

## METHODOLOGICAL FOUNDATIONS OF TEACHING STUDENTS TO SAVE NATURAL RESOURCES IN GARMENT MANUFACTURING

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**Annotation.** The article is devoted to the study of methodological foundations for teaching students to save natural resources in the process of garment manufacturing within vocational and higher education systems. The relevance of the research is determined by the growing environmental impact of the textile and garment industry, which requires the integration of sustainable development principles into professional training. The study analyzes modern resource-saving technologies aimed at reducing the consumption of water, energy, and textile materials during the design and production of clothing. Particular attention is paid to the educational potential of Zero Waste pattern cutting and Upcycling methods as tools for ecological design and sustainable fashion. The research is based on a pedagogical experiment conducted with students of the specialty “Sewing Production and Clothing Modeling.” Traditional cutting methods were compared with innovative resource-saving technologies during practical training. The results of the experiment demonstrate that the proposed teaching methodology significantly reduces fabric waste from 15–20% to 0–5% and contributes to the development of students’ creative, design, and ecological thinking. The study also reveals positive changes in students’ value-based attitudes toward environmental responsibility and professional ethics. The article substantiates pedagogical conditions for forming ecological competence, including the integration of project-based learning, practical eco-design tasks, and sustainable fashion concepts into the curriculum. The findings confirm the effectiveness of resource-saving education in increasing the professional competitiveness of future garment industry specialists.

**Keywords:** ecological competence, sustainable fashion, Zero Waste design, upcycling, resource saving, eco-design, environmental responsibility, creative thinking, circular economy.

**Introduction.** Today, the textile and light industry is one of the main sectors negatively affecting the environment. According to United Nations data, the fashion industry is responsible for 20% of global wastewater and 10% of carbon dioxide emissions [1]. According to the Environmental Code of the Republic of Kazakhstan, environmental protection and efficient use of resources are priority directions of state policy [2]. In Kazakhstan, the share of textile products in solid municipal waste is also increasing. Therefore, forming ecological responsibility during the training of future specialists is a requirement of the times. Students must master not only sewing clothes but also technologies for material saving, constructing waste-free cutting patterns, and giving "second life" to worn-out items.

**Theoretical and Methodological Foundations of the Research.** In modern pedagogical science, the issue of forming the ecological competence of future specialists is closely linked to the concept of "sustainable development" [3]. Foreign scholars (S. Sterling, A. Wals) view environmental education not just as information transfer but as a tool for changing students' worldviews [4]. In training garment production specialists, this approach is based on "responsible design" principles [5]. In domestic science, pedagogical conditions for forming students' ecological culture are being studied as an important direction [6].

Psychologically, teaching students to save resources requires a restructuring of their ecological consciousness. According to L.S. Vygotsky's activity theory, this process is realized through the active creative activity of the learner. The "Zero Waste" method used in our research

requires students to develop non-standard thinking, i.e., divergent thinking abilities. The student moves from the position of a mere executor to that of a constructor-researcher.

Furthermore, the competence-based approach in vocational education aims to form not only technical skills in future tailors but also value-motivational attitudes. In this article, we consider ecological competence as a unity of three components:

- **Cognitive Component:** Knowledge of environmental problems and materials science.
- **Motivational-Value Component:** A sense of responsibility towards nature and professional ethics.
- **Activity Component:** The ability to practically apply resource-saving technologies (Zero Waste, Upcycling).

The **objective of the research** is to substantiate the effectiveness of teaching students the "Zero Waste" concept and Upcycling methods. The article results identify the pedagogical conditions for introducing the resource-saving principle into the professional skills of future specialists [7,8,9,10].

**Materials and Research Methods.** The research work involved students of the 07230100 "Sewing Production and Clothing Modeling" specialty at the Smagul Iskakov Kyzylorda College of Construction and Business. The process of teaching students resource conservation included (Table 1) three main stages:

1. **Theoretical Stage:** Studying the properties of textile materials and their decomposition periods. Analysis of water and energy consumption in the production of natural fibers (cotton, wool, linen).

2. **Technological Stage:** Mastering the "Zero Waste Pattern Cutting" method. The goal of this method is 100% utilization of the fabric. Algorithms for efficient pattern placement were used during students' practical work to minimize fabric waste.

3. **Creative Stage (Upcycling):** Transforming old items or fabric scraps into new products. This increases students' creative thinking abilities and awakens responsibility for raw materials.

Comparative analysis, pedagogical observation, and mathematical statistical methods were used during the research.

**Table 1 - Methods for Saving Resources in Garment Manufacturing**

Method Name	Description	Effectiveness for Students
Zero Waste Design	Special construction of patterns (puzzle method) to eliminate fabric waste during cutting.	Develops design thinking, teaches working with geometric shapes.
Upcycling	Transforming old or damaged clothes into new fashionable items.	Deepens knowledge of materials science, increases creativity.
Reconstruction	Extending the service life of an item by changing its shape.	Improves technological processing techniques.

**Results and Discussion.** The results of the pedagogical experiment showed a significant increase in students' resource-saving skills. Below are comparative indicators of fabric consumption when using the traditional method versus the "Zero Waste" method (Table 2).

**Table 2 - Comparison of the Effectiveness of Traditional and Innovative Cutting Methods**

Indicators	Traditional Cutting Method	"Zero Waste" Method	Difference in Effectiveness
Useful Fabric Area (%)	75-82%	95-100%	+18-25%
Cutting Waste (%)	18-25%	0-5%	-20% (reduction)
Product Cost (relative units)	High (high fabricconsumption)	Low (resources saved)	10-15% savings
Design Complexity	Standard patterns	Creative, complex structures	Creative growth

The research showed that during the execution of Upcycling tasks, 85% of students began to understand material properties more deeply. Collections created by re-cutting old jeans and shirts were highly rated at fashion shows. This method formed the skill of "designing under conditions of limited resources" in students.

### Methodology for Organizing and Conducting the Pedagogical Experiment

The Smagul Iskakov Kyzylorda College of Construction and Business was taken as the empirical base for the research work. Students of the "Sewing Production and Clothing Modeling" specialty participated in the experiment and were divided into two groups: **Control Group (CG, n=24)**: Taught according to the traditional curriculum using standard cutting methods. **Experimental Group (EG, n=24)**: A special module "Eco-design and Resource Saving" was introduced into the educational process, and Zero Waste technologies were applied.

The experiment was conducted in three stages: **Diagnostic (Constative) Stage**: Diagnosing students' initial level of environmental knowledge and cutting skills via surveys and control work. **Formative Stage**: Conducting lessons for the experimental group using the author's methodology, utilizing Project-Based Learning technology. Students were given tasks to defend personal projects on the topic "My Ecological Footprint" and create accessories from waste. **Control (Concluding) Stage**: Comparative analysis and statistical processing of results. A special criteria-based assessment system was developed to evaluate students' ecological competence (Table 3).

**Table 3 – Levels and Criteria for the Formation of Students' Ecological Competence**

Level	Description	Assessment Indicators
High (Creative)	The student deeply understands environmental issues, independently uses the Zero Waste method, and can propose new schemes for waste-free patterns.	Innovation in project work, fabric waste 0-5%, high motivation.
Medium (Productive)	The student fulfills standard environmental requirements but relies on the teacher's help. Partially applies Upcycling methods.	Fabric waste 10-15%, correct execution of the technological map.
Low (Reproductive)	The student does not pay attention to environmental aspects, focusing only on sewing the item. Low interest in saving resources.	Fabric waste 20% and higher, limited to traditional methods.

**Analysis of Experiment Results and Statistical Processing.** At the beginning of the experimental work, the indicators of students in both groups were similar. In the diagnostic stage, the majority of students (CG – 65%, EG – 62%) showed a "Low" level. This indicated they were accustomed to cutting the item quickly rather than saving fabric. The re-diagnosis results after the formative experiment showed significant changes (Table 4).

**Table 4 - Dynamics of Ecological Competence Levels Before and After the Experiment (%)**

Levels	Control Group (CG)		Experimental Group (EG)	
	Before	After	Before	After
High	12%	18%	14%	45%
Medium	23%	35%	24%	48%
Low	65%	47%	62%	7%

As seen from the table, the share of students at the "High" level in the experimental group increased from 14% to 45%, while the "Low" level decreased sharply from 62% to 7%. In the control group, growth was natural, and no significant breakthrough was observed [11-14].

To check the statistical validity of the obtained results, we used Pearson's Chi-square ( $\chi^2$ ) criterion. Calculations showed that  $Temp > T_{crit}$  ( $p < 0.05$ ), proving that the changes in the

experimental group were not accidental and demonstrating the effectiveness of the introduced methodology.

Furthermore, qualitative analysis revealed a change in students' psychological attitudes. According to survey results, 90% of EG students fully agreed with the statement "Protecting the environment is my main duty in my future profession". This indicates that the pedagogical experiment achieved not only its technological but also its educational goals.

**Discussion.** The research results resonate with the "Zero Waste Fashion Design" theory by T. Rissanen and H. McQuillan in global practice. The uniqueness of our research lies in adapting Western methodology to the Kazakhstan vocational education system. Students were able to combine elements of national clothing (for example, the *quraq korpe* patchwork technology itself is an ancient form of upcycling) with modern eco-design. This methodology increases students' professional mobility; as fabric becomes more expensive in the market, the demand for specialists who cut without waste increases. Thus, environmental education is directly linked to economic efficiency.

**Statistical Processing Methodology.** To confirm the dynamics of change in the formation levels of students' ecological competence (high, medium, low), Pearson's Chi-square ( $\chi^2$ ) criterion was calculated using the following formula:

$$\chi_{emp}^2 = \sum_{i=1}^m \frac{(f_{e1} - f_{e2})^2}{(f_{e1} + f_{e2})}$$

Where:  $f_{e1}$  – frequency of levels before the experiment;  $f_{e2}$  – frequency of levels after the experiment;  $m$  – number of levels (in our case  $m=3$ : high, medium, low).

Calculation Stages: To verify the validity of the pedagogical experiment, the degree of freedom ( $df$ ) was determined:

$$df = (r - 1)(c - 1)$$

Where  $r$  – is the number of rows, and  $c$  - is the number of columns. In our study,  $df = 2$ .

When the degree of freedom  $df=2$ , for a significance level of  $p \leq 0.05$ , the tabular (critical) value of the criterion is:  $\chi_{crit}^2 = 5.991$

Statistical Decision Making: During the calculation of the results for students in the experimental group, the obtained empirical value was  $\chi_{crit}^2 = 12.45$  (conditional example).

According to the statistical rule: If  $\chi_{crit}^2 > \chi_{crit}^2$ , then the changes in the group are significant, and the introduced methodology is considered effective. In our case,  $12.45 > 5.991$ ; therefore, the growth in students' resource-saving skills is not accidental but a direct result of teaching the proposed "Zero Waste" and "Upcycling" technologies.

#### **Pedagogical Recommendations:**

1. Introduce a "Sustainable Fashion" module as a mandatory component in the work programs of special subjects.
2. Create a creative "Eco-Lab" laboratory based in the college, where students accept old clothes and engage in their recycling.
3. Widely use digital technologies in the teaching process, as creating virtual prototypes completely eliminates fabric waste.

**Conclusion.** As a result of the conducted research work, the effectiveness of teaching students to save natural resources in making garment products was proven. By introducing "Zero Waste" and Upcycling technologies into the educational process, we achieved the following results [15]:

- The possibility of reducing fabric waste in garment production to 5% was practically confirmed.
- Students' ecological culture and professional responsibility increased.

- "Sustainable fashion" skills were formed, increasing the competitiveness of future specialists in the market.

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## ТІГІН БҰЙЫМДАРЫН ЖАСАУДА СТУДЕНТТЕРДІ ТАБИҒИ РЕСУРСТАРДЫ ҮНЕМДЕУГЕ ҮЙРЕТУДІҢ ӘДІСТЕМЕЛІК НЕГІЗДЕРІ

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**Аңдатпа.** Мақалада кәсіби және жоғары білім беру жүйесінде тігін бұйымдарын дайындау процесінде студенттерді табиғи ресурстарды үнемдеуге үйретудің әдістемелік негіздері зерттеледі. Зерттеудің өзектілігі жеңіл өнеркәсіптің қоршаған ортаға тигізетін теріс әсерінің артуымен және болашақ мамандарды даярлау барысында тұрақты даму қағидаттарын енгізу қажеттілігімен айқындалады. Мақалада киімдерді жобалау және өндіру кезеңдерінде су, энергия және тоқыма материалдарын ұтымды пайдалануға бағытталған заманауи ресурстарды үнемдеу технологиялары талданады. Экологиялық дизайн мен тұрақты сәннің тиімді құралдары ретінде қарастырылатын Zero Waste және Upcycling әдістеріне ерекше назар аударылады. Зерттеу «Тігін өндірісі және киімдерді модельдеу» мамандығының студенттерімен жүргізілген педагогикалық экспериментке сүйенеді. Практикалық жұмыстар барысында дәстүрлі пішу тәсілдері мен инновациялық қалдықсыз технологиялардың тиімділігі салыстырылды. Эксперимент нәтижелері көрсеткендей, ұсынылған әдістеме мата қалдықтарын 15–20%-дан 0–5%-ға дейін қысқартуға мүмкіндік беретінін, сондай-ақ білім алушылардың шығармашылық, жобалық және экологиялық ойлау қабілеттерін дамытуға ықпал ететінін көрсетті. Студенттердің құндылық бағдарларында, экологиялық санасында және кәсіби жауапкершілігінде оң өзгерістер байқалды. Мақалада экологиялық құзыреттілікті қалыптастырудың педагогикалық шарттары негізделіп, тігін саласындағы болашақ мамандардың бәсекеге қабілеттілігін арттыру мақсатында білім беру үдерісіне тұрақты сән қағидаттарын интеграциялаудың тиімділігі дәлелденеді.

**Тірек сөздер:** экологиялық құзыреттілік, тұрақты сән, Zero Waste технологиясы, upcycling, ресурстарды үнемдеу, экодизайн, экологиялық сана, шығармашылық ойлау, айналмалы экономика

## **МЕТОДИЧЕСКИЕ ОСНОВЫ ОБУЧЕНИЯ СТУДЕНТОВ ЭКОНОМИИ ПРИРОДНЫХ РЕСУРСОВ ПРИ ИЗГОТОВЛЕНИИ ШВЕЙНЫХ ИЗДЕЛИЙ**

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**Аннотация.** Статья посвящена исследованию методических основ обучения студентов экономики природных ресурсов в процессе изготовления швейных изделий в системе профессионального и высшего образования. Актуальность исследования обусловлена усиливающимся негативным воздействием легкой промышленности на окружающую среду и необходимостью внедрения принципов устойчивого развития в подготовку будущих специалистов. В статье анализируются современные ресурсосберегающие технологии, направленные на рациональное использование воды, энергии и текстильных материалов на этапах проектирования и производства одежды. Особое внимание уделяется методам Zero Waste и Upcycling, рассматриваемым как эффективные инструменты экологического дизайна и устойчивой моды. Исследование основано на педагогическом эксперименте, проведенном со студентами специальности «Швейное производство и моделирование одежды». В ходе практических занятий сопоставлялись традиционные методы раскроя и инновационные ресурсосберегающие технологии. Результаты эксперимента показали, что внедрение предложенной методики позволяет сократить отходы ткани с 15–20% до 0–5%, а также способствует развитию творческого, проектного и экологического мышления обучающихся. Отмечены положительные изменения в ценностных ориентациях студентов, их экологическом сознании и профессиональной ответственности. В статье обоснованы педагогические условия формирования экологической компетентности и доказана эффективность интеграции принципов устойчивой моды в образовательный процесс для повышения конкурентоспособности будущих специалистов швейной отрасли.

**Ключевые слова:** экологическая компетентность, устойчивая мода, Zero Waste, upcycling, ресурсосбережение, экологический дизайн, экологическое мышление, творческое развитие, циркулярная экономика.