its relevance and direct impact in preparing students for professional roles within engineering.

The predominantly positive responses underscore the D&B module's success in providing a realistic and comprehensive educational experience that effectively bridges the gap between theoretical knowledge and practical application. The positive reception of teamwork and communication skill development highlights the module's alignment with industry demands for collaborative and versatile engineers.

However, the presence of a notable percentage of negative responses, particularly concerning the real-world relevance of tasks, suggests room for refining how the project objectives are communicated and ensuring all activities are clearly linked to professional standards and ensuring clarity in how these align with industry practices.

TABLE I. QUESIONNIRE RESULTS BASED ON 69 PARTICIPANTS. THE DISPLAYED VALUES REFLECT "AGREEMENT" OR "DISAGREEMENT" WITH THE LISTED STATEMENTS; IF NEITHER, THE STUDENTS INDICATED THAT THEY ARE NEUTRAL

	Questionnaire results		
	Aspect	***Agree***	***Dis-agree***
On the ffectiveness of the Group Project	The group project allowed me to apply design and building concepts to a realistic scenario.	56 (81%)	9 (13%)
	Working collaboratively helped me develop communication and teamwork skills necessary for the design and building field.	52 (75%)	9 (13%)
	The project challenged me to integrate various design and building skills like research, analysis, and presentation	58 (84%)	6 (9%)
	The feedback provided on The group project helped me improve my design and building abilities.	53 (77%)	5 (7%)
On the benefits of the Group Project	Real-world relevance: Tasks provide professional practices or future studies.	48 (70%)	13 (19%)
	Application of knowledge and skills: Focuses on using learned concepts to solve problems.	51 (74%)	8 (12%)
	Integration of multiple skills: Combines various design and building skills like research, analysis, communication, and collaboration.	57 (83%)	7 (10%)
	Multiple perspectives: Encourages consideration of user needs, functionality, and design principles.	52 (75%)	7 (10%)
On the Relevance for Future Job Prospects	Effectiveness of learning activities used in this course for future job applications	68* (99%)	1 (1%)

* Extremely effective (21/69), Very Effective (26/69), Somewhat Effective (21/69).

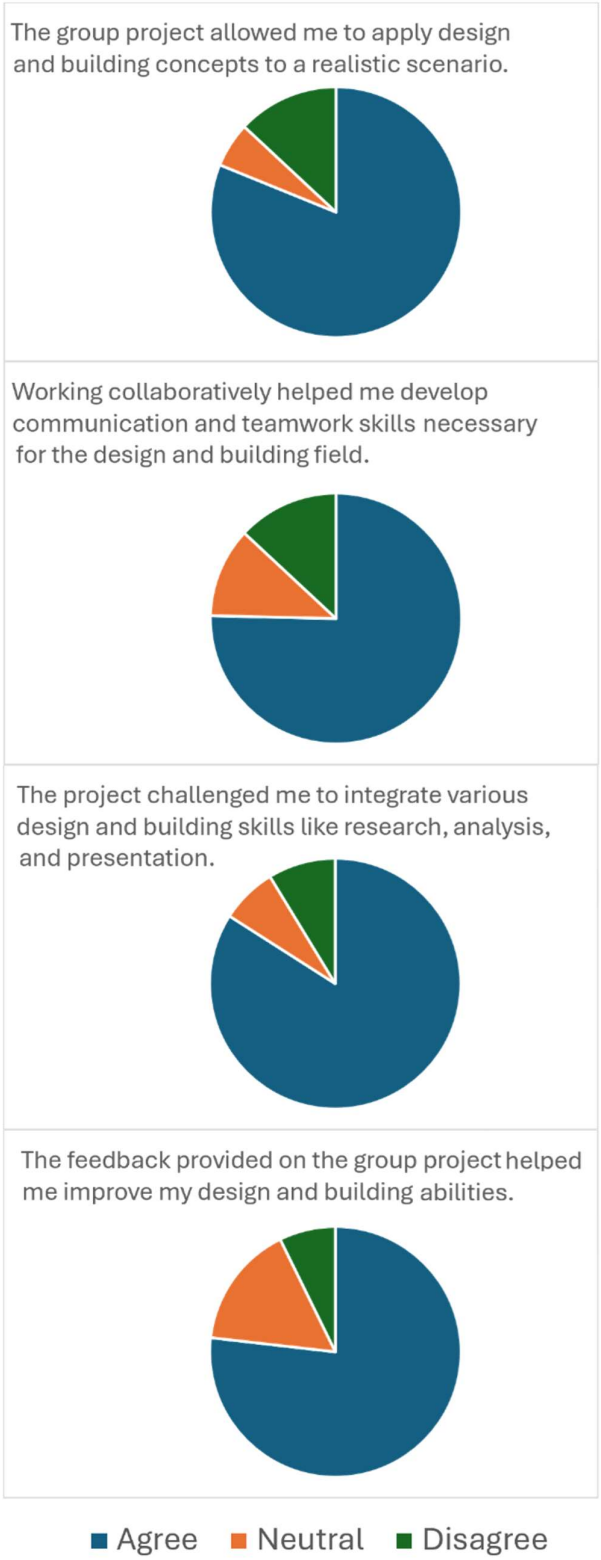

Fig. 1. Survey responses, baseed on questions related to the percived ffectiveness of the Group Project

V. CONCLUSIONS

This study has systematically examined the D&B module integrated into undergraduate engineering programmes, demonstrating its substantial impact on bridging the theoretical and practical aspects of engineering education. The module's design, combining hands-on training with interdisciplinary collaboration, aligns closely with the evolving needs of the modern engineering industry. The observed benefits were mainly attributed to the utilisation of the cross-programme grouping method.

In line with the annual review of graduate employment observation, a survey was conducted to substantiate the observed patterns, and the key findings were as follows:

- On the Enhanced Practical Skills: The module effectively enhances students' practical engineering skills, as evidenced by the significant majority of students who reported improved abilities in applying engineering concepts to real-world scenarios.
- On Fostering Teamwork and Communication: The interdisciplinary nature of the module has proven vital in developing students' teamwork and communication skills, crucial for success in diverse and dynamic professional environments.
- On Innovative Problem-Solving: Encouraging innovation and initiative, the module has equipped students with the competencies necessary to tackle complex engineering problems creatively and effectively.
- On Alignment with Industry Standards: Feedback and outcomes from the module show a strong alignment with industry expectations, particularly in preparing students for the practical demands of engineering roles.

The D&B module not only meets the educational objectives it sets out to achieve but also contributes significantly to the discourse on the need for educational reform in engineering. By implementing a curriculum that parallels professional practice, the module prepares students not just to enter the workforce but to excel in their respective fields.

Moving forward, it would be beneficial to expand the module's application to include more engineering disciplines and perhaps integrate additional technologies and methodologies that reflect the latest industry trends. Further research could also explore long-term impacts on employability and career progression for graduates who benefited from the module.

In conclusion, the D&B module serves as a robust model for educational institutions aiming to enhance their engineering curricula. Its success lays a foundation for continued innovation in engineering education, ensuring that future engineers are well-prepared to meet the evolving demands of the global market.

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