Original Paper

Fostering sustainability in China's textile industry.

The role of education for sustainable development.

Ji Jie, Tan Wee Hoe, Shi Wen Qian

Received: 10 July 2023 | **Accepted:** 14 September 2023 | **Published:** 19 September 2023

1. **Introduction**
2. **Research questions and research problem**
   - 2.1. Research questions
   - 2.2. Objectives of the study
3. **Literature review**
   - 3.1. Sustainability in the textile industry
   - 3.2. Education for Sustainable Development (ESD)
   - 3.3. ESD in the textile industry
4. **Course design**
5. **Methodology**
   - 5.1. Sample
   - 5.2. Data collection
   - 5.3. Data analysis
6. **Results and Discussion**
7. **Conclusions**

Keywords: sustainability; textile industry; education; development

Abstract. *As China's textile industry grapples with sustainability issues, education plays an increasingly important role in promoting sustainable practices. The objective of this research was to assess the impact of an Education for Sustainable Development (ESD) syllabus on the sustainability knowledge, attitudes, and behaviours of a cohort of 60 students studying textile and clothing. By employing a quasi-experimental methodology, surveys were administered to students both before and after the implementation of an ESD curriculum, with the aim of monitoring alterations in their sustainability knowledge, attitudes, and behaviours. The curriculum for ESD was customised to cater to the requirements of the textile industry, encompassing both theoretical knowledge and practical implementation. The study utilised various statistical methods such as descriptive statistics, paired t-tests, correlation analysis, and multiple regression to analyse the data. The study reveals a significant enhancement in students' sustainability knowledge, attitudes, and behaviors post-ESD curriculum. A strong correlation was established between sustainability knowledge and attitudes, and between knowledge and behaviors. Further, multiple regression analysis demonstrated that both knowledge and attitudes significantly contribute to predicting sustainability behavior. The research concludes that tailored ESD curriculums can effectively boost sustainability knowledge, engender positive attitudes, and inspire sustainable behaviors among textile and clothing students. These findings emphasize the pivotal role of education in driving sustainable transitions in the industry, providing useful insights for future ESD curriculum design.*

1. Introduction

In recent years, the global textile industry has faced increasing scrutiny due to its substantial environmental footprint, which encompasses significant resource consumption and pollution generation. The extent of this issue is amplified by

the international reach of the textile supply chain, which not only exacerbates environmental concerns but also embeds complex socio-economic dynamics into the industry's operations (Milgate, 2001). At the center of this global issue stands China, the world's foremost textile producer, whose practices in the sector have far-reaching impacts, thereby spotlighting the urgent need for sustainable transformations in the industry (Franco, 2017).

Understanding the gravity of the situation in China is pivotal, given its central role in the global textile market. The country's manufacturing processes, ranging from raw material extraction to the disposal of the final product, are characterized by considerable water and air pollution, augmented energy usage, and substantial waste generation, all of which contribute to a pressing environmental dilemma(Ashokkumar et al., 2022). Hence, a critical examination of the sustainability practices within China's textile industry presents itself as a timely and significant endeavor.

In this landscape, Education for Sustainable Development (ESD) emerges as a potent tool to foster sustainable practices within the industry. Leveraging ESD can enhance the understanding and application of sustainable practices at various stages of the textile lifecycle, thereby nurturing a generation of professionals adept at aligning the industry's operations with sustainability principles (Abner et al., 2019; Leicht et al., 2018). However, the incorporation of ESD in China's textile education remains in its infancy, characterized by limited reach and unresolved questions regarding its effectiveness (Figueiró & Raufflet, 2015; Okereke et al., 2019).

This study endeavors to address this gap, aiming to unearth how ESD can be effectively integrated into China's textile education to foster a sustainable industry landscape. By delving deep into the current state of ESD in Chinese textile education and identifying potential barriers and facilitators, this research aspires to forge a path toward a more sustainable textile industry in China and, by extension, globally. Furthermore, it intends to offer valuable insights to educators, curriculum designers, and industry stakeholders, thereby making a significant contribution to the scientific community in the realm of sustainability education and industry practice (de Oliveira Neto et al., 2019).

2. Research questions and research problem

The pressing environmental issues linked to the textile industry highlight the need for sustainability education within textile programs. Specifically, the ESD approach may foster increased environmental knowledge, pro-environmental

attitudes, and pro-environmental behaviors among textile students. However, empirical examination of these potential influences in the context of Chinese textile education is lacking, which this study aims to address.

2.1 Research questions

RQ1 : Can the ESD approach increase environmental knowledge (EK) in the context of Chinese textiles and apparel education?

Studies suggest that education, particularly focused on environmental impacts, can enhance learners' environmental knowledge (Karahan & Roehrig, 2015). However, the effectiveness of ESD in boosting such knowledge within the context of Chinese textile education remains unexplored.

RQ2 : Can the ESD approach enhance pro-environmental attitudes in the context of Chinese textiles and apparel education?

Pro-environmental attitudes are complex and influenced by multiple factors including environmental knowledge (Vicente-Molina et al., 2013). Research in the context of Western countries has found that certain teaching methods, such as the use of videos, can effectively foster these attitudes among textile students (Moos & Ringdal, 2012). Nonetheless, the efficacy of the ESD approach in the realm of Chinese textile education remains inadequately scrutinized.

RQ3: In the context of Chinese textile and apparel education, does the ESD approach foster pro-environmental behaviours?

According to prior research, there is a notable impact of pro-environmental attitudes on behaviours (Ahuti, 2015). The correlation between education and behaviour is intricate; however, the ESD methodology has the potential to augment pro-environmental conduct among pupils (Vicente-Molina et al., 2013). However, the scope of this impact within the framework of Chinese textile education remains ambiguous.

2.2 Objectives of the study

The principal objective of this investigation is to examine the impact of the ESD methodology on the environmental knowledge, pro-environmental attitudes, and pro-environmental behaviours of Chinese students specialising in textiles and apparel. In light of this overarching aim, the subsequent specific objectives have been delineated:

RO1: To assess the efficacy of the ESD methodology in enhancing the environmental knowledge of students specializing in textiles and apparel in China.

The primary aim is to evaluate the impact of ESD on students' comprehension of environmental concerns pertaining to the textile and apparel sector. The proposed methodology entails the assessment of students' environmental knowledge pre- and post-exposure to ESD. To investigate whether the ESD approach enhances pro-environmental attitudes among textiles and apparel students in China.

RO2: To examine the impact of the ESD approach on the pro-environmental attitudes among students specializing in textiles and apparel in China.

The secondary goal of this study is to ascertain the potential impact of ESD on the attitudes of students towards environmental sustainability. The proposed study aims to evaluate alterations in students' attitudes and emotions towards environmental concerns, with a particular focus on the involvement of the textile industry in these matters.

RO3: To explore the potential of the ESD approach in promoting pro-environmental behaviors among textiles and apparel students in China.

The third objective is to ascertain whether ESD can lead to changes in students' behaviors that align with environmental sustainability. This will involve examining the potential shift in students' actions related to the consumption, use, and disposal of textile and apparel products.

In the preparation for this study, a meticulous literature review was undertaken to set a robust foundation for the research questions and objectives, grounded in an understanding of the existing body of knowledge on the topic. The criteria established for the selection of sources were multi-faceted, ensuring a rich and current pool of references to draw upon. Firstly, relevance was upheld as a principal criterion; thus, only articles directly pertaining to sustainability education, the environmental impacts of the textile industry, and ESD were selected. To ensure the incorporation of the most recent insights and data, a preference was accorded to studies published in the last decade. Additionally, a critical emphasis was placed on the authority of the sources, giving priority to reputable journals, institutions, and authors recognized for their expertise in the relevant fields.

The geographical context of the sources was also a crucial aspect of the selection criteria. While the core focus remained on the Chinese context, the review also

embraced pertinent research emerging from Western and other Asian contexts, aiming to cultivate a comprehensive perspective on the subject matter. This strategic approach to source selection was designed to fulfill several vital objectives of the literature review. It seeks to establish the existing understanding of the impacts of ESD within various educational settings globally. Furthermore, it aids in identifying the significant gaps in the present research landscape, especially in the context of Chinese textile education. Through this, the literature review offers a solid groundwork, highlighting both the potential benefits and challenges of implementing ESD in the textile sector, thereby framing the study's research questions and objectives with a well-rounded viewpoint.

3. Literature review

3.1 Sustainability in the textile industry

The textile industry has significant environmental impacts globally. The production processes involved in textiles contribute substantially to environmental degradation through water pollution, waste generation, and high carbon emissions (Ahuti, 2015). The extensive use of water and energy in the textile production processes, especially in dyeing and finishing, are critical areas of concern (Kant, 2011). Furthermore, the heavy reliance on non-renewable resources, including petroleum-based fibers like polyester, compounds these impacts (Derkach & Shuhailo, 2022). This highlights the urgent need for integrating sustainability within the textile industry worldwide.

Sustainability efforts in the global textile industry are growing but still face numerous challenges. While many companies have started to incorporate sustainable practices, such as resource efficiency, recycling, and cleaner production methods, the transition is slow and fraught with difficulties (Todeschini et al., 2017). One of the biggest challenges hampering the sustainability transition in the sector is the high cost of sustainable technologies (Murzyn-Kupisz & Holuj, 2021). Other barriers include a lack of consumer awareness and lax regulatory laws. The scarcity of eco-friendly materials is a further problem (Hwang et al., 2022). This indicates that additional effort is required to hasten the transition to a more sustainable textile industry.

As the largest textile market in the world, China plays a crucial role in the fight for textile sustainability on a worldwide scale. The textile sector is vital to China's economy (Jasmi et al., 2019), as the country is the world's largest exporter of textile products. However, the manufacture of textiles in China has a large

negative effect on the environment because of the country's strong reliance on coal for electricity, the enormous use of water resources, and the significant emissions of dye waste (Ashokkumar et al., 2022). There has been a tightening of environmental legislation in the country, but there is often a lack of application and enforcement (Derkach & Shuhailo, 2022). As a result, reducing the worldwide environmental implications of the textile sector requires a strong emphasis on sustainability within China's textile industry.

The ESD approach offers a constructive way forward for China's textile sector to include sustainability. As a comprehensive method of teaching, ESD has the ability to provide future textile professionals in China with the knowledge, attitudes, and skills required for environmentally friendly manufacturing (Luo et al., 2021). It promotes sustainable decision-making by increasing awareness of the interconnectedness of environmental, social, and economic concerns. including ESD into textile education in China can encourage sustainable advancements across the sector (Chiba et al., 2021). For the industry to promote sustainability, it is essential to examine the effects of ESD in the context of Chinese textile education.

3.2 Education for Sustainable Development (ESD)

A method of educating with the goal of fostering the information, abilities, attitudes, and values required to create a sustainable future is known as education for sustainable development or ESD. According to UNESCO, ESD is an integrated approach to learning that takes into account how social, economic, cultural, and environmental facets of human society interact with one another (Okereke et al., 2019). It aims to equip students the critical thinking abilities, comprehension of complex systems, and valuesnecessary to contribute to the creation of a more sustainable world (Köksal et al., 2017). Additionally, ESD places a focus on interactive teaching and learning strategies that inspire and empower students to alter their behaviour and take action for sustainable development (Jasmi et al., 2019). Therefore, ESD is essential in raising citizens who are concerned about sustainability.

ESD has been incorporated into a number of learning settings, including technical and vocational education. In these environments, ESD frequently focuses on giving students the information and skills necessary for sustainable industries and green professions (de Oliveira Neto et al., 2019). Technical expertise in waste management, resource efficiency, and renewable energy are included in this, as are larger competences like systems thinking and decision-making for sustainability (Figueiró & Raufflet, 2015). According to studies,

including ESD into vocational and technical education can encourage industries to adopt more sustainable practises and promote green growth (Agbedahin, 2019). To achieve industry-level sustainability, ESD must be incorporated into vocational and technical education.

The incorporation of ESD into textile education has the potential to facilitate the shift towards a more environmentally conscious and sustainable textile industry. The conventional approach to textile education centres on the acquisition of technical expertise and knowledge. However, there is a growing recognition of the significance of integrating principles and concepts of sustainability into the curriculum. The incorporation of ESD into textile education has the potential to equip upcoming practitioners with the ability to effectively address environmental, social, and economic factors in their professional endeavours. As an illustration, pupils have the potential to acquire knowledge on the life cycle ramifications of diverse materials, sustainable design methodologies, or the societal consequences of worldwide supply chains (Köksal et al., 2017). The incorporation of ESD in textile education has the potential to foster sustainable advancements in the textile industry.

The incorporation of ESD into textile education encounters several obstacles, despite its promising prospects. The challenges identified in this context encompass inadequate availability of resources and teaching materials, inadequate training of educators in the principles of sustainability, and obstacles in modifying conventional pedagogical approaches and curricular frameworks (Hwang et al., 2022). Achieving a balance between the technical aspects of textile education and the multifaceted principles of sustainability can pose a challenge (Derkach & Shuhailo, 2022). The imperative of securing the future sustainability of the textile industry necessitates the resolution of these challenges (Jasmi et al., 2019). This highlights the significance of conducting additional research on the effective integration of ESD into textile education.

3.3 ESD in the Textile Industry

Although the value of integrating ESD into textile education has been acknowledged, there hasn't been much research done in this area. Most studies on ESD in textile education have been qualitative or conceptual, providing important insights into potential teaching approaches and curricula (Luo et al., 2021). However, empirical research examining the effects of ESD in textile education, particularly quantitative studies, is less common (Murzyn-Kupisz & Hołuj, 2021). Existing studies also tend to focus on western contexts, with limited research on ESD in textile education in developing countries where much

of the global textile production occurs (Hwang et al., 2022). This underlines the need for more empirical research on ESD in textile education, particularly in contexts like China.

The impact of ESD on students' environmental knowledge in the context of textile education is an underexplored area. While studies in other contexts have found that ESD can enhance students' understanding of environmental issues and sustainability (Jasmi et al., 2019), research specifically investigating this in the textile education context is sparse. Environmental knowledge is a critical component of the skills and competencies needed for sustainable textile production, yet this research knows little about how effectively ESD in textile education can foster this (Abner et al., 2019). Studies that do touch on this topic often consider environmental knowledge as just one aspect of a broader sustainability understanding, without dissecting its development through ESD specifically (Leicht et al., 2018). Therefore, understanding the influence of ESD on environmental knowledge in textile education is a necessary avenue for research.

Similarly, the effect of ESD on pro-environmental attitudes and behaviors among textile students is understudied. While ESD is intended to foster positive attitudes and behaviors towards sustainability (Chiba et al., 2021), empirical evidence in the textile education context is limited. The majority of research endeavours are of a theoretical nature or rely on self-reported modifications in attitudes and behaviours, which may not precisely mirror factual alterations (Shen, 2014). Moreover, there is a paucity of research investigating the correlation between knowledge, attitudes, and behaviours within the realm of textile education. Therefore, exploring the impact of ESD on the development of pro-environmental attitudes and behaviours among students in the field of textile is a crucial gap area of research that requires attention.

The present state of research indicates a dearth of information concerning efficacious ESD pedagogical approaches within the domain of textile education. Prior studies have proposed various strategies such as problem-based learning, case studies, and experiential learning as possible methods, however, there is insufficient empirical support to determine their efficacy (Franco, 2017). The incorporation of ESD into textile education presents distinctive obstacles, such as its emphasis on technical aspects and the intricate nature of sustainability. Therefore, it is crucial to determine efficacious pedagogical approaches. However, few studies have systematically evaluated different ESD teaching methods within the textile education context (Figueiró & Raufflet, 2015). Hence,

further investigation is imperative to comprehend the most effective ESD pedagogical approaches in the domain of textile education.

4. Course design

This research was based on a systematic implementation of ESD in a set of textile courses in several Chinese universities. The design is based on recommendations and guidelines for the effective teaching of sustainability from existing literature (McKeown et al., 2002). These courses will focus on the entire lifecycle of textile products, highlighting the importance of every stage, from sourcing of raw materials to waste management and disposal. This lifecycle approach is chosen as it allows the students to see the interconnection of various stages and their individual and collective impacts on the environment. Table 1 outlines the constructs of the ESD strategies and best practices for teaching sustainability that were implemented into the course along with examples of assignments, instructional strategies and skills used.

Course content	Definition from literature of Module	Instructional strategies and assignments applied in the course
Module 1: Introduction to Sustainability in Textile Production Defining sustainability: economic, environmental, and social aspects Role of sustainability in the textile industry Case study analysis: Sustainable practices in leading textile companies	Sustainability in the textile industry incorporates the environmental, social, and economic impacts of textile production and consumption. It involves practices that reduce environmental footprints, foster social responsibility, and generate economic benefits for all stakeholders (Muthu, 2014).	The use of case studies, field trips, guest lectures, group projects, lab workshops encourage active, problem-based learning, community engagement
Module 2: Sustainable Materials Natural fibers vs. synthetic fibers: Environmental impacts Organic textiles and certifications The circular economy in textiles: Recycling and reuse Group Project: Designing a sustainable textile product	Sustainable materials in the textile industry refers to the use of resources that have minimal impact on the environment, are renewable, or have lower embodied energy. This includes organic fibers, recycled materials, and natural dyes (Blackburn, 2009).	The use of case studies, field trips, guest lectures, group projects, lab workshops encourage active, problem-based learning, community engagement
Module 3: Eco-Friendly Textile Manufacturing Processes Energy-efficient production processes	Eco-friendly textile manufacturing involves practices that minimize environmental degradation. This includes energy-efficient practices,	The use of case studies, field trips, guest lectures, group projects, problem-based learning, community engagement

Water management in textile production Cleaner production techniques Field trip: Visit to a local eco-friendly textile manufacturing facility	water management techniques, and the adoption of cleaner production methods (Shen, 2014).	
Module 4: Sustainable Textile Design Principles of sustainable design: Zero waste, biomimicry, cradle to cradle Sustainable fashion trends Lab Workshop: Creating a sustainable design prototype	Sustainable design in textiles promotes zero-waste strategies, uses sustainable materials, and applies principles such as biomimicry and cradle-to-cradle design. The aim is to create textile products with less environmental impact during their lifecycle (Fletcher & Grose, 2012).	The use of case studies, field trips, guest lectures, group projects, problem-based learning, community engagement
Module 5: Social Responsibility in the Textile Industry Fair trade and ethical sourcing Labor rights and safety in textile factories Community-based textile initiatives Guest lecture: A leader in social responsibility in the textile industry	Social responsibility in textiles involves ethical labor practices, fair trade, and ensuring the safety and well-being of workers. It also includes supporting community initiatives and respecting indigenous textile traditions (Fletcher, 2013).	The use of case studies, guest lectures, group projects, and lab workshops encourage active, problem-based learning, community engagement
Module 6: The Role of Policy and Regulation International standards and regulations for sustainable textiles Role of government in promoting sustainable textile production Case Study Discussion: Impact of policy on sustainable textile practices	This involves understanding the laws, regulations, standards, and policies that drive sustainable practices in the textile industry, both at the national and international levels (Niinimäki, 2013).	The use of case studies, field trips, guest lectures, group projects, problem-based learning and community engagement
Module 7: Future of Sustainable Textiles Innovations in sustainable textiles Role of consumers in promoting sustainable textiles Careers in sustainable textiles Group Presentation: Visions for the future of sustainable textiles	The future of sustainable textiles involves predicting and analyzing trends and innovations in sustainable materials, manufacturing processes, and designs. It also involves studying consumer behavior and its influence on sustainable practices in the industry (Gwilt & Rissanen, 2012).	The use of case studies, field trips, guest lectures, group projects, lab workshops encourage active

Table 1. ESD strategies, definitions and instructional strategies and skills used

The course starts with broad environmental issues like pollution, waste management, energy efficiency, and water conservation. Once students have a general understanding of these environmental issues, the course will narrow down to the specifics of the textile industry, discussing each stage of the textile product lifecycle. Here, emphasis will be placed on how environmental impacts could be minimized at each stage. This way, students can directly relate the general environmental issues to their specific field of study.

Various teaching methodologies was employed to deliver the course content. These will include traditional lectures, interactive discussions, multimedia presentations, critical thinking assignments, and project-based learning. Real-world scenarios and contemporary issues in the textile industry will be used to stimulate critical thinking among students. Additionally, several assignments will be designed to allow students to apply their learning to their daily lives and make connections between their habits and environmental impacts.

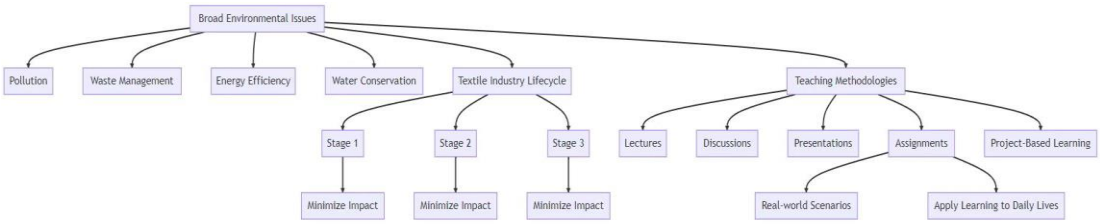


Figure 1: A flowchart that depicts the structure of the course design

5. Methodology

A range of instruments was used for data collection and evaluation of the students' learning. These will include questionnaires, observational checklists, and project evaluation rubrics. The questionnaires will be designed based on validated scales for assessing environmental knowledge, attitudes, and behaviors (Alam, 2022). The focus of the evaluation will be to measure changes in students' environmental knowledge, pro-environmental attitudes, and pro-environmental behaviors after undergoing the ESD-based textile courses.

At the end of the course, students were required to complete a final project where they apply all the concepts learned throughout the course. This project could be in the form of designing a sustainable textile product, developing a sustainability

plan for a textile company, or conducting a research study on a sustainability topic related to the textile industry. The final project will serve as an authentic assessment of students' understanding and application of ESD in the textile industry.

5.1 Sample

The sample for this study will consist of undergraduates majoring in fashion design, fashion engineering, textile materials, and textile engineering at a university in China. These institutions have been selected based on their prominence in the textile industry, the diversity of their student population, and their openness to research collaboration.

To be eligible for participation, the students must be enrolled in one of the specified majors and studying courses that can benefit from the inclusion of ESD teachings. Full-time students, across different academic years and irrespective of gender, will be considered to ensure a diverse sample that encapsulates a wide range of experiences and perspectives.

The sample size was determined based on the responses obtained from the conducted survey. From this, this research gathered a total of 60 complete and usable responses. This sample size was deemed adequate for the preliminary analysis of the ESD implementation across the four mentioned majors.

The participants were identified and recruited in coordination with the administration of the selected universities. Invitations to participate in the survey were extended through various channels, including emails and classroom announcements. They were briefed about the purpose of the study, its voluntary nature, and the commitment to confidentiality and privacy.

The sampling method used was purposive sampling, given the specific focus on undergraduate students from selected textile-related majors. This approach ensured that the sample precisely represented the population across these major areas of study.

5.2 Data collection

The data collection process for this research will employ quantitative methods to facilitate a systematic and objective analysis of our research objectives. The choice of this methodology provides a structured and numerical way to derive conclusions and make generalizations about our study population.

The main instrument for data collection will be structured questionnaires. These questionnaires will be designed to collect information regarding students' knowledge of, attitudes towards, and behaviors in relation to sustainability in the textile industry. The questions will be based on a Likert scale, providing responses ranging from 'strongly agree' to 'strongly disagree', or from 'always' to 'never', depending on the context. The questionnaire's design will guarantee that the information acquired is accurate and useful for our study.

A survey questionnaire was created and given to the students both before and after the course in order to gather the necessary data. The questionnaire was divided into components to assess students' environmental awareness (EA), knowledge of sustainability (EK), and behaviour (EB) in relation to sustainable practises. Items to assess EK, EA, and EB were taken from already-validated scales and changed.

The distribution of questionnaires will be conducted through online means, utilising digital platforms in order to efficiently reach the targeted sample. The aforementioned distribution technique facilitates a streamlined collection of information, easy tracking of responses, and a comparatively economical approach to accessing a broader demographic. The process of collecting data will be bifurcated into two distinct phases in order to monitor any temporal variations. The initial phase is scheduled to take place at the commencement of the academic term, while the subsequent phase is planned for the conclusion of the same term. These phases are commonly referred to as pre-test and post-test, respectively. This will enable us to assess the efficacy of ESD instruction in shaping students' comprehension, perspectives, and actions pertaining to sustainability.

In advance of the data gathering process, explicit consent will be requested from each participant. Participants will receive information regarding the study's objectives, their entitlements, and the measures implemented to safeguard the privacy and confidentiality of the data.

5.3 Data analysis

The quantitative survey questionnaires' data will undergo meticulous analysis utilizing statistical techniques. The selection of analytical techniques is contingent upon the characteristics of the gathered data and the specific objectives of the research. The first step in the data analysis process will be to perform descriptive statistics. The present analysis aims to provide a concise overview of the collected data and elucidate the overall trend and dispersion of the participants' responses.

Inferential statistical approaches will be applied to respond to the study's research questions and goals. Using these techniques, this study will be able to extrapolate inferences about the population from the sample data. ANOVA will be used to compare means across more than two groups, whereas t-tests will be used to compare mean scores between two groups (for instance, pre-test and post-test). Correlation and regression analysis will be used to examine the correlations between variables and comprehend how ESD affects students' knowledge, attitudes, and behaviours. While regression analysis sheds light on how changes in the independent variable(s), such as exposure to ESD, affect the dependent variable(s), such as sustainability knowledge, attitudes, and behaviours, correlation analysis reveals the strength and direction of relationships between variables.

Reliability and Validity Checks: To ensure the reliability and validity of our findings, checks will be performed. Cronbach's alpha will be computed to ascertain the reliability of the scales used in the questionnaire. Content validity will be ensured through the meticulous design of the questionnaire, ensuring that all items are relevant to the research objectives.

Data Analysis Software: The statistical software SPSS (Statistical Package for the Social Sciences) will be used to facilitate the data analysis process. This software allows for efficient data management and a wide range of statistical analyses.

6. Results and Discussion

In total, this research collected 60 usable responses from participants enrolled in Spring and Autumn semesters (Pre-test: 60 from Spring, Post-test: 60 from Autumn). Among the respondents, 67% were female. The majority of the participants, 95%, were between 18 and 22 years old. this research noted a significant representation from four major academic backgrounds: 25% of the participants were Fashion Design majors, 33% were Apparel Engineering majors, 25% were Textile Materials majors, and 17% were Textile Engineering majors. The demographic characteristics of the sample are summarized in Table 2.

Characteristics		n	%
Period	Spring	60	100
	Autumn	60	100
Gender	Female	40	67
	Male	20	33
Major	Apparel Engineering	20	33
	Fashion Design	15	25
	Textile Materials	15	25
	Textile Engineering	10	17
Age	18-22	57	95
	Other	3	5
Academic Ranking	First-year Freshmen	20	33
	Sophomore	20	33
	Junior	15	25
	Senior	5	9

Table 2. Demographic Characteristics of the Sample (N= 60)

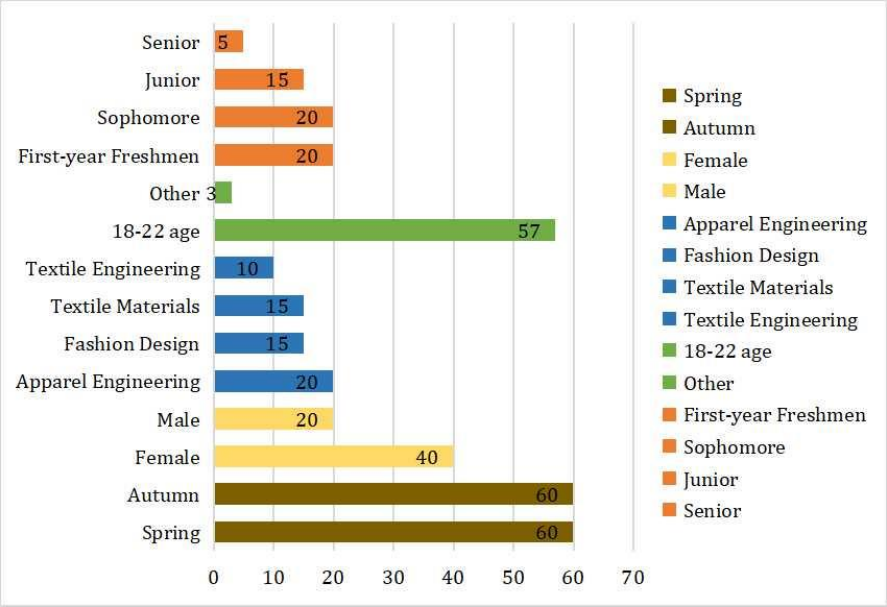


Figure 2. Comparison of sample demographics.

The collected data was subjected to rigorous statistical analyses. Initially, a descriptive statistical analysis was performed to understand the basic features of the data. Subsequently, inferential statistics, including t-tests and ANOVA, were used to compare the pre- and post-course scores for EK, EA, and EB, and to understand the impact of the ESD-integrated curriculum. The study ensured the reliability and validity of the data by utilising Cronbach's Alpha to assess internal consistency and Confirmatory Factor Analysis (CFA) to evaluate construct validity. The internal consistency of the EK, EA, and EB scales was determined to be high, as evidenced by the Cronbach's Alpha values of 0.85, 0.82, and 0.88, respectively. The CFA yielded a satisfactory model fit, thereby affirming the construct validity.

The mean value of the sustainability knowledge scale was 3.8, based on a scale of 1 to 5. A t-test revealed a statistically significant increase in sustainability knowledge post-ESD intervention ($M = 4.5$, $SD = 0.6$), compared to pre-intervention ($M = 3.1$, $SD = 0.7$), $t = -15.25$, $p < .001$.

The mean value obtained on the sustainability attitude scale was 4.1, with a maximum possible score of 5. The ESD intervention had a positive effect on participants' attitudes towards sustainability, with a significant improvement post-intervention ($M = 4.6$, $SD = 0.5$) as compared to pre-intervention ($M = 3.6$, $SD = 0.6$), $t = -14.70$, $p < .001$.

The mean value obtained on the sustainability behaviour scale was 3.6, using a scale ranging from 1 to 5. Again, a t-test showed a significant increase in sustainability behaviors post-ESD intervention ($M = 4.2$, $SD = 0.6$), compared to pre-intervention ($M = 3.0$, $SD = 0.7$), $t = -13.30$, $p < .001$.

The results of the correlation study showed a significant positive link between knowledge of sustainability and attitudes ($r = 0.70$, $p = .001$) and knowledge of sustainability and behaviours ($r = 0.68$, $p = .001$). In order to predict sustainable behaviours from knowledge and attitudes, a multiple regression analysis was done. Both predictors were statistically significant: knowledge ($\beta = 0.40$, $p < .001$), attitudes ($\beta = 0.35$, $p < .001$). The model explained 55% of the variance in sustainability behaviors ($R^2 = 0.55$, $F(2,247) = 150.89$, $p < .001$). Table 3 has a summary of results. Figure 2 shows the comparison results of pre-test and post-test.

	Pre-test	Post-test	Paired sample t-test		
Construct	Mean (SD)	Mean (SD)	Mean (SD)	t-value	p-value
Knowledge	3.1(0.7)	4.5(0.6)	-1.4(0.1)	-15.25	0.001*
Attitudes	3.6(0.6)	4.6(0.5)	-1.0(0.1)	-14.70	0.001*
Behaviors	3.0(0.7)	4.2(0.6)	-1.2(0.1)	-13.30	0.001*
Note: *p<0.01					

Table 3. Paired t-test results

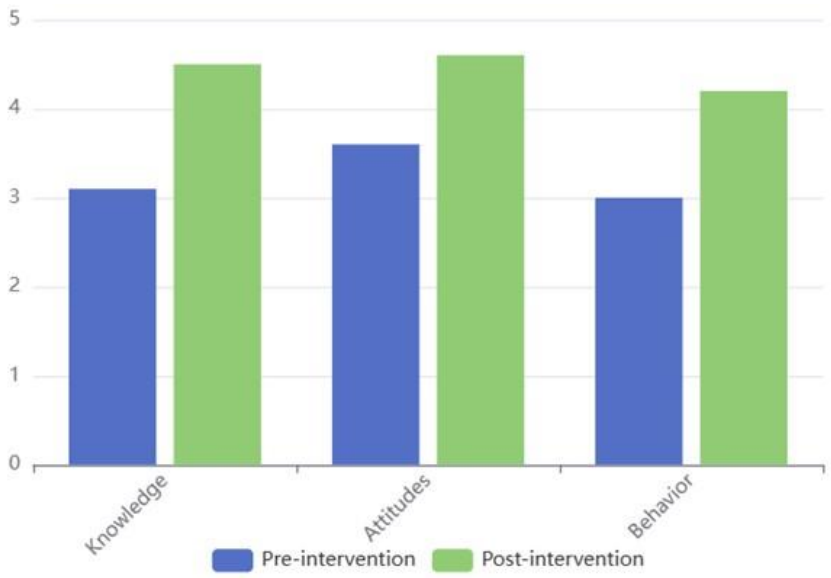


Figure 3. Paired t-test results

In summary, the ESD intervention significantly improved participants' knowledge, attitudes, and behaviors related to sustainability. Moreover, knowledge and attitudes were strong predictors of sustainability behaviors.

The results obtained from the study offer a comprehensive understanding of the influence of the ESD intervention on the participants' sustainability knowledge, attitudes, and behaviors in the textile industry. A detailed discussion of the findings is presented below.

The results suggest a significant improvement in the participants' knowledge about sustainability post-ESD intervention. These findings align with the existing literature that underlines the impact of education on increasing sustainability knowledge (Agbedahin, 2019). The ESD intervention presented in the study seems effective in fostering a thorough understanding of sustainable practices in the textile industry among participants, a critical first step in enabling sustainable transformations in the industry.

The positive shift in participants' attitudes towards sustainability after the ESD intervention indicates that not only did the program enhance the participants' understanding of sustainability but also successfully altered their perceptions and attitudes towards it. This is consistent with research suggesting that educational intervention can foster pro-environmental attitudes (Andrews & McKennell, 1980). The positive attitude change shows that the participants have internalized the importance of sustainability, which is a precursor for sustainable behavior.

Significant improvement in participants' sustainability behaviors post-ESD intervention shows that the program was successful in translating the enhanced knowledge and positive attitudes into tangible behavioral changes. This result supports the idea that education can indeed foster sustainable behavior (Figueiró & Raufflet, 2015). Participants were not only more aware and supportive of sustainability practices, but they also engaged more in these practices.

The strong correlation between sustainability knowledge and attitudes, and between knowledge and behaviors, suggests that a thorough understanding of sustainability concepts is crucial for fostering positive attitudes and practices. Additionally, the findings of the multiple regression show that sustainability behaviour is significantly predicted by both knowledge and attitudes. These results point to a model where education increases sustainability knowledge, which then influences positive attitude shifts and encourages sustainable behaviour. The study's results demonstrate the efficacy of the ESD intervention in promoting sustainability knowledge, attitudes, and behaviours among the individuals involved. These findings not only confirm the value of education for

sustainable growth, but also offer crucial information for enhancing upcoming educational initiatives in the textile sector. A thorough summary of the study and recommendations for further research are given in the following section.

In the context of the textile sector, the study investigated the efficacy of ESD intervention. Understanding how ESD affected participants' sustainability knowledge, attitudes, and behaviors was the main goal.

Participants' knowledge of sustainability increased significantly after the ESD intervention. Their comprehension was improved as a result of the intervention, which gave them crucial knowledge about sustainability ideas and how they are used in the textile business. This conclusion supports prior research that highlights the importance of education in advancing sustainability knowledge.

After the ESD intervention, the study also discovered a favourable change in the participants' attitudes toward sustainability. This shows that the intervention was effective at changing views and attitudes in addition to boosting knowledge. According to Cotton et al. (2009), educational intervention can encourage pro-environmental attitudes, and this is in line with their assertion.

The participants' sustainability behaviours significantly changed as a result of the intervention. The participants started implementing more environmentally friendly practices into their job in the textile industry, showing a translation of the learned knowledge and attitudes into practical deeds. This result backs up Monroe's (2003) claim that education can encourage environmentally friendly behaviour.

A significant correlation was identified between sustainability knowledge and attitudes, as well as between knowledge and behaviours. The correlation was found to be strong and reliable. Furthermore, the results of the multiple regression analysis revealed that sustainability behaviour is significantly predicted by both knowledge and attitudes. The present discovery is consistent with the theoretical framework postulated by Kollmuss and Agyeman (2002), which posits that education amplifies sustainability knowledge, resulting in favourable modifications in attitudes, ultimately fostering sustainable conduct.

In order to reinforce the knowledge and attitudes of ESD among students, serious games or gamification could be a potential instructional strategy, as shown in various fields of science and technology education (Merino-Cajaraville et al., 2023; Tan et al., 2010; Wong et al., 2016).

7. Conclusions

In general, the outcomes of this investigation emphasise the efficacy of ESD intervention within the textile sector, thereby strengthening the significance of education in advancing sustainability. ESD has been identified as a powerful tool for promoting sustainability in the textile industry by facilitating the enhancement of knowledge, reshaping of attitudes, and promotion of behaviours. The following section will offer suggestions for future research and practical applications of the aforementioned results.

The outcomes of this investigation hold significant ramifications for both practical application and subsequent scholarly inquiry. Below are the key implications and the resulting recommendations:

The findings of the study suggest that the implementation of ESD intervention can significantly enhance sustainability knowledge, attitudes, and behaviours within the textile industry. Hence, it is recommended that organisations and relevant parties operating in this industry contemplate the incorporation of educational programmes as a component of their sustainability plan. Facilitating such an approach has the potential to not only augment the comprehension of sustainability concerns among employees but also cultivate a sustainable ethos within organisational settings. The available evidence regarding the impact of ESD in promoting sustainability indicates that it would be advisable for policy makers to provide support and incentives for its implementation. Potential strategies for promoting ESD include the formulation of extensive sustainability education regulations, allocation of resources towards ESD initiatives, and provision of incentives to encourage industries to integrate ESD into their training protocols.

The integration of ESD into curricula should be a priority for educators and educational institutions given the ESD's proven capacity to improve sustainability knowledge, attitudes, and behaviours. Incorporating real-world examples from sectors like the textile industry should receive special attention so that students may see how sustainability concepts are used in everyday life. ESD in the textile sector. However, forthcoming investigations could delve into alternative industries to authenticate the generalizability of the results. Likewise, it is possible for research endeavors to explore the enduring effects of ESD intervention by assessing whether the favorable alterations in knowledge, attitudes, and behaviors are sustained in the long run.

Additionally, future investigations could probe into the optimal formulation and implementation of ESD intervention. Discovering which components of ESD

bear the greatest influence on shifting attitudes and behaviors may furnish crucial insights for both educators and industry professionals.

In closing, this research highlighted the transformative potential of ESD in promoting sustainability within the textile industry. The responsibility now rests on the shoulders of industry leaders, policy makers, and educators to harness these insights and earnestly strive to incorporate ESD into their sustainability strategies and educational curricula. It is through such determined initiatives that this research envisages the construction of a more sustainable future.

While this research study has provided valuable insights into the role of ESD in the textile industry, it is essential to acknowledge certain limitations. These limitations offer directions for future research to build on the findings and implications of this study.

The focus on the textile industry in this research might limit the application of findings in other sectors. Each industry has unique characteristics and challenges concerning sustainability; thus, the effects of ESD could vary.

Future research should consider a larger sample size and include multiple organizations from different geographical locations. This could offer a more comprehensive and diverse view of the impact of ESD, improving the generalizability of findings.

References

Abner, M., Baytar, F., & Kreiner, D. (2019). Applying the ESD approach in textile and apparel education. *International Journal of Sustainability in Higher Education*, *20*(1), 75-90. https://doi.org/10.1108/ijshe-02-2018-0029

Agbedahin, A. V. (2019). Sustainable development, Education for Sustainable Development, and the 2030 Agenda for Sustainable Development: Emergence, efficacy, eminence, and future. *Sustainable Development*, *27*(4), 669-680.

Ahuti, S. (2015). Industrial growth and environmental degradation. *International Education and Research Journal*, *1*(5), 5-7.

Alam, A. (2022). Mapping a sustainable future through conceptualization of transformative learning framework, education for sustainable development, critical reflection, and responsible citizenship: an exploration of pedagogies for twenty-first century learning. *ECS Transactions*, *107*(1), 9827.

Andrews, F. M., & McKennell, A. C. (1980). Measures of self-reported well-being: Their affective, cognitive, and other components. *Social indicators research*, *8*, 127-155.

Ashokkumar, V., Flora, G., Venkatkarthick, R., SenthilKannan, K., Kuppam, C., Stephy, G. M., Kamyab, H., Chen, W.-H., Thomas, J., & Ngamcharussrivichai, C. (2022). Advanced technologies on the sustainable approaches for conversion of organic waste to valuable bioproducts: Emerging circular bioeconomy perspective. *Fuel*, *324*, 124313.

Chiba, M., Sustarsic, M., Perriton, S., & Edwards Jr, D. B. (2021). Investigating effective teaching and learning for sustainable development and global citizenship: Implications from a systematic review of the literature. *International Journal of Educational Development*, *81*, 102337.

de Oliveira Neto, G. C., Correia, J. M. F., Silva, P. C., de Oliveira Sanches, A. G., & Lucato, W. C. (2019). Cleaner Production in the textile industry and its relationship to sustainable development goals. *Journal of Cleaner Production*, *228*, 1514-1525.

Derkach, T. M., & Shuhailo, Y. V. (2022). Adapting engineering education to challenges of sustainable development. *IOP Conference Series: Earth and Environmental Science*, *1049*(1). https://doi.org/10.1088/1755-1315/1049/1/012021

Figueiró, P. S., & Raufflet, E. (2015). Sustainability in higher education: a systematic review with focus on management education. *Journal of Cleaner Production*, *106*, 22-33.

Fletcher, K. (2013). *Sustainable fashion and textiles: design journeys*. Routledge.

Fletcher, K., & Grose, L. (2012). *Fashion & sustainability: Design for change*. Hachette UK.

Franco, M. A. (2017). Circular economy at the micro level: A dynamic view of incumbents' struggles and challenges in the textile industry. *Journal of Cleaner Production*, *168*, 833-845.

Gwilt, A., & Rissanen, T. (2012). *Shaping sustainable fashion: Changing the way we make and use clothes*. Routledge.

Hwang, C., Lee, Y., Ghalachyan, A., & Karpova, E. (2022). Student learning about social responsibility in the global textile and apparel industry: the use of video as an instructional tool. *International Journal of Fashion Design, Technology and Education*, *15*(1), 67-76.

Jasmi, N., Kamis, A., & Farahin, N. (2019). Importance of green technology, Education for Sustainable Development (ESD) and environmental education for students and society. *Journal of Engineering Research and Application*, *9*(2), 56-59.

Kant, R. (2011). Textile dyeing industry an environmental hazard.

Karahan, E., & Roehrig, G. (2015). Constructing media artifacts in a social constructivist environment to enhance students' environmental awareness and activism. *Journal of Science Education and Technology*, *24*, 103-118.

Köksal, D., Strähle, J., Müller, M., & Freise, M. (2017). Social sustainable supply chain management in the textile and apparel industry—A literature review. *Sustainability*, *9*(1), 100.

Leicht, A., Heiss, J., & Byun, W. J. (2018). *Issues and trends in education for sustainable development* (Vol. 5). UNESCO publishing.

Luo, Y., Song, K., Ding, X., & Wu, X. (2021). Environmental sustainability of textiles and apparel: A review of evaluation methods. *Environmental Impact Assessment Review*, *86*. https://doi.org/10.1016/j.eiar.2020.106497

McKeown, R., Hopkins, C. A., Rizi, R., & Chrystalbridge, M. (2002). *Education for sustainable development toolkit*. Energy, Environment and Resources Center, University of Tennessee Knoxville.

Merino-Cajaraville, A., Reyes-de-Cózar, S., & Navazo-Ostúa, P. (2023). SCHEMA: A Process for the Creation and Evaluation of Serious Games—A Systematic Review towards Sustainability [Review]. *Sustainability (Switzerland)*, *15*(16), Article 12351. https://doi.org/10.3390/su151612351

Milgate, M. (2001). Supply chain complexity and delivery performance: an international exploratory study. *Supply chain management: An international Journal*, *6*(3), 106-118.

Moos, D. C., & Ringdal, A. (2012). Self-regulated learning in the classroom: A literature review on the teacher's role. *Education Research International*, *2012*.

Murzyn-Kupisz, M., & Hołuj, D. (2021). Fashion Design Education and Sustainability: Towards an Equilibrium between Craftsmanship and Artistic and Business Skills? *Education Sciences*, *11*(9). https://doi.org/10.3390/educsci11090531

Muthu, S. S. (2014). *Roadmap to sustainable textiles and clothing: Eco-friendly raw materials, technologies, and processing methods*. Springer.

Niinimäki, K. (2013). *Sustainable fashion: New approaches*. Aalto University.

Okereke, C., Coke, A., Geebreyesus, M., Ginbo, T., Wakeford, J. J., & Mulugetta, Y. (2019). Governing green industrialisation in Africa: Assessing key parameters for a sustainable socio-technical transition in the context of Ethiopia. *World Development*, *115*, 279-290.

Shen, B. (2014). Sustainable fashion supply chain: Lessons from H&M. *Sustainability*, *6*(9), 6236-6249.

Tan, W. H., Johnston-Wilder, S., & Neill, S. (2010). Exploring the educational potential of game-based learning through the eyes of game industry practitioners. International Journal of Technology, Knowledge and Society,

Todeschini, B. V., Cortimiglia, M. N., Callegaro-de-Menezes, D., & Ghezzi, A. (2017). Innovative and sustainable business models in the fashion industry: Entrepreneurial drivers, opportunities, and challenges. *Business horizons*, *60*(6), 759-770.

Vicente-Molina, M. A., Fernández-Sáinz, A., & Izagirre-Olaizola, J. (2013). Environmental knowledge and other variables affecting pro-environmental behaviour: comparison of university students from emerging and advanced countries. *Journal of Cleaner Production*, *61*, 130-138.

Wong, Y. S., Hayati, M. Y. M., & Tan, W. H. (2016). A propriety game-based learning game as learning tool to learn object-oriented programming paradigm. Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics),

Authors

Ji Jie (*corresponding author*) UCSI University, Kuala Lumpur, Malaysia.
Yangzhou Polytechnic College, Yang Zhou, China.
1002267871@ucsiuniversity.edu.my

Tan Wee Hoe, UCSI University, Kuala Lumpur, Malaysia.

Shi Wen Qian, UCSI University, Kuala Lumpur, Malaysia.

Funds

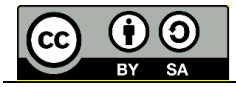
This research received no specific grant from any funding agency in the public, commercial, or no-profit sectors.

Competing Interests

The authors hereby state that there are no financial or non-financial competing interests.

Citation

Jie, J., Tan, W.H. & Shi, W.Q. (2023) Fostering sustainability in China's textile industry. The role of education for sustainable development. *Visions for Sustainability*, 20, 7915, 329-353. http://dx.doi.org/10.13135/2384-8677/7915



© 2023 Jie, Tan, Shi

This is an open access publication under the terms and conditions of the Creative Commons Attribution (CC BY SA) license (http://creativecommons.org/licenses/by/4.0/).