Using Product Lifecycle Management (PLM) software to teach the product development process: Developing industry-ready graduates

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Introduction: The apparel industry has undergone massive transformation and technological advancements over the last decade (Conlon, 2021). These changes have brought about innovations within every aspect of the industry, but specifically within product development (Romeo & Lee, 2013). One of the technologies that is revolutionizing the way in which apparel items are designed and developed is product lifecycle management (PLM) software (Romeo & Lee, 2013 & Conlon, 2021). PLM is an integrated approach to product creation, organization, and management across a company's entire enterprise and its suppliers (Conlon, 2020) and offers brands a stable and clear channel of communication (Bedolla et al., 2013). PLM is becoming an essential tool for apparel companies to stay competitive amidst fragmented global supply chains, increased market competition, shortened product lifecycles, and fickle consumer demand (Frame et al., 2004; Mora-Orozco et al., 2016; Mullon, 2015).

Technological advancements have impacted every step of product development and altered the skills necessary to work within the apparel industry. Based on research, hiring managers within apparel design and product development are looking for graduating seniors who are familiar with and able to use PLM software. Additionally, employers are looking for new hires to have strong knowledge of apparel construction (e.g., appropriate stitch and seam types), the ability to translate a creative design into a producible product, and a firm understanding of financial implications within the product development process (Romeo & Lee, 2013).

One of the challenges within apparel and textile education is how to provide students with a sense and understanding of the complex interconnectedness of the industry's landscape (Conlon, 2021) while supplying them with relevant and necessary skills. To address these challenges, a cloud-based PLM software was integrated into a senior level design and product development course curriculum at a large mid-western university.

Strategy Objective: Currently there is not a standard best practice for PLM implementation within an educational setting (Conlon, 2021; Mora-Orozco et al., 2016). Thus, the purpose of this teaching strategy was to integrate PLM into a select senior-level design and product development course to suggest a curricular framework that will develop students' proficiencies for industry.

Implementation of teaching strategy: A cloud-based PLM software was integrated into a senior-level design and product development course focusing on the technical design process. Within this course students are taught the fundamentals of technical design (e.g., construction details, grading, and fitting) and technical package development. Student learning of the PLM system was addressed from not only acquiring functional skills but also increasing critical thinking capacity through a holistic product

development approach. PLM learning was interwoven into weekly class assignments, one industry project, and a final capstone project.

Functional Skills: To teach students the necessary functional skills needed to work within the PLM system, weekly assignments were created with coordinating training videos and classroom instruction. The assignments covered the functional aspects of the PLM software and prepared the students to complete the necessary tasks for the industry project and capstone project. These 'low-stakes' (formative assessment) assignments allowed students to practice using the software while applying content knowledge from the course (Flynn & Haberman, 2018).

Industry Project: A partnership with a small apparel start-up firm was created to facilitate the industry project. Students were put into teams of 3. Within this project the industry partner functioned as the student team's merchandiser providing design direction. After the initial design direction, the student teams were directed to design three different styles based on the design direction given by the 'merchandiser.' For each of the styles designed within the student teams' category, the student teams created condensed technical packages for each style. The technical specifications include style or product summary, construction specifications, bill of materials (BOM), and coordinating component files for each of the raw materials. At the completion of the project each team presented their styles and coordinating technical packages to the industry partner.

Capstone Project: The final PLM project was implemented in conjunction with the students' senior design line. The students took a single design from their collection and created a technical package. The technical package included the style summary page, construction specifications, BOM and coordinated component files, graded sizing, points of measure (POM), and product costing. The project culminated with each student presenting their design and technical package created using the PLM software.

Effectiveness of Strategy: The majority of the students prior to this course had never put together a complete technical package nor had they experience with any PLM software. By the end of the course all students had put together 4 technical packages within the PLM software program. Overall, the students showed growth in understanding the product development process, communicating product specifications, and considering the different aspects of effectively developing a producible product. A few students shared that they "liked learning a new software that can help [them] be more marketable to future employers." Other students mentioned that they were excited to learn the software and that excitement "helped drive [them] to understand the software." A quarter of the of students attained enough proficiency to receive a level of certification from the PLM software company, with one student being hired immediately after graduation in part due to their knowledge of PLM. Additionally, the small apparel company owner that partnered with the course to facilitate the industry project was extremely pleased with the student teams' styles and quality of technical packages.

However, there was a steep learning curve for most of the students, and they struggled with fully understanding how to create complete construction specifications that clearly communicated the assembly steps for the product and understanding the coordination and management of materials and trims within the PLM system. Despite the struggles, the implementation of the cloud-based PLM software through functional skills and project-based learning, provided students with a holistic view of product development while also providing them with the necessary skills to be highly employable.

Future PLM Integration: The apparel industry is changing at a rapid pace. As educators we must adapt our teaching methods and tools to provide students with the knowledge and skills vital for the industry. Teaching design and product development students PLM software through functional skill and project-based approaches will not only prepare them for the workforce; it will make them more effective designers and product developers. Future curriculum changes may look at integrating functional PLM skills alongside lecture material to better connect theory and practice and give a more grounded view of the product development process. Additionally, educators should consider integrating PLM software across several courses (in a scaffolded structure) or creating cross collaboration project opportunities across design, product development and merchandising courses to provide students with a more realistic industry experience.

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