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WIP: Developing a Framework to Accommodate Implementation of Prior Learning Assessment in Engineering Design and CAD Course

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Professor Raja's research interests include the development of new materials and the application of computational methods to understand and predict the behavior of solid materials under various conditions. He has published several papers in reputable journals and presented his findings at international conferences.

Outside of his academic responsibilities, Daniel Raja is passionate about community service and often participates in initiatives that promote STEM education among young students. His dedication to both his profession and his community makes him a respected and valued member of Greenville University.

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WIP: Developing a Framework to accommodate Implementing Prior Learning Assessment (PLA) in Engineering Design and CAD Course

Abstract

This paper presents a framework for implementing Prior Learning Assessment (PLA) in engineering design and CAD courses, emphasizing the recognition and validation of skills acquired through non-academic experiences. The study underscores the importance of assessing prior knowledge to support non-traditional students, such as adult learners and those with significant work experience, in advancing their education and careers. The proposed framework integrates direct and indirect measurement methodologies to comprehensively evaluate CAD competencies. By aligning PLA with industry standards and course objectives the framework aims to enhance access to higher education, promote academic success, and foster institutional collaboration. Additionally, the research explores the potential for integrating PLA with industry-recognized certifications, thereby increasing the credibility and value of the PLA process for students and employers.

Introduction

Computer-Aided Design (CAD) plays a crucial role in the engineering education curriculum. Students could acquire CAD experience through various avenues. Internships provide hands-on experience in real-world settings, while online courses and self-study offer flexible learning opportunities. Participation in engineering clubs and competitions also allows students to acquire and apply their CAD skills in practical, team-based projects. These extracurricular activities serve as prior knowledge or prior learning through which students learn CAD.

The assessment of prior knowledge is crucial since students whose prior knowledge is assessed are more likely to pursue higher education opportunities that can advance their socio-economic status [1]. By understanding their starting point, educators can provide the necessary support and resources to help these students succeed, ultimately contributing to their long-term academic and professional growth.

This research examines the impact of CAD on student learning outcomes, industry readiness, and the overall advancement of engineering education. By exploring both formal and informal learning environments we aim to highlight the comprehensive benefits of CAD training and its role in preparing the next generation of engineers for the challenges of a rapidly evolving industry.

Prior Learning Assessment (PLA) is a process that institutions can utilize to recognize and validate an individual's skill and knowledge that was gained through non-academic experiences. The process of recognizing and validating learning applied to knowledge that has been acquired or taken place external to institutions of higher education is known as prior learning assessment (PLA) [2]. A search among the literature reveals that much research is being done to assess prior learning [1, 3–6] in the U.S., Canada, and E.U. However, very little research has been done related to the prior learning assessment of engineering graphics, with the bulk of this research utilizing the Purdue Spatial Visualization Test as a predictor of student success [7]. Prior learning has been assessed for the purpose of determining student skill before intervention [7], but not as an assessment of competency. PLA can be extremely useful in the evaluation of adult learners or returning students as many have gained experience in the field. PLA has been recognized as a valuable tool in enhancing adult student persistence towards obtaining a baccalaureate degree [8]. The use of PLA has practical applications, as seen in the review of Bloom's Taxonomy and Kolb's Theory of Experiential Learning [9]. However, the standardization of PLA portfolios has been a challenge, with research showing that a universal portfolio may not be feasible without sacrificing functionality [10].

Furthermore, the development of a PLA for a computer aided drafting (CAD) course can provide a pathway for experienced professionals or students with high school experience to earn academic credit and alleviate unnecessary constraints on student time and money. The primary participants in PLA are unconventional learners, many of them with significant work experience in CAD. However, this could also include individuals with high school experience or internet-taught experience. While these individuals may lack formal academic credentials, they possess substantial practical knowledge and skills. The recognition of these skills and knowledge increases access to higher education for unconventional students. This is even more impactful for those who may not have the time or resources to pursue traditional academics [1]. The ability to utilize PLA's also leads to increased rates of degree persistence and graduation [11].

This paper aims to outline a pathway to explore assessment strategies and frameworks of prior knowledge in engineering graphics.

Framework

Experiential learning theories, which highlight the significance of a person's experience in learning, create the foundation for PLA's. Dewey's model of learning says that learning is a dialectic process that integrates conceptual knowledge with a person's observations and experience [12]. Piaget's model of learning and cognitive development indicates that learning is constructivist in nature and requires the learner to integrate their own observations and experiences into the conceptual knowledge being gained [13]. Kolb's experiential learning theory suggests that knowledge is created through the transformative process of experience [14].

Another relevant framework to be considered is Polanyi's concept of tacit knowledge. This theory refers to the implicit knowledge gained through practice that individuals possess [5]. PLA processes attempt to take this tacit knowledge and make it explicit. This allows it to be assessed and credited. All these theories support the idea that any skills or knowledge gained through experience, whether academic or work-related, is equally valuable.

The development of a PLA for a CAD course involves several fundamental steps. *Firstly*, the most important step is to create a reliable and valid assessment tool which accurately measures the required CAD competencies. This can include practical tasks, simulations, and portfolio assessments. *Secondly*, the next crucial step is to ensure faculty members are properly trained to evaluate an individual's prior learning effectively. Training must include, not only the assessment tools, but the goals and the scoring process. *Thirdly*, clear standards for awarding credit based on established competencies are mandatory. This indicates that the assessment must be aligned with both course objectives and industry standards [15].

To evaluate a student's prior learning, an instructor must evaluate utilizing a framework that encompasses various methods for assessing their existing knowledge and skills. The framework must consider both direct and indirect measures to gain a comprehensive understanding of the student's preparedness. Table 1 shows a list of direct measurement methods and Table 2 shows a list of indirect measurement methods that can be used to assess a student's prior learning/knowledge.

Table 1: Direct Measurement Methodologies

Testing and Assessments	The use of pre-tests, quizzes, or exams specifically design to assess the student's understanding of relevant concepts or skills
Concept Maps	Visual tools that help students organize and connect concepts, revealing their existing knowledge structure.
Portfolio	A compilation of collection of a student's work, demonstrating their skills and knowledge development over time.
Presentations or Performance	Evaluate a students' ability to demonstrate their understanding through presentations, projects, or performances.
Rubrics	Use scoring rubrics to provide a structured and objective way to evaluate student work and performance.

Table 2: Indirect Measurement Methodologies

Self-Reports	A student's reflection report on their prior learning experiences and identify areas of strength and weakness.
Inventory of Prior Courses and Experiences	Gather information about the student's past academic experiences and relevant skills.
Interviews	Conduct structured interviews to assess the student's understanding of specific concepts or skills
Observations	Observe a student's behavior and interactions in class or during activities to assess their knowledge and skills

Proposed Framework

Typically, students spend the first ten weeks learning the theory of engineering graphics and the CAD software SolidWorks. In the eleventh week, they are introduced to the engineering design process. During weeks twelve and thirteen, students work in groups to develop a new product that is an evolution or an improvement of an existing product. Subsequently, students leverage the skills acquired in their first-year introduction to engineering course in computational modeling and senior design. Neither course is dependent on the use of a specific design software, and allows students the autonomy of choosing their own software. For the senior design (capstone) course, any issues pertaining to compatibility would be addressed on a case by case basis.

The proposed framework involves a combination of direct and indirect measurement methodologies. Direct measures include portfolios, presentations, and performance assessments. Indirect measures encompass self-reports, interviews, and analysis of coursework. It is important to note that this framework can only assess whether the applicant possesses the necessary CAD or engineering graphic skills.

To evaluate their engineering graphics knowledge, applicants must apply for a prior learning assessment using the prior learning assessment form of the university. The application should include a self-report detailing prior learning experiences, including areas of strength and weakness. Applicants then schedule an appointment to discuss the self-report's contents. During the appointment, applicants are interviewed on key concepts of engineering graphics. Following the interview, the instructor reviews the applicants' responses to the interview questions, the contents of the self-report, and any relevant documentation regarding previous coursework and portfolios. The final step involves a performance or presentation assessment, typically using the mid-term examination of the course. During this test, applicants are observed throughout the process and may use their preferred CAD software. If the test is conducted remotely, a video call must be set up to monitor the applicants' keyboard strokes, mouse movements, and screen activity. After completion of the evaluation, the students ability will be appraised, and a decision will be made on whether or not the skill level is adequate for course credit.

Conclusion

The integration of Prior Learning Assessment (PLA) in the Engineering Design and CAD course offers a valuable pathway for recognizing and validating the skills and knowledge acquired through non-academic experiences. By leveraging both direct and indirect measurement methodologies, the proposed framework ensures a comprehensive evaluation of students' CAD competencies. This approach not only enhances access to higher education for unconventional learners but also supports their academic and professional growth by acknowledging their practical expertise. The recognition of prior learning through PLA can significantly reduce the time and financial constraints on students, enabling them to focus on advancing their education and careers [1]. Furthermore, the alignment of PLA with industry standards and course objectives ensures that students are well-prepared to meet the demands of the modern engineering workforce .

By acknowledging the practical expertise of unconventional learners, PLA fosters a more inclusive educational environment that values diverse learning experiences. This inclusive approach not only benefits the students but also enriches the academic community by bringing in varied perspectives and skills. The alignment of PLA with industry standards and course objectives ensures that students are well-prepared to meet the demands of the modern engineering workforce. As a result, PLA contributes to the overall advancement of engineering education by bridging the gap between academic learning and practical application.

Future Work

The immediate next steps are the development of the assessment including evaluation metrics and alignment with course/program objectives to ABET student learning outcomes. Additionally, setting fees, determining interview questions, portfolio analysis metrics, and test administration processes must be determined. Looking ahead, the future scope of the project involves various potential trajectories that can span across disciplines and institutions.

From a student perspective, examination of the specific impact of PLA on non-traditional students, such as adult learners and those with significant work experience, could be completed. This could help educators better understand the students' unique challenges and needs, and help in tailoring the PLA process to better support this demographic. Studies to evaluate how well students who had their prior learning assessed perform in other design courses could provide valuable insights into the effectiveness of PLA in preparing students for advanced coursework and its overall impact on their academic success and skill development. From an institutional perspective, the development and refining of standardized assessment tools for engineering graphics can be applied across numerous different institutions. This would help in maintaining consistency and reliability in evaluating prior learning experiences.

This research also has the potential to promote collaboration between institutions to share best practices and develop a cohesive approach to PLA. This could involve creating a consortium of universities that work together to standardize and improve PLA methodologies. Lastly, from an industry perspective, this research has the potential for integrating PLA with industry-recognized certifications. This could enhance the credibility of the PLA process and provide students with additional credentials that are valued by employers.

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