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# Einstein Aggregators on Picture Fuzzy Sets for Evaluating Competencies in Blueprint Reading

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## ABSTRACT

This work highlights an evaluation of blueprint reading competencies among university students, with particular attention to common and core competencies. Recognizing the ambiguity and imprecision arising from such an evaluation, Einstein aggregation operators on picture fuzzy sets were adopted to model the judgments of participants derived from a pool of mechanical technology students. Results reveal the students' competency level for each pre-identified task in blueprint reading. Although they display above-average performances, areas requiring enhancement in both competency types are identified. Pathways from these findings involve various strategies: conducting a separate in-depth study for a deeper understanding of the subject matter, incorporating particular emphasis on blueprint reading tasks, introducing competency-based exercises within relevant courses, and facilitating industry experts' collaboration. Comparative analysis with those of intuitionistic fuzzy sets and Dombi aggregation operators yields similar results.

## KEYWORDS

Einstein Aggregators, Picture Fuzzy Sets, Competencies, Attributes, Blueprint Reading, Mechanical Technology

## INTRODUCTION

Drawing and sketching serve as a universal language utilized by engineers, technicians, and skilled artisans, serving as a bridge to convey comprehensive details essential for the construction of parts, machines, vehicles, and various infrastructures like buildings, bridges, and roads (Elyan et al., 2018). A cornerstone in product manufacturing, blueprints and technical drawings assist as a visual language integrating lines, numbers, symbols, and illustrations vital in visually communicating how a design is constructed, with the goal of conveying all the necessary information from design planning to implementation (Aladağ & Bekdaş et al., 2018). Introduced by an English polymath and mathematician

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in 1842, John Herschel (Herschel, 1842), technical drawing in the form of blueprints allowed the rapid production of design used in construction and eradicated the difficulty of photolithographic reproduction or the hand tracing of graphics. Gunderson (2013) described blueprints as mechanical or technical drawing copies, with blueprint reading essentially associated with interpreting concepts depicted in drawings, irrespective of whether they conform to traditional blueprint formats. In the domain of industrial manufacturing and design representation, competency in interpreting technical drawings stands as pivotal for most practitioners (Raaphorst, 2020).

In most technical drawing courses, the academic success of students greatly depends on learning how to use visual language symbols, perspectives, units of measurement, and page layout, among others, to ensure the drawing is unambiguous and relatively easy to understand (Contreras et al., 2018). Learning these techniques can prepare students to design complex structures (Barros, 2022), such as robots (Ramanujam et al., 2022). As students complete their studies and then integrate into the workforce, they enable knowledge management processes and organizational capabilities for smart organizations (Al Shawabkeh et al., 2022) and help develop high-tech industries to improve regional economic performance (Yeo, 2022). Given the support these outputs provide, the skills needed by the end-users in interpreting the prints and plans must be examined to generate practical outputs (Hung & Weinman, 2019). Furthermore, although some educational institutions with related technical drawing courses have the same objective of improving the development of drawing and presentation techniques, evaluating the ability of students to comprehend these visual representations is rarely explored.

Existing studies show blueprint reading comprehension is scarcely discussed in the domain literature, especially those focusing on the application and correctness of students' interpretation of the technical drawings. Earlier studies paid attention to the instruction of creating technical drawings and how these graphics were delivered to learners. For instance, Tornbre (1992) discussed the importance of draftsmanship in interpreting and understanding technical drawing at a semantic level. Additionally, through an aptitude visualization test, Adanez and Velasco (2004) suggested change in spatial visualization toward technical drawings can be an efficient indicator in the teaching-learning process. Consequently, McLaren (2008) explored the perception of learners and teachers in traditional drawing, along with the presence of increasingly popular digital drawing, and found that some values between the various groups contribute to learning technical drawings.

In recent studies, on the other hand, domain scholars have considered different applications and additional factors to help improve how learning technical drawings is better managed. Okwelle and Owo (2018) cited a significant improvement in students' academic performance through collaborative learning of technical drawings. Furthermore, Contreras et al. (2018) discussed the importance of spatial ability and visualization training in improving interpretations of technical drawings. Additionally, Ching (2019) presented an updated guide for designers in both traditional (i.e., hand drawings) and digital drawings (e.g., hybrid floor plans, digital models, and fabrication). Finally, image projection and difficulty of understanding technical drawing materials were found to be fairly enhanced by simulation learning media. The aforementioned studies agreed that proficiency in technical drawing and mastery in interpreting technical drawings in the form of blueprints stand as pivotal skills crucial in fabricating objects in various projects. Although considered a critical agenda (El-Demerdash et al., 2021), an actual evaluation of how students comprehend technical drawings and what competencies they lack remains a gap in the current list of studies in the literature.

Thus, this work is put forward to enhance the teaching and learning processes of blueprint reading, ensuring students possess the desired skills to interpret blueprints effectively. Intending to assess readiness for national competency standards (i.e., Philippines), this study primarily focuses on assessing common and core competencies of mechanical technology students in blueprint reading and comprehension, which are fundamental in project execution. A self-structured questionnaire, aligning with standards (e.g., Philippine Technical Education and Skills Development Authority [TESDA]), facilitates gauging the present competency levels of students. Bridging the gap between