"Fiberlytics": Textile Costing Modeling Website—An Interactive Educational Tool for Material and Process Simulation

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ABSTRACT

This research presents "FiberLytics", a web-based textile costing modeling tool that changes the way textiles are taught by turning static cost exercises into dynamic, real-time simulations. The solution incorporates Google Spreadsheets to facilitate material and process simulations in the fiber, yarn, and fabric categories. The technology enhances digital literacy, encourages hands-on learning, and equips individuals for careers through interactive decision-making. It also has the potential to be commercialized by schools and the textile industry, since it offers a scalable, cloud-based solution for training, process improvement, and long-term innovation. The interactive platform lets you study from anywhere, work on projects with other people, and customize it for use in the textile sector. Its versatility makes it a game-changing tool for improving processes and teaching textiles.

Keywords— Textile Costing, Modelling, Simulations, Textile Technology, Innovation

INTRODUCTION

The textile and clothing business is growing quickly because people want things to be more efficient, customizable, and environmentally friendly. In this evolving landscape, it is essential to comprehend pricing, necessitating both expertise and practical experience to accurately evaluate material properties, manufacturing processes, and economic feasibility. Conventional pedagogical approaches, such as monotonous lectures and extensive spreadsheet analyses, often fail to fully engage students or demonstrate the complexities of real-world scenarios. FiberLytics is a new web-based platform that aims to change how textiles are taught and how people are trained for jobs in the industry. Students and professionals in the field can utilize the tool, which incorporates Google Spreadsheets, to input specifications for fiber, yarn, and fabric and observe their real-time costs. Based on the principles of Industry 4.0 and Education 5.0, the application promotes interactive learning through the incorporation of visual feedback, dynamic tables, and accessibility from any location. The approach pushes students to look at, change, and understand cost problems using a real-world, cloud-based interface. The approach makes students more interested in class and gives them important digital skills they'll need for future employment. Automated feedback systems, better evaluation methods, and more flexibility for hybrid or remote learning environments all help faculty personnel.

Many textile firms have trouble figuring out how to compete in the global market (Blaga et al., 2017). Numerous strategies have been attempted, yet each presents its own challenges. Revitalization of the textile company necessitates innovative concepts and improved methodologies (Mahmood, 2020). Digital technology must be a part of textile education since the textile industry needs more data-driven insights and real-time analytics (Gubiotti et al., 1973). Sometimes, students don't have access to interactive tools that mimic real-life situations. Such an absence makes textile costing classes less relevant to real life, makes students less interested, and leads to skill mismatches in the job market (Cheramie, 2018). The "FiberLytics" platform attempts to fill this gap by giving students an interactive platform where they can do material and process simulations and observe how different factors affect the total cost of manufacturing. "FiberLytics" "aims to bridge this gap by providing an interactive environment where students can participate in material and processing simulations and observe the impacts of various factors on total production costs. This paper discusses the origin of the tool, its distinctive features, and the research opportunities it presents (Angelova et

al., 2025). "FiberLytics" is a big step forward in making complex analytics and computations more accessible to a wider audience and encourages innovation in industry and academics.

Conceptual Design

Costing is an important part of making textiles since it affects everything from choosing raw materials to setting the price of the finished product. Static resources, such as printed charts and basic Excel assignments, are often used in traditional teaching approaches. Often, these methods lack human participation and fail to effectively illustrate the complexities of real-life situations (Gönlügür, 2019). It's important to remember that these traditional methods often don't do enough to help textile engineers and designers today improve their digital skills, critical thinking, and problem-solving skills. Additionally, students often struggle to comprehend the relationship between input costs and production costs. This lack of connection makes it difficult for the students to grasp concepts, limits the analysis capability, and results in a low student participation rate in lectures. "FiberLytics" addresses these educational shortcomings by bringing together process modeling, real-time data visualization, and cloud-based access into one digital platform. By incorporating a simulation-based approach, this platform has significantly enhanced textile teaching and learning. Students can modify variables such as the types of fiber, the number of yarns, and the fabric structures to immediately observe how these changes affect prices. This hands-on approach helps students understand more, improves their digital literacy, and fits with teaching techniques that focus on active and student-centered learning.

The global industry requires its employees to operate in a comprehensive data and technology environment. Thus, it is significantly important that the textile industry education framework be upgraded with modern approaches that are able to assist student learning as well as enhance real-world work experiences. Textile education faces significant challenges due to the rapid evolution of business demands, computer technology, and the global labor market (Hui, 2011). Educators are encouraged to revise their lesson plans to adapt to these developments, employing contemporary technology and methodologies to deliver experiential, real-world learning that aligns with the future skill requirements of the fashion industry (Mesjar et al., 2023). With the globalization of the textile industry, textile schools must emphasize instructing students in product innovation and cost management to maximize textile product cost, operations, and profitability (Ievtushenko & Hodge, 2012; Xue, 2022). "FiberLytics" meets this need by adding simulation, analytics, and visualization to the educational framework, which improves people's ability to understand data and make decisions. Further improvements include the incorporation of artificial intelligence and machine learning that opens up new possibilities for the future. There may be predictive modeling on the platform to help with cost optimization, demand forecasting, and sustainability evaluation (Yaiprasert & Hidayanto, 2023). AI-based guiding systems might then assist students in developing a methodology for maximizing profitability by analyzing input variables.

Moreover, "FiberLytics" is user-friendly and offers a scalable alternative to conventional textile laboratory environments, particularly for educational institutions in underdeveloped regions. The digital tool promotes equity and inclusiveness in education by allowing students to access it anytime and anywhere, requiring only a web browser and an internet connection (Zou et al., 2025). The "FiberLytics" is open to students from all kinds of socioeconomic backgrounds. The students would use the platform to learn and enhance their knowledge in textile costing, which would help the community to progress and potentially offer long-term work opportunities. Additionally, small and medium industries will be able to use the platform to model how much different materials and production methods will cost without having to acquire expensive Enterprise Resource Planning (ERP) systems. With a highly cost-effective costing platform, companies can educate more employees on costing methods, thereby enhancing organizational efficiency. The project will yield sophisticated pricing strategies and sustainability initiatives, essential for global enterprises aiming to optimize resource utilization and reduce their carbon footprint (Yuzgenc & Aydemir, 2023). The "FiberLytics" platform has the potential to enhance textile education, promote sustainable production, and stimulate economic growth in the industry by uniting academia and the private sector.

TECHNICAL FUNCTIONALITY

This study demonstrates the functionality of the "FiberLytics" platform by navigating its interactive web-based

modules hosted at sites.google.com/uitm.edu.my/txlmodeler/home. The main page introduces the tool and provides access to three specialized costing modules: Carded, Combed, and Woven Fabrics. Each module includes another three additional sub-modules: one for entering data, a second for generating results, and a third for conducting visual analysis. These sub-modules assist with real-time simulations and provide costing information that supports hands-on learning and digital teaching methods. Figure 1 outlines the "FiberLytics" web interface for the main page and submodules.

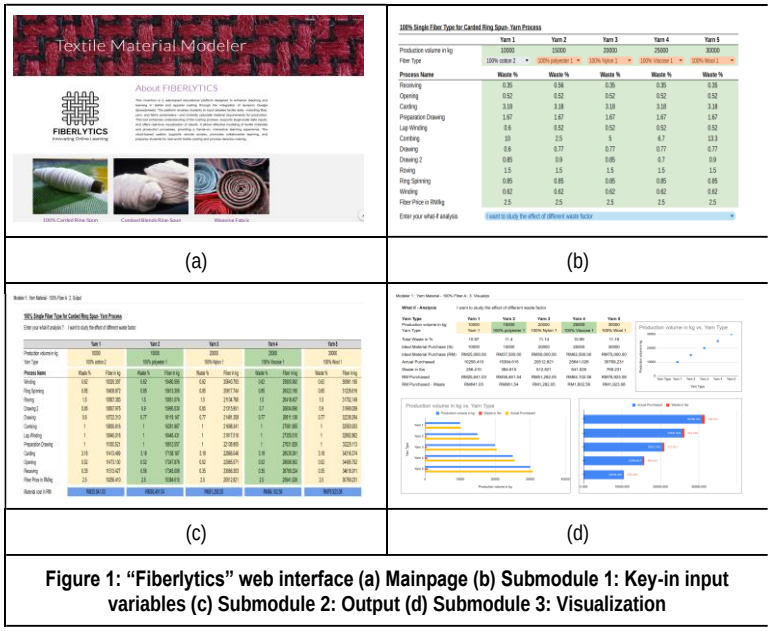

Figure 1: "Fiberlytics" web interface (a) Mainpage (b) Submodule 1: Key-in input variables (c) Submodule 2: Output (d) Submodule 3: Visualization

Module 1: 100% Carded Ring-Spun

Users can enter information about five different types of yarn in the Carded Ring-Spun module. Users may change the amount of production, the type of yarn, and run "what if" scenarios. Next, users may also modify the waste factors for each subprocess to see how they affect the use of materials. This module helps users learn more about how different yarn specifications affect costs and improve student abilities in controlling ring-spun yarn costs through digital modeling and scenario-based experimentation.

In the Output submodule, users will review and analyze the full costing results that depend upon the input parameters. The submodule provides information on the amount of trash and materials needed for all carded yarn sub-processes. These findings show how the many parts of the manufacturing process work together, which helps students understand what the previous input numbers mean. This structured study helps students learn not only about how costing works but also about how to develop more cost-effective textile products. In the visualization module, automated trendline graphs show how actual, ideal, and production waste compare for each subprocess. Students examine variations in trash and material usage to identify inefficiencies. This visual simulation helps students learn by making it easier to understand data patterns and cost changes, as well as critical thinking.

Module 2: 100% Combed Ring-Spun

The Combed Ring-Spun module replicates the structure of the carded module and includes three submodules: Input, Output, and Visualization. Users can enter data for five yarn types and define relevant waste factors in the input section. The output module calculates production requirements and waste metrics, while the visualization module presents results through charts and trendlines. This comprehensive structure encourages simulation-based learning and practical understanding of combed yarn costing dynamics.

Module 3: Woven Fabric

The Woven Fabric module is divided into three submodules. In the first, users input fabric parameters and define weaving waste levels. The second submodule presents output datasets, detailing the material

requirements for five distinct woven fabrics. The third submodule visualizes warp and weft calculations, material usage, and associated costs through dynamic tables and charts. This integrated modeling framework helps students develop analytical and cost estimation skills for woven fabric production.

Educational Outcomes

Using "FiberLytics" in a university classroom had beneficial effects in several areas. When compared to standard spreadsheet activities, the quantitative findings revealed a big improvement in the accuracy and speed of cost calculations. Figure 1(d) shows how “FiberLytics” visual tools assist students in comprehending how waste, such as the percentage of waste, affects the ultimate cost of carded ring-spun yarns. The simulations indicate that even slight variations in the amount of waste influence the total cost of making the yarn. These calculations in real time let students play around with different input factors and see how they affect the total cost. Qualitative feedback from students highlighted the platform's ease of use and its ability to illustrate intricate cost relationships within textile production. The survey feedback is statistically significant, and the platform significantly improved student engagement, as outlined in the following Table 1.

Table 1: “FiberLytics” Survey Feedback

Category	Response
1. Ease of Use	Most students gave the site a good rating (4.1 out of 5), saying it was easy to use and fast. People have said things like "very easy and quick to use" and "easy to know and access data," which show how straightforward it is to use. Some students said they would be able to utilize the tool better if they got more support.
2. Engagement and Interaction	People liked the interactivity and real-time feedback, which got an average score of 4.1. Students reported that trendline graphs and other visual aids improved their understanding, although a few believed these tools were too difficult for beginners.
3. Learning Impact	The platform made learning much better, with an average score of 4.4. Students liked how it made challenging math easier and helped them grasp how to figure out the cost of textiles better through hands-on simulation.
4. Overall Opinion	Students generally thought that "FiberLytics” was a smart, new, and useful tool for both school and work. They called it a "game-changer," "insightful," and "a brilliant innovation," and they also talked about how useful it may be in the future and how important it is for digital textile education.

In summary, students responded positively to the "FiberLytics" platform, which improved their comprehension, engagement, and overall educational experience.

CONCLUSIONS

In conclusion, the "FiberLytics" platform is a new, interesting, and simple way to educate textile engineering students. When students use Google Sheets to model production costs in real time, they learn about the economics of production, the many different factors that can affect the manufacturing process, and how the material behaves. The platform's cloud-based design makes it easier for students to study from home or in a hybrid setting, and it also makes it easier for students to work together and participate. It encourages students to continue learning throughout their lives and enables low-income areas to access high-quality digital education at a reasonable cost. "FiberLytics” helps the textile sector find research-based solutions, make operations more efficient, and assist workers in learning new skills. The platform suggests that connecting theory with practice has a big impact because it can change and grow the community. “FiberLytics” will drive innovation and the digital revolution in textile production and education by combining AI with a focus on sustainability.

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