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The Application Value of Environmentally Friendly Functional Textiles in College Basketball Teaching and Sports Equipment

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Article

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ABSTRACT

The traditional textile materials used in sports equipment have certain restrictions in protecting the environment and performance. It is hard to meet the requirements of classroom quality, sports performance ability and green sustainable development in the teaching of basketball in colleges and universities at the same time. This paper establishes a multi-index evaluation system based on environmental protection, performance and teaching adaptability, and uses analytic hierarchy process (AHP) to quantify the weight of each index. The performance index of the environmentally friendly materials are tested in experiment. Weighted comprehensive scoring model is used for quantitative comparison. The results show that the environmentally friendly functional textiles have certain advantages in the performance of green with residual rate of only 9.2% after 100 days of degradation. This study shows that the method can scientifically evaluate the degree of application value and sustainability of environmentally friendly functional textiles in the equipment of teaching basketball in colleges and universities, and provides theoretical basis for improving classroom teaching quality and building green campus.

KEYWORDS

environmental performance, functional textile materials, basketball teaching application, teaching adaptability, sustainable material utilization

INTRODUCTION

In recent years, the teaching of college basketball has attracted much attention, and equipment performance is becoming as significant as teaching quality and student fitness. Simple breathability, comfort, and durability are provided by traditional sports textiles; however, environmental friendliness and functional scalability are lacking because of increasing requirements for sustainability [1,2]. Heavy use of synthetic fibers and

generated waste make traditional sports textiles incompatible with the green campus being developed by universities[3,4]. Traditional sports textiles are inadequate for high-intensity, long-duration basketball training because they provide simple perspiration absorption, heat dissipation, and load reduction functions [5,6]. It has been reported that with repeated aging, porosity and durability of traditional fabrics decrease significantly, and that recycled polyester maintains its functional properties better [7]; and that traditional textiles cause great environmental impact throughout their life cycle [8]. Therefore, it is a key issue to balance sustainability and sports performance in the improvement of basketball teaching and equipment development [9,10] to motivate this study.

Recent studies have reviewed environmentally friendly functional textiles and affirmed their sustainability and application potential. Zhang et al. [11] summarized preparation methods, multifunctional properties, and sustainable uses of functional textiles, while Li et al. [12] highlighted advances in hydrophobic textile fabrication for green development. In recycling, Suen et al. [13] examined technologies converting textile-waste cellulose into high-value products, and Nayak et al. [14] emphasized bacterial cellulose as a sustainable fiber substitute. Together, these works demonstrate notable progress in eco-friendly functional textiles and provide theoretical support for evaluating their use in college basketball instruction and sports equipment. In the sports equipment field, environmentally friendly functional textiles have become an important research focus [15,16]. Cui and Wang [17] reviewed advances in material innovation, intelligent sensing, and sustainable manufacturing, while Soundri [18] showed that sustainable materials can simultaneously meet high-performance demands and support green industry goals. Salopek Čubrić et al. [19] Correlation analysis and multiple regression models were used to reveal that yarn linear density, hairiness, fabric thickness, and weight play a dominant role in the thermal comfort and breathability of knitted fabrics. Collectively, these studies underscore the performance and sustainability advantages of eco-friendly functional textiles and offer support for developing basketball training and competition equipment aligned with athletic and environmental requirements.

In this study, an evaluation framework of environmental protection, functionality and pedagogical effect was constructed to evaluate environmentally friendly functional textiles applied in basketball teaching. The weighted comprehensive model was established based on the multi-level index system and AHP-based weighting to experimentally test and evaluate classroom use. The results revealed that environmentally

friendly functional textiles are suitable for high-intensity basketball teaching and contribute to sustainable development, which are consistent with the previous studies on preparation and material recycling.

IMPLEMENTATION PATHS FOR PERFORMANCE EVALUATION OF ENVIRONMENTALLY FRIENDLY FUNCTIONAL TEXTILES

Construction of a Multidimensional Evaluation System

The application value of environmentally friendly functional textiles in university basketball teaching and sports equipment needs to be quantified through a systematic, multidimensional framework [20,21]. The evaluation system sets the target layer G , which represents the comprehensive application value; below it is the criterion layer $C=\{C_1, C_2, C_3\}$, which corresponds to the three first-level indicators of environmental protection, functionality, and teaching adaptability; the bottom layer is the indicator layer $I = I_{ij}$, where I_{ij} represents the j -th second-level indicator under the i -th first-level indicator, $i \in \{1,2,3\}$, $j \in \{1,2,3,4\}$. Specifically, I_{11} and I_{12} under C_1 represent degradability and recycling rate, respectively; I_{21} , I_{22} , and I_{23} under C_2 represent moisture absorption and perspiration rate, air permeability coefficient, and wear resistance, respectively; I_{31} , I_{32} , I_{33} , and I_{34} under C_3 represent exercise comfort, movement completion, physiological feedback, and classroom task achievement rate, respectively. This constitutes a tree-like model with three layers of structure: target layer, criterion layer, and indicator layer, ensuring the logical integrity and operability of the evaluation system.

In the data processing phase, to eliminate the dimensional differences between indicators, the original data set $X = x_{ij}$ needs to be standardized. For positive indicators, extreme value standardization is used:

$$z_{ij} = (x_{ij} - \min(x_i)) / (\max(x_i) - \min(x_i)) \quad (1)$$

For negative indicators, reverse normalization is used:

$$z_{ij} = (\max(x_i) - x_{ij}) / (\max(x_i) - \min(x_i)) \quad (2)$$

In formula (2), x_{ij} represents the observed value of the j -th evaluation object on the i -th indicator; z_{ij} is the dimensionless value after standardization; x_i is the set of observed values of the i -th indicator. After normalization, all indicator data are mapped to the interval $[0,1]$ to ensure comparability among indicators.

In the indicator aggregation logic, the secondary indicators are weighted and aggregated into the scores of the primary indicators to which they belong. The calculation formula is:

$$s_i = \sum (w_{ij} \times z_{ij}) \quad (3)$$

In formula (3), s_i is the comprehensive score of the first-level indicator of category i ; w_{ij} is the weight of the second-level indicator; z_{ij} is the standardized value. The comprehensive score S of the final target layer is defined as:

$$S = \sum (\alpha_k \times s_k) \quad (4)$$

In formula (4), α_k is the weight of the k -th first-level indicator, and s_k is the corresponding weighted result. This structure ensures the balance and scientific nature of the three dimensions of environmental protection, functionality; and teaching adaptability in the overall evaluation, laying a framework foundation for subsequent weight determination and comprehensive scoring.

The evaluation indicators were selected based on textile industry standards, national sports material testing procedures, and pedagogical requirements for basketball teaching. Degradability and recycling rate were chosen to represent environmental impact. Moisture absorption, air permeability, and abrasion resistance were included as key functional parameters affecting sportswear performance. Exercise comfort, movement completion, physiological feedback, and task achievement rate were identified-through expert consultation-as indicators of teaching adaptability. The weighting process in Section Quantification of Weights Using the Analytic Hierarchy Process reflects expert judgments while ensuring consistency between independent evaluators to reduce subjectivity.

Quantification of Weights Using the Analytic Hierarchy Process

Once the indicator system for the three dimensions of environmental protection, functionality, and teaching adaptability is established, the weight of each indicator needs to be assessed using the Analytic Hierarchy Process (AHP) [22]. This method is predicated on expert scoring and forms a judgment matrix $A = [a_{ij}]$ that reflects the relative importance relationship among the indicators, with a_{ij} indicating the importance of indicator i relative to indicator j , which satisfies $a_{ij} = 1/a_{ji}$ and $a_{ii} = 1$. The experts' scores were combined using element-wise geometric means to preserve the multiplicative nature of AHP ratios. A collective judgment

matrix A was formed by taking the geometric mean of corresponding elements from all valid expert matrices, ensuring consistency with the AHP fundamental scale. Five experts participated: two textile-materials professors, one physical-education associate professor, and two senior engineers from a sports-equipment company. Each conducted pairwise comparisons using the standard 1-9 AHP scale, and their matrices were checked for internal consistency. Valid matrices were then geometrically aggregated to form the final judgment matrix, from which the principal eigenvalue and eigenvector were calculated to produce the weight vector. In the weight calculation process, it is necessary to extract the maximum eigenvalue λ_{max} of the judgment matrix and its corresponding eigenvector $v = (v_1, v_2, \dots, v_n)^T$. After normalization, the weight vector $w = (w_1, w_2, \dots, w_n)^T$ is obtained, and its calculation formula is:

$$w_i = v_i / \sum_j v_j \quad (5)$$

In formula (5), v_i is the i -th component of the eigenvector, and w_i is the weight of the i -th indicator.

To test the consistency of the judgment matrix, it is necessary to calculate the consistency index CI:

$$CI = (\lambda_{max} - n) / (n - 1) \quad (6)$$

The consistency ratio CR is then calculated:

$$CR = CI / RI \quad (7)$$

In the above formulas (6) and (7), n is the order of the judgment matrix, and RI is the random consistency index corresponding to n . When $CR < 0.1$, the judgment matrix has satisfactory consistency, and the weight distribution is effective; if $CR \geq 0.1$, the expert scores need to be revised, and the judgment matrix needs to be reconstructed.

Through this process, the three first-level indicators—environmental protection, functionality, and teaching adaptability—were assigned weights of 0.312, 0.358, and 0.330, respectively. Corresponding second-level indicator weights were calculated within each category using the same eigenvalue method. The first-level judgment matrix produced $\lambda_{max} = 3.016$, with $CI = 0.008$ and $CR = 0.009$, meeting the $CR < 0.1$ consistency requirement. All secondary-indicator submatrices also passed the consistency test. The normalized weights

were then used as inputs to the weighted comprehensive scoring model in Section Construction of a Weighted Comprehensive Scoring Mode, ensuring that the final evaluation accurately reflected the relative importance of each indicator dimension.

Design of Material Performance Measurements

To achieve quantification of indicator level I_{ij} , this section designs experiments and establishes a one-to-one correspondence between parameters and indicators. Items I_{11} and I_{12} of the environmental dimension C_1 measure degradability D and recycling rate R , respectively. Items I_{21} , I_{22} , and I_{23} of the functional dimension C_2 measure moisture absorption and perspiration rate H , breathability P , and wear resistance W , respectively. Items I_{31} , I_{32} , I_{33} , and I_{34} of the teaching adaptability dimension C_3 measure exercise comfort C , movement completion F , physiological feedback K , and classroom task achievement rate U , respectively.

The experimental parameters are determined as follows:

I_{11} : Degradability is characterized by the residual mass ratio:

$$D = (m_0 - m_t)/m_0 \times 100\% \quad (8)$$

In formula (8), m_0 is the initial mass, and m_t is the residual mass at time t .

I_{12} : The recycling rate is expressed as:

$$R = m_r/m_{tot} \times 100\% \quad (9)$$

In formula (9), m_r is the mass of the recycled material, and m_{tot} is the mass of the total material.

I_{21} : Moisture wicking rate performance is calculated as the mass change per unit time:

$$H = \Delta m/\Delta t \quad (10)$$

In formula (10), Δm is the mass change, and Δt is the time interval. In the experimental process, the mass change Δm was recorded over a fixed fabric area of 100 cm², and the moisture wicking rate was further normalized to the same area to ensure comparability among different samples. All tests were performed under a controlled environment of 25 ± 1°C and relative humidity of 65 ± 2%, in accordance with GB/T 21655.1-2008. The measured wetting time, spreading radius, and absorption behaviour followed the technical requirements of GB/T 21655.1-2008. The mass-change-per-time data used in the perspiration evaluation were

recorded through continuous weighing during exercise tests and were not part of the indicator system defined in GB/T 21655.1-2008. Each specimen was preconditioned for 24 hours prior to measurement to eliminate the effect of moisture history on the results.

I_{22} : Air permeability is determined by a steady-state air permeability test:

$$P = V / (A \cdot \Delta p \cdot t) \quad (11)$$

In formula (11), V is the air permeability volume; A is the sample area; Δp is the pressure difference; t is the test time.

I_{23} : Wear resistance is expressed as the number of cycles required to fail:

$$W = Nf \quad (12)$$

In formula (12), Nf is the number of friction cycles required for the specimen to fail. The failure criterion in the abrasion resistance test was defined as the occurrence of a visible hole with a diameter greater than 2 mm or a 20% loss of the specimen's original mass, whichever occurred first. All tests were carried out using a Martindale abrasion tester under a constant pressure of 9 kPa following GB/T 21196.2-2007, and the number of cycles recorded at the point of failure was taken as the final result for wear resistance.

I_{31} : Motion comfort is obtained by scoring on a questionnaire scale ranging from 1 to 10 points.

I_{32} : Action completion is counted through video recognition:

$$F = Nc / Nt \times 100\% \quad (13)$$

In formula (13), Nc is the number of correct actions completed, and Nt is the total number of actions.

I_{33} : Physiological feedback uses the relative changes in Heart Rate (HR) and Body Temperature (BT) to represent the physiological load level during exercise. It is calculated as follows:

$$K = \alpha \cdot \frac{HR_t - HR_0}{HR_0} + \beta \cdot \frac{T_t - T_0}{T_0} \quad (14)$$

In formula (14), HR_t is the average heart rate during exercise; HR_0 is the baseline heart rate; T_t is the average body surface temperature during exercise; T_0 is the baseline temperature; α and β are weight coeffi-

cients. The coefficients α and β were derived from a pre-test with ten participants performing exercise at identical intensity. A regression model relating heart-rate change to body-temperature variation was built, and standardized partial regression coefficients were used to determine parameter sensitivity. Heart rate contributed 0.62 and body temperature 0.38 to total physiological load, and these values were adopted as α and β . Robustness testing with $\pm 10\%$ coefficient adjustments produced less than 3% fluctuation in the physiological-load index, confirming stable sensitivity. A higher index indicates greater circulatory and thermoregulatory stress, while a lower index reflects reduced physiological burden and better exercise adaptability of the material.

I_{34} : Classroom task completion rate is calculated through task completion statistics:

$$U = N_s/N_p \times 100\% \quad (15)$$

In formula (15), N_s is the number of tasks actually completed, and N_p is the number of planned tasks.

The experimental output data is uniformly recorded as X_{ij} , which serves as the original measurement value of each indicator I_{ij} . Before entering the comprehensive evaluation model, all X_{ij} are standardized and dimensionless according to the method described in Section Construction of a Multidimensional Evaluation System to ensure the comparability between different indicators and the scientific nature of subsequent weight calculations.

Construction of a Weighted Comprehensive Scoring Model

After establishing the indicator system, assigning weights, and obtaining material performance data, each indicator must be transformed into a comprehensive evaluation result to quantify the application value of eco-friendly functional textiles in college basketball teaching and equipment. The comprehensive scoring model outputs the target-layer value and enables comparison and decision-making among different materials through hierarchical analysis of indicator data.

This section mainly constructs two analysis modules:

- 1) Analysis of the contribution of first-level indicators: the experimental data and the results of the second-level indicator weights are aggregated to the first-level indicator layer to obtain the contribution of each first-level indicator to the final comprehensive value. Let s_i be the score of the i -th first-level indicator (calculated in Section Construction of a Multidimensional Evaluation System). The contribution rate of the first-level indicator to the overall comprehensive score can be expressed as:

$$CR_i = (\alpha_i \times s_i) / S_{total} \times 100\% \quad (16)$$

In formula (16), α_i is the weight of the first-level indicator, and S_{total} is the overall comprehensive score. This indicator reflects the relative importance of environmental protection, functionality, and teaching adaptability in the comprehensive scoring, and provides a basis for colleges and universities to determine priority strategies in material selection or curriculum design.

2) Secondary indicator sensitivity analysis: to further quantify the role of a single secondary indicator in the comprehensive score, the single contribution rate CR_{ij} can be defined:

$$CR_{ij} = (\alpha_i \times w_{ij} \times Z_{ij}) / S_{total} \times 100\% \quad (17)$$

In formula (17), w_{ij} is the secondary indicator weight, and Z_{ij} is the standardized experimental data. This analysis can reveal the relative influence of each secondary indicator in different dimensions, and provide a quantitative basis for optimizing textile performance design, improving sports equipment, and adjusting teaching programs.

Comprehensive scoring application: through statistical analysis of S_{total} , CR_i , and CR_{ij} , the following functions can be achieved: ranking and screening different environmentally friendly functional textile materials; analyzing which performance indicator contributes most to the overall application value, thereby guiding material improvement or equipment optimization; providing a quantitative basis for college basketball teaching and optimizing classroom task arrangements and teaching adaptability.

In establishing the comprehensive scoring model, based on the experimental data and indicator weights, this study applies the integrated analysis method to evaluate the eco-functional textiles' green performance, functionality and teaching applicability. The data standardization and hierarchical aggregation process are implemented, which transform the analysis results into the basis of decision-making and quantify the differences between EG and CG. To ensure the logic of the closed-loop feedback, the analysis framework is depicted in Figure 1.

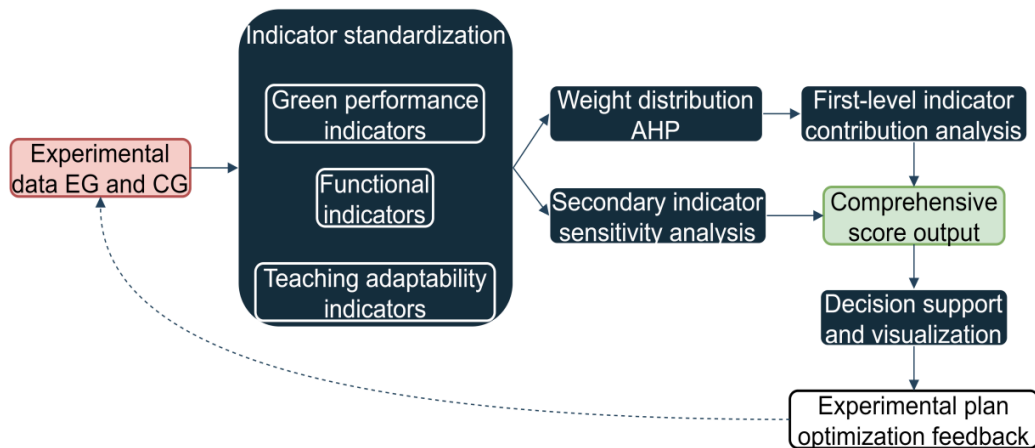


Figure 1. Comprehensive evaluation of environmentally friendly functional textile experiments

Figure 1 shows that, after data standardization and weighting, the model generates a comprehensive score through first-level contribution analysis and second-level sensitivity analysis, which then feeds into decision support and solution optimization. Actually, the evaluation is not on the single performance base, but on the base of multi-dimensional aggregation and stepwise summation with feedback. The weighting process plays the role of an important hub to guarantee the scientific allocation of environmental protection, performance and teaching adaptability. Finally, the comprehensive score is directly used for iteration of decision and experiment. Generally, the whole procedure is a closed loop from data to decision feedback.

This model combines indicator-level weights with experimental data, and effectively extends and applies the content of Sections 2.1(Construction of a Multidimensional Evaluation System)–2.3(Design of Material Performance Measurement) through contribution rate analysis rather than redefining standardization or weighting formulas. The final output includes: total comprehensive score S_{total} ; first-level indicator contribution rate CR_i ; second-level indicator single contribution rate CR_{ij} .

This method not only maintains the unity of the indicator system and data standardization processing, but also enhances the decision-making reference value of the comprehensive evaluation, providing scientific and quantitative support for the application of green and functional textiles in college basketball teaching and sports equipment.

ANALYSIS OF THE APPLICATION VALUE OF ENVIRONMENTALLY FRIENDLY FUNCTIONAL TEXTILES

Design and Implementation of a Comparative Experimental Plan

To verify the application value of eco-friendly functional textiles in university basketball teaching and equipment, this study conducts comparative experiments evaluating their green performance, functionality, and teaching adaptability against traditional textiles.

Experimental sample: EG is an environmentally friendly functional textile made of a composite of biodegradable polylactic acid and functional regenerated fiber [23], which has green environmental protection and functional characteristics. CG is a traditional sports textile commonly used in colleges and universities, that is, ordinary polyester fabric, which does not have obvious green functions.

The eco-friendly textile used a plain-woven composite of 70% polylactic-acid filament and 30% regenerated cellulose fiber (PLA 75 denier, cellulose 60 denier). weight 185 g/m², densities 32 ends/cm (warp) and 28 picks/cm (weft). Subsequently, it was given a hydrophilic finish with a nonionic surfactant and a thin polyurethane inner coating to improve the abrasion resistance without clogging the air-flow channels. These values describe the characteristics of the fabric and will be reproducible in subsequent research works.

Test indicators and methods:

Green performance: Degradability is tested using the soil degradation method (GB/T 19277-2011) under 25 °C and 65% RH, while recyclability is evaluated with the fiber recycling test (GB/T 38470-2019) to determine fiber retention and reuse efficiency.

Functionality was assessed according to GB/T 21655.1-2008 by measuring wetting time, spreading radius and absorption rate to characterise moisture transport, while perspiration mass-change per hour was calculated from continuous weighing during exercise as an additional indicator beyond the standard. Air permeability was tested following GB/T 5453-1997, and abrasion resistance was measured with a Martindale tester per GB/T 21196.2-2007 under 9 kPa and 60 cycles/min until failure, defined as a perforation larger than 2 mm or fiber fracture across more than 10% of the worn area. Surface morphology after abrasion was examined at 200× magnification, with all friction modes evaluated using the same failure criteria to ensure comparability. Sports applicability was assessed through subjective comfort scores recorded on a 0-1 scale after training, following a unified instruction to ensure consistent interpretation, with values later normalized according to the indicator rules. Action completion rate was obtained from high-definition recordings of basketball movements independently scored by two blinded experts, and inter-rater reliability was evaluated using a two-way

random-effects ICC with 95% confidence intervals. Physiological feedback was recorded with a Polar H10 heart-rate monitor and an iButton DS1922L skin-temperature sensor (both pretested), worn at fixed positions on the chest, and recorded synchronously for the acquisition of heart rate at 1 Hz and temperature every 30 s. Classroom task completion rate was calculated from unified teaching tasks, which integrated teachers' evaluation and students' output.

Experimental subjects and procedures: Forty university students (20 males, 20 females) with more than one year's basketball training took part and were randomly assigned into two groups of twenty each by gender stratified randomization method, with an equal number of males and females in each group. The allocation sequence was produced by an independent researcher and kept sequestered until the time of implementation of the experiment. Both groups were taught by the same teacher and trained according to the same work load. The experimental group wore sustainable textiles whereas the control group wore polyester textiles. Each indicator was measured three times and the average values were used for analysis. Control group data were used as the baseline references for the weighted scoring model to provide an indication of the experimental group's additional benefits.

All signs of green performance and functionality readiness as well as readiness to teach were backed by clear testing procedures that ensured the scientific independence of the results. The study was registered with the Ethics Committee of Beijing Wuzi University. All respondents were informed about the study and data purpose, and data were collected anonymously without storage of identifiable data.

Material Green Performance

In evaluating materials for college basketball equipment, green performance is essential. This study uses mass residual rate as the core indicator and conducts a 100-day degradation test under constant temperature and humidity, with measurements taken every five days to compare the degradation behavior of environmentally friendly functional textiles (EG) and traditional polyester textiles (CG). The results are shown in Figure 2.

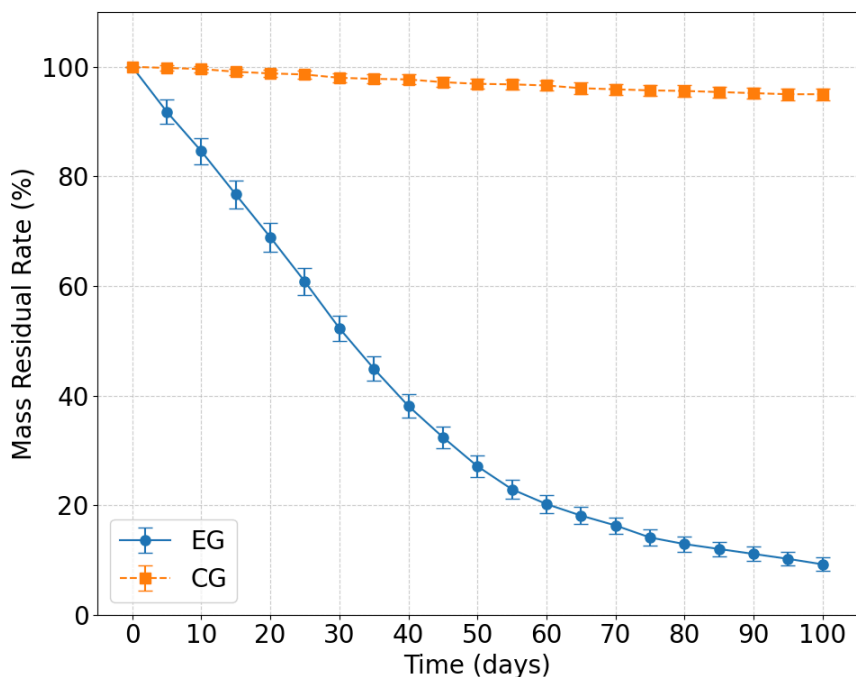


Figure 2 . Curves of the quality residual rate of environmentally friendly functional textiles and traditional textiles over a 100-day period: Mass residual rate of EG and CG samples

The mass residual rate of EG sample rapidly decreased to 91.8% on day 5, 60.8% on day 25, and 9.2% on day 100. The test was performed in a specific soil system with living microorganisms (3.1×10^7 CFU/g, C/N=12, pH 7.1, 25 °C, 65% RH). Meanwhile, the accelerated degradation of PLA component (24% crystallinity) was ensured. The above-mentioned accelerated decay of EG sample was caused by the low bond energy and structural vulnerability of PLA-based fibers under the action of microorganisms and moisture. However, the mass residual rate of CG sample was above 95% during the test process, which was chemically stable for polyester. Residual rate refers to the remaining mass compared with the initial mass. The results further indicate that the environmentally friendly textile has an excellent biodegradability and an ecological advantage over traditional fibers.

Both composite materials and polyester fabrics exhibit distinct behaviour during recycling processes. In order to gain insight into how the regenerative quality and recycling rate of EG and CG can be compared to those of CG, the experiment encompassed mechanical, chemical, biodegradation and thermal recovery pathways, registering both total yield and recovered products from each pathway. Mechanical recycling was defined as shredding the waste to a fibre material of 5 mm, hot-pressing at 180°C and yield was taken as the ratio of recovered mass of fibre with respect to the original sample. Chemical recycling depolymerized the polyester

phase in ethylene glycol with zinc acetate at 190°C, and yield was calculated from the mass of purified monomers. Biodegradation used cellulase and proteinase K at 37°C, with yield expressed as the proportion of residue converted to soluble products. Thermal recovery quantified energy release under complete oxidation. Recovered fractions were analyzed by FTIR to confirm expected chemical structures and absence of unexpected functional groups. The recycling-rate indicator thus reflects resource-reuse efficiency across different pathways, as shown in Figure 3.

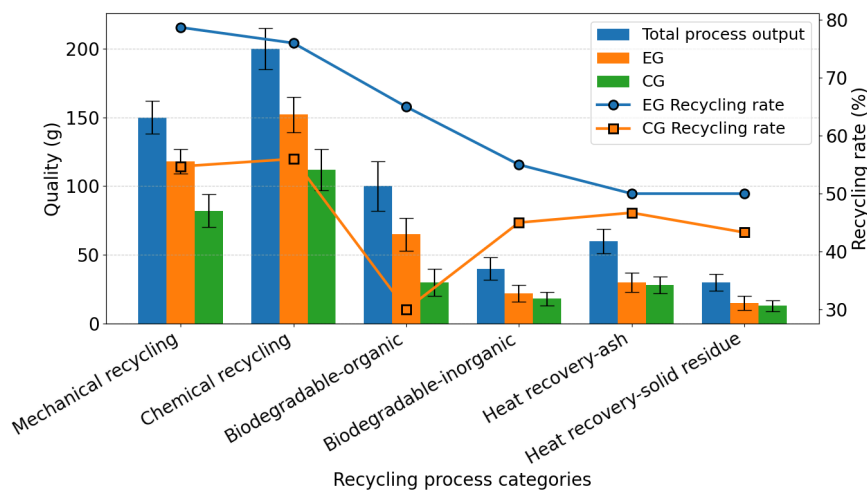


Figure 3. Comparison of the quality and recycling rate of EG and CG recyclables under different recycling processes

Figure 3 shows that in terms of mechanical recycling, EG achieved a recovery rate of 78.7%, while CG only achieved 54.7%. Chemical recycling efficiencies were similar, at 76% and 56%, respectively. In terms of biodegradation, EG achieved a recovery rate of 65%, while CG only achieved 30%. The recovery rates of mineralized residues were relatively close between the two materials (55% and 45%, respectively), and the differences in heat recovery rates were also small. Overall, EG exhibited higher recovery potential in the early physical and chemical stages, but in later energy recovery processes, the performance of both materials tended to converge.

To extend these results to the weighted scoring model, the normalized values of EG and CG for degradability, recycling, perspiration, breathability, and wear resistance were input into the system. Ultimately, EG scored 0.82 contrasted with CG (0.54). The largest differences were observed in degradability (EG: 0.91, CG: 0.05) and moisture absorption (EG: 0.85, CG: 0.47). The results demonstrate the green performance and functional performance benefits of EG. The fast degradation of EG originates primarily from the PLA phase. Because

the crystallinity and amorphous region of PLA are low, the microorganisms can easily cause the hydrolysis. However, the service durability of EG originates from the recycled cellulose fiber network and thin PU coating. The service durability is ensured by these two components because they can keep the surface cohesion without restraining the internal degradation of the PLA phase. Therefore, this dual phase can ensure the mechanical robustness in use and fast biodegradability after use.

Performance of Functional Adaptation

In basketball training, athletes' sweat production increases and the fabric breathability of the garment increases the comfort of the athlete. In this study, the weight change of each sample before and after ten minutes of shuttle run, high-knee, sliding step and running were recorded and air-permeability was measured to compared the performance of moisture absorption, perspiration and breathability of environmentally friendly functional fabrics and conventional fabrics in real basketball training.

According to the mass change result in Figure 4 and formula (10), EG has a higher perspiration rate than CG in all training exercises, and the breathability values are also higher for EG. That is, EG can transport sweat faster and promote air entry more efficiently, and thus can offer better thermal-moisture management during basketball training. Perspiration was measured by recording mass in real time during exercise. GB/T 21655.1-2008 was used only for the wetting-performance testing.

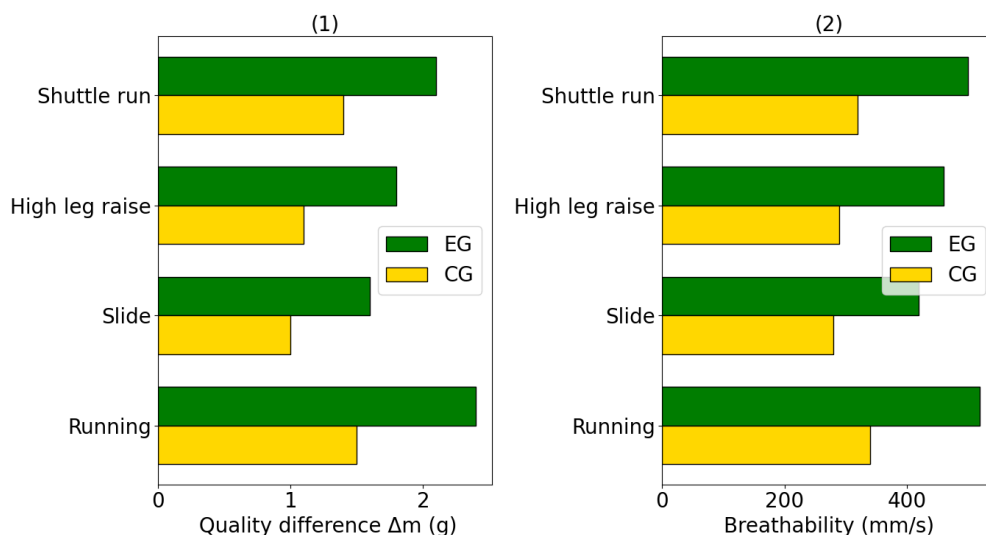


Figure 4. Comparison of moisture absorption and perspiration rate and breathability during basketball physical training: (1) Quality gap; (2) Breathability

When testing wear resistance, the designed experiment experienced the typical friction conditions during basketball in three modes, namely, multidirectional swinging, linear reciprocation, and localized high-pressure friction. The number of cycles to failure of EG and CG were counted under the same condition to compare the two fiber's performances, as shown in Figure 5.

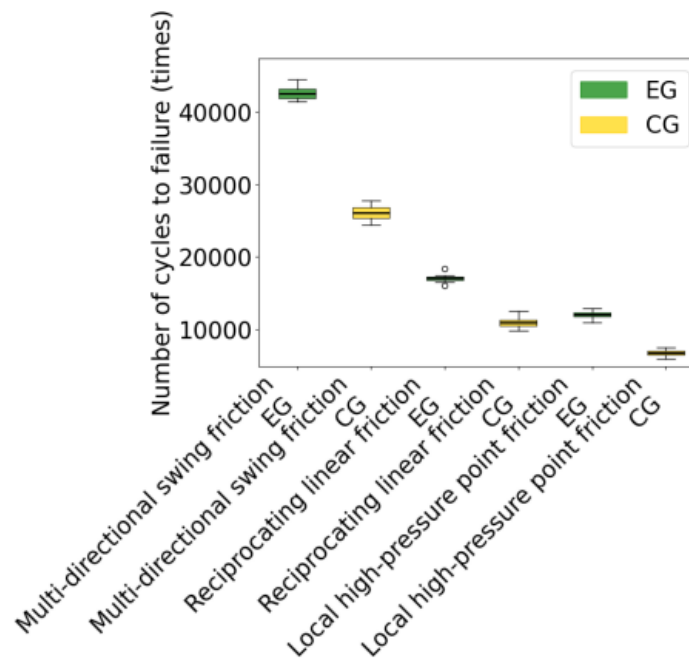


Figure 5. Comparison of wear resistance of EG and CG fabrics under different friction modes

Regardless of whether the friction mode is multi-directional friction, linear reciprocating friction, or localized high-pressure friction, Figure 5 shows that EG has a significantly higher number of friction cycles than CG. This result is attributed to the tighter interweaving structure of EG fibers and the abrasion-resistant surface coating, which delay fiber breakage under repeated or multiple stresses. In summary, EG generally exhibits superior abrasion resistance compared to polyester training apparel used in college sports. Therefore, EG can withstand prolonged basketball training, reducing the frequency of replacements and enhancing its durability in teaching/training applications.

Improving Individual Student Performance

In basketball instruction, equipment influences both overall performance and subtle movement execution. To assess the practical effectiveness of environmentally friendly functional textiles, this study compares student responses in comfort, movement completion, heart rate, and body temperature during free throws, front

direction changes, between-the-legs dribbling, and layups. The first two indicators are positively normalized and the latter two negatively normalized, with results for EG and CG presented using radar charts.

Figure 6 Comfort and movement-completion values of EG are higher than those of CG. In free throws, the comfort score of EG is higher, representing better breathability in static ball handling. In direction-change drills, EG provides better completion because its lower weight and higher heat dissipation can enhance faster movement. and In between-the-legs dribbling and layups, EG can maintain lower heart rate and body temperature, representing lower physiological load when performing high-intensity actions. The environmentally friendly textile can improve students' movement performance in these aspects.

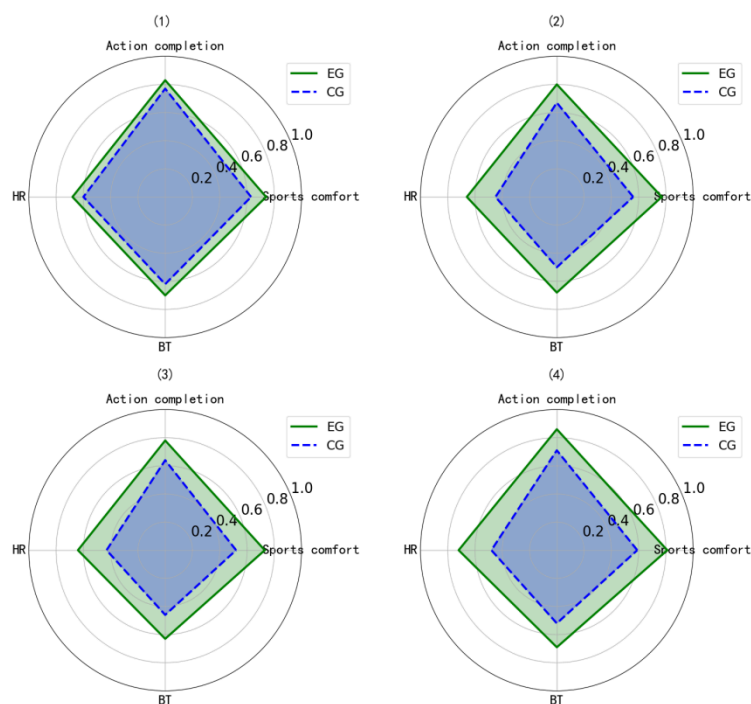


Figure 6. Correlation between EG and CG in four types of basketball actions: (1) Free throw; (2) Frontal change of direction; (3) Underfoot dribbling; (4) Layup

Bottom line: These improvements add up in the classroom. Faster moisture extraction and better thermal comfort contribute to helping students stay on their feet longer during a single instruction session, enhancing their performance and extending the life of the fabric on equipment invested in throughout multiple semesters, while lowering related replacement expenses. Low degradation residual rate also helps meet universities sustainability goals so that basketball courses can be used to maximize both instructional effectiveness and environmental awareness on campus.

Group Teaching Effectiveness Evaluation

To analyse the effects of environmentally friendly functional textiles on classroom effectiveness of college basketball instruction, this study analysed EG and CG in technical actions, tactical coordination, physical fitness and game performance. The research took into consideration shooting, layups, dribbling, cooperation quality, offensive and defensive efficiency, speed, agility, endurance dribbling, weight-training performance, scoring rate and defensive success rate. Defensive coordination refers to the temporal-spatial relationship during collective defence, measured by the percentage of successful switches, double-teams and positional changes in drills (see Figure 7) .

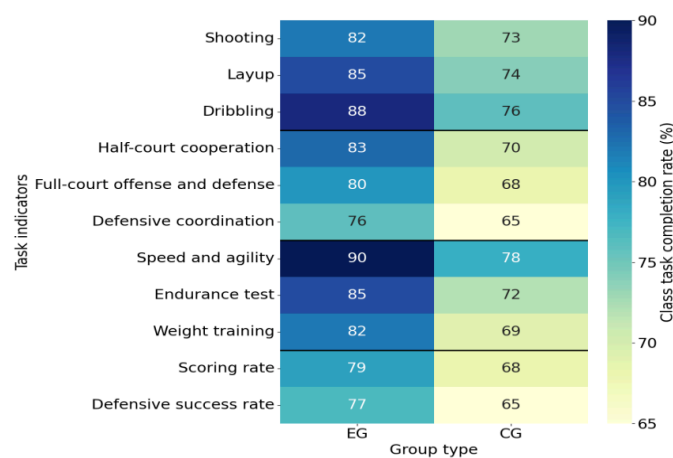


Figure 7. Comparison of completion rates of basketball-specific classroom tasks

Figure 7 Environmental friendly functional textiles influence group basketball teaching. EG is obviously superior to CG in all classroom behaviors . EG reaches 82% in shooting and 85% in layups which are both superior to CG (73% and 74%). EG in dribbling and cooperative execution are obviously more than 83% while CG is between 70% and 76%, suggesting better continuity of movement probably due to better continuity of force absorption. EG reaches 90% in speed-agility and 85% in endurance while CG is 78% and 72% respectively, indicating less fatigue in environmentally friendly functional textiles when the intensity of physical exercise is higher. In addition, EG reaches 79% in scoring efficiency and 77% in defensive success which are both more than CG (68% and 65%). The weighted comprehensive score is also higher in EG (0.79) than that in CG (0.58). Environmentally friendly functional textiles can improve completion, physical performance and teaching effect in group basketball teaching.

CONCLUSION

This article analyzed the application value of environmentally friendly functional textiles in basketball teaching of colleges. Based on environmental performance, function and pedagogic applicability, the multi-dimensional evaluation index system of environmental performance was established. And the comprehensive evaluation method based on AHP and weighted scoring model was developed. The experimental results show that environmentally friendly textiles have the advantages of ecology and comfort than traditional materials. This study has some limitations. Firstly, the sample size and period of observation are limited. Secondly, the validation experiment should be carried out in more institutions and competition fields. In the future, the wearable sensing technology will be used to monitor the physiology, the scope of durability tests will be expanded, and the life cycle assessment will be carried out to verify the ecological benefits. In summary, environmentally friendly functional textiles have the potential to apply in green campus construction. It is expected that the procurement practices and design standards of environmentally friendly functional textiles will affect the procurement behavior of sports equipment manufacturing enterprises in the sports textile industry.

Author Contributions

Xinlong Wang designed, collected and analyzed the data, and drafted the manuscript. Xinlong Wang conducted the study, critically revised the manuscript for important intellectual content, and gave final approval of the version to be published. Xinlong Wang participated fully in the work, take public responsibility for appropriate portions of the content, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Conflicts of Interest

The author declares no conflict of interest.

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Ethics Approval and Consent to Participate

This survey was conducted in compliance with Ethics Committee of Beijing Wuzi University. Participants were informed of the study's purpose and data usage prior to participation, and responses were collected anonymously. No personally identifiable information was stored.

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