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# WIP: Adaptive Comparative Judgement as a Tool for Assessing First-Year Engineering Design Projects

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# WIP: Adaptive Comparative Judgement as a Potential Tool for Assessing First-Year Engineering Design Projects

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## Abstract

Design projects are an important part of many first-year engineering programs. The desire to employ holistic assessment strategies to student work with open-ended and divergent responses has been widely noted in the literature. Holistic strategies can provide insight into the role of qualities (e.g., professional constructs) that are not typically conducive to standard assessment rubrics. Adaptive Comparative Judgement (ACJ) is an assessment approach that is used to assess design projects holistically. The assessment of projects using ACJ can be carried out by experts or students to scaffold their learning experience. This Work-in-Progress paper explores the use and benefits of ACJ for assessing design projects specifically focusing on first-year engineering students and educators. Further, conference attendees will be provided the opportunity throughout the conference to engage with the ACJ software to experience how this system can work in practice for assessing student design projects.

*Index Terms: Adaptive Comparative Judgement, Engineering Design, Assessment*

## Introduction

First-year engineering students are typically required to engage in team and problem-based activities through introductory coursework to support the development of design capabilities [1], [11]. This type of activity is typically assessed using rubrics, portfolios, and criterion-grading tools [2]–[6]. However, there are issues in assessing open-ended and divergent tasks in this manner including; reliability, teacher bias, excessive time investment, and timeliness of feedback [1]–[5]. Adaptive Comparative Judgement (ACJ) is a holistic assessment tool that can address such issues [1], [2], [5]–[7]. This paper will explore the capacity of ACJ to be used as an assessment and learning tool for first-year engineering students.

## ACJ Assessment Tool

ACJ is premised on the comparison of items of work and using software, like RM Compare [7], is driven by an algorithm that intentionally and adaptively pairs two items or portfolios to refine statistics and accelerate achieving a reliable rank order of group performance [1], [2], [4], [5], [8]. The pairs of portfolios generated by the algorithm are presented to several judges who compare the work based on specific criteria or on their own perception of professional constructs such as innovation, creativity, quality of design, etc. [1]–[10]. Validity has been demonstrated in both approaches to making judgements [9]. In past studies, judges have been students, professionals, and instructors/professors [1], [3], [4], [6], [8]–[10]. The number of judgements made by each judge depends on the number of portfolios and judges. The number of portfolios is multiplied by 10 and divided by the number of judges e.g., with 300 portfolios and 300 judges, each judge is required to make 10 judgements [7].

Judges are presented with two portfolios at a time, intentionally assigned to them by the ACJ algorithm to ensure that each portfolio is judged on multiple occasions [2], [5], [7]. Judges must select the portfolio they believe meets the assigned design criteria and in a formative assessment approach provide comments and feedback on each of the designs. This feedback is collated and provided to each student [7]. By judging portfolios on multiple occasions, a consensus is reached on the positioning of the work within the cohort, and a rank-ordered list is produced that can be used to determine grades or monitor progress (see [3], [4], [6], [7], [9] for detailed descriptions of tabulation and grade computation using ACJ assessment). Where students serve as judges, they may be assigned their work to judge. However, if their judgement of their work does not align with that of the other judges this will be identified through statistical calculation. Within the ACJ system, a misfit statistic can be calculated to identify outliers among the judges and allow for that judge to be advised in relation to the judging process or for their assessments to be removed from the analysis [1]–[3], [7], [9].

The reliability and validity of ACJ have been a topic of discussion in the literature. With regards the reliability of ACJ, Pollitt [2] notes that reliability coefficients calculated for ACJ are Judge Consistency Coefficients (JCC), while the validity of ACJ refers to the validity of the rank-ordered list. Studies using ACJ for design assessment have reported JCC's of ~0.9 [1], [4]–[7], [9], [10]. ACJ validity is commonly determined by comparing ACJ scores with scores obtained through traditional rubrics or professional marking where significant positive correlations have previously been found between these assessment approaches [3], [4], [6], [9]. As ACJ relies on the judgements of multiple assessors to determine the standard of work, it also addresses issues of bias in traditional rubric assessments [2]–[4], [9].

**Opportunities with ACJ for First-Year Engineering Students and Educators**

Research has indicated the validity and reliability of ACJ as a holistic assessment tool where it is most commonly used to assess open-ended design projects [1]–[4]. ACJ offers several potential benefits for first-year engineering students' learning experience. ACJ can be used to assist assessment *for* learning by actively including students in their assessment as a member of the judging panel [5], [7]. When used for formative assessment in the past, students have noted that ACJ is beneficial for feedback, gaining inspiration and ideas, and that the holistic assessment approach allows them to be more innovative and creative in their designs [4], [7]–[10]. Developing these key design capabilities is a central aim of introductory engineering courses [1]. Engaging with ACJ for holistic assessment could support first-year engineering students in developing an appreciation and value of professional constructs such as creativity, innovation, quality, etc., while also improving their overall design project performance [4], [8]–[10]. ACJ can also enhance the work of lower-performing students by exposing them to work of superior quality [8]. ACJ's use with first-year engineering students during design projects should be closely monitored as consistently low performers could lose motivation and consistently high performers may become complacent [5].

ACJ also offers benefits for first year engineering educators. Educators could use ACJ to reduce the significant time investment required to assess and provide feedback on large volumes of design portfolios as previous research has demonstrated a significant correlation between students' assessment of peers work and educator's assessment of the same work [3], [4], [6], [9]. In addition, ACJ can be used to give timely and rich feedback to students from multiple perspectives to help them refine and evolve their designs [3], [4], [8]. This can

reduce the burden experienced by educators to provide effective formative and summative feedback to all students in a large class.

**Experiencing ACJ for Assessing Engineering Student Designs**

In the current study, the authors are examining the role of spatial cognition in design creativity among undergraduate engineering students where ACJ will be included as an assessment mechanism. Students were administered several tests of spatial cognition and completed two brief paper-and-pencil design tasks (i.e., these were not design-build tasks). The first task was to design a ping pong ball launcher, capable of striking a target from a certain height a given distance away. In the second task, participants were invited to generate as many design solutions as possible for collecting rainwater in a remote location. Throughout the FYEE conference, attendees will be able to participate in ACJ panels examining (i.e., judging) student work on these two tasks. Participation in actual ACJ panels will enable judges to gain a "feel" for what this assessment technique entails and how it could be used to enhance first-year engineering students learning experiences. At the end of the FYEE conference, results from the panels will be available for those who are interested.

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