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D-LAD - A FRAMEWORK FOR PROJECT-BASED DESIGN ASSESSMENT: EDUCATORS' INSIGHTS

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ABSTRACT
Through exploration of the literature on design project assessment themes, five dimensions were defined and presented as 'lenses' to help explore the challenges and variance in design project assessment. These were: Assessing Output v Process; Summative v Formative; Teacher-led v Student-led; Assessment of Learning v Assessment for/as Learning; and Individual v Team Assessment. These dimensions provide key considerations for design educators when re-designing existing or developing new modules and courses. Using the Lotus Blossom method, educators participated in sharing their insights on the dimensions, which then formed the basis of a workshop at the Design 2024 Conference in Dubrovnik, Croatia. Findings showed the variance in educational outcomes desired by industry project partners versus those emphasised in academia: industry project partners often value demonstrable technical proficiency and client-focused deliverables over process nuances (i.e. project knowledge); whilst most educators place higher importance on the iterative nature of design processes as a learning tool for students (i.e. process skills). Based on insights from the workshop, a framework was then developed as a means to review and potentially adjust assessment by adopting an emphasis on design knowledge, skills and products. It can also be used as an iterative feedback mechanism to balance industry expectations and educational goals to support more effective preparation pathways for students transitioning into professional practice and guide effective instructional assessment design.

Keywords: Project-based design assessment, educators, dimensions, framework

1 INTRODUCTION
Although project-based learning (PBL) is now central to design education, there are a broad range of assessment practices across institutions, creating varied student experiences and outcomes and prompting the need for a more coherent understanding of assessment practice. To address this, we propose the Design Learning Assessment Dimensions (D-LAD) Framework which includes specific dimensions that can characterise how students' project work is evaluated, helping educators align assessment strategies for learning stages and outcomes.
Our investigation initially considered a perceived divide in design education, spanning art-focused to engineering-oriented programmes. We hypothesised that arts-based modules might highlight final outputs, while engineering modules would focus more on the design process. In practice, these approaches form a spectrum. Through literature review and discussions with seven experienced design educators, we identified seven aspects of assessment, which were then consolidated into five key dimensions: design output vs. design process, summative vs. formative assessment, teacher-led vs. student-led assessment, assessment of learning vs. assessment for/as learning, and individual vs. team assessment. These dimensions can: underscore vital considerations for educators when creating or refining PBL modules; provide a common language to meet industry expectations and accreditation standards; help communicate to students how their work is assessed; and align assessment techniques with learning outcomes.

Building on teaching experience and literature reviews, we introduced these dimensions at the Design 2024 Conference, using the Lotus Blossom method to map real-world assessment challenges. To better understand the complexity and diversity of assessment in project-based design education, the workshop explored the dimensions through a systematic process, identifying key assessment challenges and mapping them to the five dimensions based on teaching experiences. All notes and discussions for each dimension were then analysed and refined to create the Design Learning Assessment Dimensions (D-LAD) Framework presented in this paper. This framework highlights the five dimensions' significance for project-based modules, and includes insights collected from the workshop of design-education experts, offering practical context for how the framework can be used. By adopting this framework, educators can employ varied assessment methods aligned with multiple learning styles, thereby fostering more coherent student journeys. Ultimately, it will offer a structured way to continuously improve assessment practices in project-based design education, to better prepare learners for professional environments and institutional benchmarks.

2 THE DIMENSIONS OF PROJECT-BASED DESIGN EDUCATION

This section defines each of the 5 dimensions of our D-LAD Framework by presenting shortened versions of the literature reviews that were conducted in advance of the Design 2024 workshop. Each section provides definitions of assessment aspects identified as opposite poles to describe each dimension, and a few words on their known strengths and weaknesses.

2.1 Assessing Output v Process

Assessing design output focuses on the final product or result from a design project, while assessing design process focuses on the steps and activities undertaken to arrive at the design output. Each have different assessment criteria. Assessing the design output offers several advantages. Educators can evaluate students based on their ability to meet project objectives, creativity in design solutions, technical skills, and overall execution. This assessment can be faster and easier to conduct, prepares students for the client expectations they will face in their careers, and celebrates students' achievements and success. However, it may discourage experimentation and risk-taking. Assessing design output in isolation might overlook nuances in: individual contributions to the collaborative process; the project context that allows assessors to recognise the output's novelty and creativity. On the other hand, assessing the design process allows educators to evaluate students' understanding and application of design principles, theories, and methodologies. It encourages reflection, adaptability, continuous learning, and the development of professional skills. However, developing robust assessment methods for different projects is difficult due to project variability. Assessing and providing feedback during the design process is time-consuming. Additionally, some aspects of the design process may not always be easily documented. Studies show that common practice in design project assessment uses a blend of design-output and design-process criteria. Davis et al. [1] state that assessments must allow students to demonstrate these three types of capabilities: design knowledge, design process skills, and design products. Steiner et al. [2] identified variety in assessment practice including elements such as: communication skills, team participation, design process, and project results.

2.2 Summative v Formative Assessment

Formative and summative assessments play complementary roles in engineering design education. Formative assessment involves ongoing evaluation that provides feedback to students and educators, guiding improvements in learning and instructional methods. These assessments enable continuous monitoring of student progress and allow for real-time adjustments to teaching strategies [3]. Effective formative assessments facilitate self-regulated learning by offering students insight into their performance and guiding them toward improvement strategies. They occur concurrently with the learning process, can be formal or informal, and may or may not contribute to final grades. Summative assessments evaluate student performance at the end of a learning period and measure achievement against predefined benchmarks. These typically include final exams, reports, and project deliverables. In engineering design education, summative assessments often focus on evaluating the final products rather than the iterative processes involved in their development. However, because design education emphasises iteration, exclusive reliance on summative assessments of design artifacts can be problematic, as they fail to capture the effective application of the design process. Balancing formative and summative assessments are particularly important in project-based learning environments such as

engineering capstone courses. Capstone design projects require a holistic assessment approach that examines both the design process and the final product. Instructors face challenges in maintaining consistency and objectivity in project assessments due to variations in project scope and team composition. Therefore, assessment plans should be robust enough to ensure fairness across different teams and institutions while effectively guiding students in their learning journeys [4]. To address these challenges, engineering educators can employ a combination of formative and summative assessments to optimise student learning and accurately measure competencies. While formative assessments provide opportunities for continuous improvement, summative assessments ensure accountability and evaluate educational effectiveness. Striking a balance between these approaches is essential for meaningful learning outcomes and for preparing students for real-world engineering challenges.

2.3 Teacher-led v Student-led Assessment

The increasing student numbers in cohorts over the years has caused concern for HE teaching staff in terms of assessment. Teacher-led assessment aligns with traditional models of instruction, where teachers are seen as experts and learners as passive recipients of information. Teacher-set assessment criteria often look for specific content to award marks, such as closed briefs and specific deliverables. It has a strong focus on learning outcomes and pedagogy. Teacher-led assessment gives clarity, guidance, consistency, and fairness. It can encourage metacognitive processing skills and reinforce student self-reflection. However, it can be time-consuming, put pressure on students, and be affected by teacher bias [5,6]. As a result, student-led assessment has been considered to alleviate some of these challenges. Student-led assessment aligns with the social constructivist view of learning, with aspects such as open criteria and students defining requirements for outcomes or deliverables. Challenges of student-led assessment include a lack of assessment literacy among students, lack of motivation and challenge, possible peer bias, and reliance on subjective judgement [5,6]. Engineering educational research has shown that involving students in the creation of assessment gives them ownership and responsibility, fostering creativity and innovation. It supports problem-solving, encourages critical thinking, and promotes collaboration through diverse perspectives. It also encourages students to self-evaluate and provides immediate and useful feedback [7]. Both approaches have their merits. A careful blend can provide a balanced approach, leveraging their strengths. A blended or hybrid approach can create a rich, effective, and holistic learning environment, offer a more personalised experience for students, and encourage continuous improvement.

2.4 Assessment of Learning v Assessment for/as Learning

‘Assessment of Learning’ (AoL) is linked to conventional summative testing, which has a well-established history within educational practices and academic disciplines, particularly within engineering design. Historically, its significance has been attributed to the acknowledgment of competencies and the imperative of certifying those competencies for professional industry standards. Nevertheless, apprehensions regarding the predominant emphasis on measurement have prompted the emergence of alternative paradigms that emphasise the necessity of refocusing on the learner's role within the learning process. These paradigms, known as ‘Assessment for Learning’ (AfL) and ‘Assessment as Learning’ (AaL), advocate for a more sustainable, transformative, and formative approach [8]. In AfL, instructional content is employed as proxies to modify learning approaches and deliver valuable and timely feedback, whereas AaL situates students in the role of self-assessors, enabling them to reflect on their learning processes and to utilise a variety of strategies to ascertain their knowledge and capabilities [9]. AfL/AaL strategy advocates for students to develop a meaningful understanding of the assessment being involved in self and peer assessment process in design. Thus, this category is also related to the student-led assessment category in section 2.3. Numerous challenges remain in engineering design. Primarily, the theoretical foundation to substantiate these emerging paradigms does not exist yet. Furthermore, approaches oriented towards performance, which culminate in showcasing the final product, continue to receive greater consideration than strategies centred on student mastery, essential for the learning process. Owing to time constraints, design classes frequently do not allow timely feedback to students, potentially resulting in frustration and demotivation. Variability in student projects presents challenges for instructors in formulating equitable assessment criteria applicable to all projects and in delivering consistent levels of feedback within teams. Conflicting objectives between academia and industry expectations have led to diversified assessment methods to comprehensively evaluate design engagement. However, this has increased the intricacy and

assessment workloads without necessarily increasing the assessments' meaningful insight [10]. Further research is needed to position and align these paradigms with the nature of design (subjective, ill-structured, open-ended). Furthermore, a robust and explicit connection between design practices in industry, education, and these paradigms needs to be articulated to move these practices forward.

2.5 Individual v Team Assessment

Collaborative projects and peer learning are aligned with a social constructivist view on learning [11] and, therefore, are increasingly valued in project-based learning. When a learning experience includes collaborative elements (e.g., team-based projects), it is not always clear whether it should be assessed at an individual or team level. Individual assessment in collaborative projects is primarily valued for acknowledging individual learning and development [12,13]. It recognises individual contributions to the collaborative effort, supporting the dynamics of individual accountability [13]. However, identifying individual contributions in collaborations can be difficult or counterproductive. Individual assessment can create intra-team competition and peer pressure [12], hindering the collaborative process and the development of collaborative competences in students. Conversely, team-based assessment rewards the group as a whole for the collaborative process, whether in terms of process or outcome [12]. Such recognition is more likely to support intra-team collaboration. However, assessing collaboration and group dynamics is challenging [13], especially when teachers' expertise is related to project content rather than collaboration. Moreover, team-based assessment can be perceived by students as unfair as it does not consider individual contributions [12,13]. Thus, both approaches present significant advantages and challenges, suggesting the need for hybrid models that can reward and support effective team dynamics and individual accountability.

3 THE FRAMEWORK

The dimensions summarised in Table 1 provide the basis for the proposed Design Learning Assessment Dimensions (D-LAD) Framework presented in Figure 1.

Table 1. Summary of the 5 Dimensions

D-1	**Assessing Output**	**Assessing Process**
	Focuses on the final product or result from a design project.	Focuses on the steps and activities undertaken to arrive at the design output
D-2	**Summative Assessment**	**Formative Assessment**
	Evaluates student performance at the end of a learning period**,** measuring achievement against predefined benchmarks.	Ongoing evaluation that provides feedback to students and educators, guiding improvements in learning and instructional methods.
D-3	**Teacher-led Assessment**	**Student-led Assessment**
	Teachers set the briefs and specific deliverables and then look for specific content to award marks.	Students are involved in the creation of assessment; criteria are open, and students define requirements for outcomes or deliverables
D-4	**Assessment of learning**	**Assessment for/as learning:**
	Conventional summative testing focused on certifying competencies using measurement.	Students develop a meaningful understanding of the assessment, receiving feedback and being involved in a self-reflecting and peer assessment process.
D-5	**Individual Assessment**	**Team Assessment**
	Recognises individual contributions to a collaborative effort in a team-based design project.	Rewards the group as a whole as the result of a collaborative design process, whether in terms of process or outcome.

The example in figure 1 shows in yellow the mapping of a design assessment where: there is one summative final group design report, (output), with some evidence of their decision-making process from concept to detail design (process), for assessment of their learning by the teacher. In pink is shown a new version of the assessment where: there are three team-based formative stage gates (2 of which are peer-marked) and one summative design report for assessment by the teacher, in which each individual student presents the design solution for their own subsystem (output), with evidence of their decision making process from concept to detail design (process).

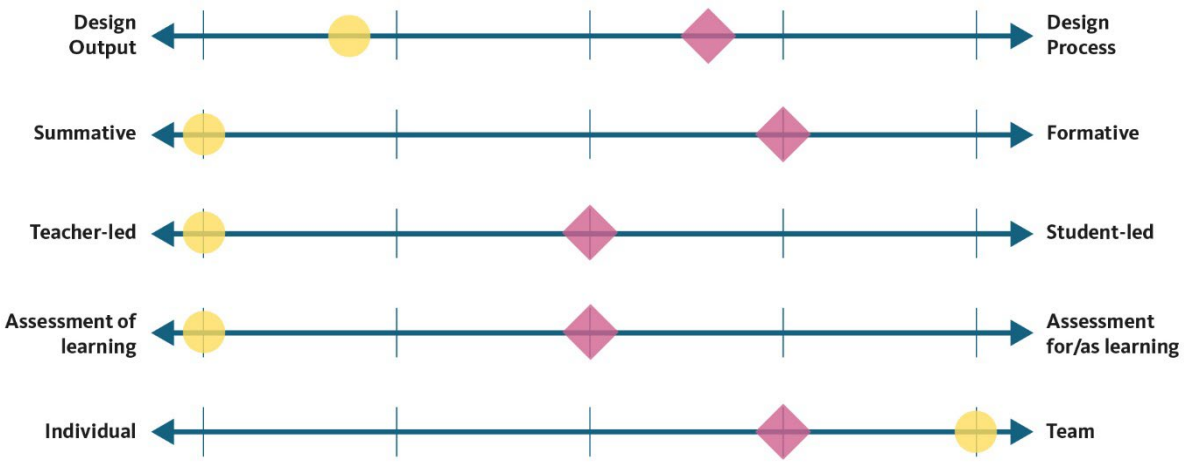

Figure 1. D-LAD Framework - an example of assessment mapping using the dimensions

4 DISCUSSIONS

The workshops revealed key themes on the nature of assessment providing context to the dimensions and their potential use as framework. When assessing output vs. process, students struggle with both the openness of a design task and the process uncertainty, even if controlled through formal iterations, stage gates, and formative assessment. For educators, if looking at the final output, it is not possible to also robustly assess the process. To assess the process, materials/outputs need to be captured along the way and presented to offer context. However, through the assessment criteria, educators can direct the balance between learning about managing the design process and what makes a 'good' design output. The choice between summative vs. formative assessment raises issues over the fairness in group assessments. Issues such as reluctance to critique peers, difficulty distinguishing effort from contributions, unequal student distribution, biases, and gendered roles complicate evaluations. Summative feedback methods may not fully capture team interactions resulting in incomplete data for assessment. Structured summative assessments incorporating peer and instructor evaluations can improve fairness. Integrating formative assessments, such as journaling and informal catchups, can help identify issues early. Training students in assessment methods and balancing individual and team metrics will enhance accuracy, ensuring equitable participation and effective collaboration. Teacher-led vs. student-led raises a concern in the appropriateness of the assessment. When assessment is set by a teacher, students focus on lost marks. This information is crucial to improve their subsequent work and learning practice. Teacher-led assessment rubrics are often used to support this despite a lack of clarity in what is being assessed. An example of this shared at the workshops is 'I hit all the areas you requested, why is my grade not 100%'. On the contrary, teachers reported some benefits in student-led assessment, however, from their perspective, student-led assessment was hampered by the number of additional variables, such as student numbers, different types of students, differing prior education, varying expertise, etc. This made it more challenging and time-consuming for teachers to use student-led assessment and often it was avoided. The discourse surrounding AoL, AfL, and AaL generates novel inquiries. Although assessment is generally perceived through the lens of measurement, there was a lack of understanding of AaL among participants. This concept is novel to most educators in this context and does not necessarily align with current practices. Despite this, AaL brings together assessment and learning within a single task which resonates with design education by promoting students as active and reflective learners. When thoroughly articulated, these three paradigms could serve as foundational pillars delineating design assessments, and accommodating its complexities, but also a means to inspire innovation and to shift perceptions toward a more sustainable, inclusive, and progressive approach to assessment. In the individual vs. team assessment debate the following question arises: 'Should collaborative competences be a part of PBL assessment? Assessing collaboration and balancing individual tasks with group tasks allows the inclusion of diverse learning styles in the learner. Peer assessment is key for collaborative activities and structured peer assessment helps guarantee process fairness. Some existing digital peer-assessment tools reduce the risk of unfair assessment by increasing awareness of activities. Nonetheless, teamwork should be explicitly assessed by educators, or at least carefully included in assessment given the students' effort required in project-based learning (PBL).

Assessment must support meaningful collaboration, balancing individual and collective learning while acknowledging teamwork complexities.

5 CONCLUSIONS

The D-LAD Framework presented in this study provides a structured analysis of assessment methods in project-based design education by identifying key dimensions that shape evaluation practices. This framework offers a wide-ranging approach to balancing diverse assessment perspectives, integrating both output-focused evaluation and process-oriented learning to support a broader measurement of student achievement. The framework will help educators select aspects and timing of assessment strategies within individual courses and across academic programmes, assisting educators in refining assessment methodologies to align with accreditation standards, industry expectations, and intended learning outcomes. It can also help enhance fairness in evaluating both individual student contributions and collaborative aspects through multiple methods for a fuller picture of achievement. Future research may explore the inclusion of additional dimensions to further enhance the framework's comprehensiveness and adaptability. Empirical validation of the framework through the analysis of existing design assessments, and case studies of assessment changes made using the framework, will provide deeper insights into its effectiveness. Disseminating the D-LAD framework and developing structured implementation guidelines, such as an educator's manual, would support broader adoption within academic institutions. These efforts could contribute to the ongoing evolution of assessment practices in design education, fostering a more consistent, inclusive, transparent, and pedagogically robust approach to evaluating student learning and professional preparedness in design.

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