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Abstract. By surveying 95 students studying design and technology in the light industry, the problems in mastering upcycling technologies were explored, and ways to overcome them were outlined. The analysis of existing problems is carried out at three levels - personal perception of upcycling, the formation of relevant skills and knowledge and lack of experience in scaling personal expertise to a business startups level. All respondents are roughly divided into those who practice upcycling frequently and those who do it occasionally. Another 15% of respondents did not decide on their preferences. Respondent attitude, control of behaviour, and behavioural intentions are the most influential factors that encourage upcycling. The influence of social factors, perceived habits and the presence of facilitating conditions is more moderate. Interviewed students have a poor understanding of the benefits of upcycling. Competence for creativity, which is key to mastering upcycling techniques, is absent in educational and professional programs in technology and design. Several examples of possible changes in curricula from 4 disciplines aimed at the formation of creativity are given. The main reasons that complicate the scaling of acquired skills and knowledge in developing business startups with upcycling are analysed. An example of a designed startup is given.

1. Introduction

New economic ideas and models, which implement the principles of the circular economy and aims to achieve conditions for sustainable development, are gradually conquering the world [1]. In implementing the concept of sustainable development, the economic system can recover, and its impact applies to virtually all sectors of economic activity. Fundamental transformations are taking place and are yet to take place in terms of the effects of economic activity on the environment. These are the development of renewable energy [2, 3]; energy-saving [4, 5]; improvement of water supply and water treatment [6, 7]; spread of green chemistry technologies [8, 9]; widespread use of natural medicines [10, 11] or the development of new drugs from natural raw materials [12].

One of the critical problems is optimal disposal and, if possible, reuse of waste [1, 3]. The global fashion industry annually produces 4% of the world's waste, a whopping 92 million tons [13]. In the UK and the US, consumers annually accumulate about 28 kg and 30 kg of textile waste, respectively [14]. Clothing is a very symbolic product, often a sign of high social status [15]. Consumers want to buy clothes as often as possible. Mass clothing trends provide low quality and inexpensive clothing. Therefore, consumers can buy more clothes and throw away

old clothes more often, not because they are worn out, but because they are outdated. Seasonal trends in fashion mean that clothes age very quickly. This pace encourages the replacement and disposal of obsolete but high-quality clothing. Most mass fashion clothing is inorganic or synthetic. Such substances are not able to decompose appropriately in the environment and eventually pollute the water. In the United Kingdom, one of the world leaders in waste recycling, only 30-40% of textiles or clothing is recycled, while the rest remains in the environment. In addition to direct pollution from textile waste, carbon emissions have a significant impact [16,17].

Knowledge of sustainable development principles is concentrated in large industries and disseminated to small and medium enterprises [1]. It must be included in academic and professional training. Universities concentrate the intellectual forces of nations through scholars' knowledge and expertise [18]. Accordingly, the role of higher education in promoting the ideas of the circular economy and the formation of ethical standards for the reuse of products is difficult to overestimate. This role will consist both in the introduction of new organisational forms that enhance the effectiveness of educational activities [19], and in bringing the content of educational programs to the requirements of professional activity in terms of sustainable development [20–22]. A broad bottom-up movement in the transition to circular models will occur only if small and medium-sized enterprises hire graduates with the economic and technical knowledge to change business models.

In Ukraine, some progress has been made in implementing sustainable development in technological and professional education, and however, implementation is still inconsistent and fragmented. After analysing the training programs in Professional Education in various specialisations and specialities, it was found that the competencies of graduates required for sustainable production are not provided at the level of approved standards of higher education in Ukraine. As a result, students have specific gaps in knowledge.

The competencies that future specialists should master are listed in the relevant standards of higher education in Ukraine. Students enrolled in training programs for technology education specialising in textile technology have to:

a) be able to implement effective methods of work organisation following the requirements of environmental safety;

b) be able to design and manufacture modern clothing for various purposes;

c) be able to organise the educational process in the disciplines of sewing in vocational education colleges;

d) know the methods of optimising materials usage and reducing waste during the manufacture of new products.

All the listed knowledge and skills belong to the requirements of a linear economy, while there are no skills that need a circular economy model. A whole layer of knowledge about existing and promising approaches and technologies is ignored. The ignored technologies are aimed at waste administration, both at all stages of production and the stage of use and subsequent disposal of used products. First of all, we should mention the technologies of recycling and upcycling. At the same time, there is a steady demand from stakeholders for professionals with these technologies. It is necessary to introduce such skills into the educational process of technology education in Ukrainian universities to train specialists capable of working in a stable environment according to modern circular economy models.

The article aims to formulate existing problems and explore ways to form the necessary competencies of future technologists and designers of the light industry, which will provide knowledge and skills on waste disposal of fashion industry products and work in the business environment of circular economy models.

2. Materials and methods

2.1. Sample of respondents

The research was conducted at the Faculty of Fashion Industry of Kyiv National University of Technologies and Design (KNUTD) with students of different years of enrolment from 2014 to 2017. Students studied in two educational programs aimed at training engineering and pedagogical specialists for the light industry. The number of students in the groups varied from 15 to 25 people. A total of 95 people took part in the survey. One part of the students minored in textile technology, and the other - in textile design.

Opportunities for the introduction of skills in working with waste textile production and used textile products were assessed in the process of teaching two disciplines, "Creative learning technologies" and "Fundamentals of engineering and pedagogical creativity."

With a volume of 180 h (6 ECTS credits), the first discipline included 54 h of lectures and 76 h of practical work. The second had a volume of 270 h (9 credits), including 44 h of lectures and 66 h of practical classes. The problem situation development method (PBL) and the project-based method (PjBL) were actively used. These methods are described in many works [23–26]. Their application in the context of the study is described in more detail in [27, 28]. The programs of both disciplines were supplemented with new lectures and practical classes to master the main components of PBL and PjBL methods. Mandatory development of an independent project was included in the discipline's curriculum as an individual research task. Students began developing real projects in the eighth semester and completed them over eight weeks.

Students participated in a survey to determine personal motives for participating in activities related to processing raw materials. The survey was conducted according to the principles of the combined model of Theory of Interpersonal Behaviour (TIB) [29] and Theory of Planned Behaviour (TPB) [30]. The main principles of the combined model and the questionnaire used are described in [31–33]. A 7-point Likert scale was used for the answers [34]. A 7-point Likert scale ranges from one extreme to another, like "extremely likely" to "not at all likely." As an example, we can say that such a scale includes options: strongly disagree; disagree; somewhat disagree; either agree or disagree; somewhat agree, agree, agree entirely.

The advantages of the 7-point scale are that: it is the most accurate scale among other Likert scales; it is easy to use; it better reflects the true assessment of the respondent. At the same time, as a disadvantage, it is known that previous questions may influence the respondents' answers. When analysing the results, mode (the number of times something happens) indicated the most common response to each statement, and the average - the overall average answer.

The responses were analysed by employing descriptive statistics, correlation analysis and non-parametric statistics for comparing groups. Statistical Package IBM SPSS ver.21 was used.

2.2. Theoretical background

The fashion industry promotes mass and fast consumption. People buy clothes to wear for a short period. Then these clothes quickly turn into textile waste. At each stage of the life cycle of a textile product, a massive amount of waste is generated. The waste consists of end-of-life material that is usually disposed of with other trash, polluting the environment. Textile waste can be classified into three categories [13].

(i) Residues of any manufacturing process in the textile and garment industry, such as pieces of fabric, yarn, leather, etc. Such waste can be called textile waste before consumption.

(ii) The second type is called textile waste after consumption. These are clothes that have lost their attractiveness or their functional properties or have collapsed. Clothes waste is often shipped and sold second-hand in developing countries.

(iii) The third category is post-industrial textile waste (gases, liquids,solids, etc.) formed during production processes as by-products.

Waste before consumption is more accessible to recycle than waste after consumption [15]. Production waste can be collected at the factory and reused together with primary materials for yarn production. This practice is more common than the use of post-consumer waste. But the problem is that the amount of waste after consumption is excessive and constantly increasing. This problem is unlikely to be solved entirely as long as designers in developing their products will not "embed" the possibility of their reuse, style change, design change, and build the option of re-production in the design of all products.

Business models of the circular economy can be divided into those that contribute to the reuse and extension of service life through repair, restoration or modernisation. And also on those that turn old goods into new ones by various types of material processing or recycling [1]. Many definitions characterise the types of recycling of materials and things [31, 35]. In the context of this work, we will use the following definitions.

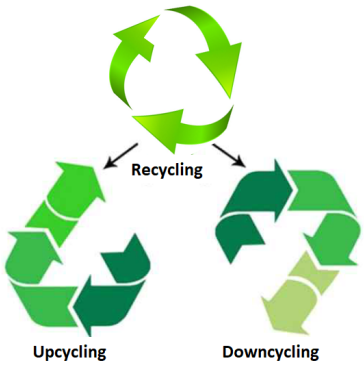

Figure 1. Diagram illustrating different types of recycling.

Recycling is a method of reusing or recycling used clothing, fibrous materials, and waste materials in the production process. As illustrated in figure 1, recycling can go one of two ways, as they differ in results obtained. The first way is downcycling when receiving the substance of lower quality due to recycling. Such a substance can be processed into a more inferior quality product. As a rule, the decrease in quality is due to the nature of the material, which does not allow it to retain its original shape and primary properties during processing. For example, the plastic obtained from the processing of plastic bottles is weaker, and secondary metals have more harmful impurities than similar primary metals. In this way, used clothes can be processed into non-woven textiles, building insulation, rags or carpeting.

Otherwise, it is possible to use the object without compromising the quality of the material from which it is made. This path, called upcycling, can be illustrated as upward processing as opposed to downcycling, where downward processing takes place. Upcycling should be considered primarily as a process of reconstruction. In other words, it creates an original waste product that usually has a higher retail cost than traditional recyclables. You can use different raw materials for upcycling - both waste before and after consumption or a combination thereof.

The process of downcycling, in most cases, can be imagined primarily as a technological process. Conversely, the upcycling process is hardly possible without a vital design component. Accordingly, the role of designers and technologists of textile products is crucial for upcycling textile materials and products. For this reason, in the future, this work will focus on the problems of upcycling in the first place.

Although upcycling is not always separated from other types of recycling, a significant difference is the additional energy consumption. Upcycling does not require processing and therefore does not require extra energy. It can be positioned between reusing and recycling. Thus, waste upcycling is one of the most sustainable circular solutions among waste disposal strategies.

3. Results and discussion

Creating business models in the fashion industry based on circular economy principles has at least three different dimensions. The first is related to personal characteristics and psychological motivation for the use of upcycling technologies. The second dimension is the availability and development of individual skills, knowledge and skills in upcycling. The third level is the knowledge and skills needed to apply upcycling technologies in the business environment.

The following three sections of this chapter will be devoted to analysing the availability and ways of developing competencies for each of the three listed dimensions of the problem of mastering upcycling technologies.

3.1. Psychological motivation

The deepest level that shapes a person's attitude to upcycling, as already mentioned, is the level associated with a person's characteristics. This dimension has been studied in detail in the works of K. Sung [31,32,34–37], which in turn took as a basis the known theories of interpersonal behaviour [29, 30, 38, 39]. Unlike other models of interpersonal behaviour, the Triandis' TIB model is known for its broad applicability [33]. In addition, this model is inclusive and therefore is the complete socio-psychological theory of behaviour and change.

The TIB model was modernised considering other theoretical ideas in [31, 32, 34]. The scheme illustrating the updated model of TIB [29] using the elements of TPB [30] is shown in figure 2. According to this scheme, TIB identifies three main factors that shape the probability of behaviour on the one side. They are the behaviour intention, the strength of habits, and the presence or absence of hindering or facilitating conditions. Habits are measured by the number of attempts to act [29]. Facilitating conditions are, for example, tools, products, materials or other favourable things or their absence. An indicator frequency of upcycling, how often the person resorted to the practice of upcycling, characterises behaviour for the other side.

In turn, behaviour intentions are formed under attitude, social factors, and perceived behaviour control. Attitude is formed by perceived consequences and the value of the consequences. Perceived consequences refer to the subjective probability that inevitable consequences will follow certain behaviours. The value of the consequences characterises the degree to which a person responds to the actual consequences, both good and bad [29]. If the expected and already experienced consequences are positive, they play the perceived benefit role. This case is illustrated in figure 2. The emotions also influence attitudes that a person feels when thinking about their behaviour. They can also be either positive or negative.

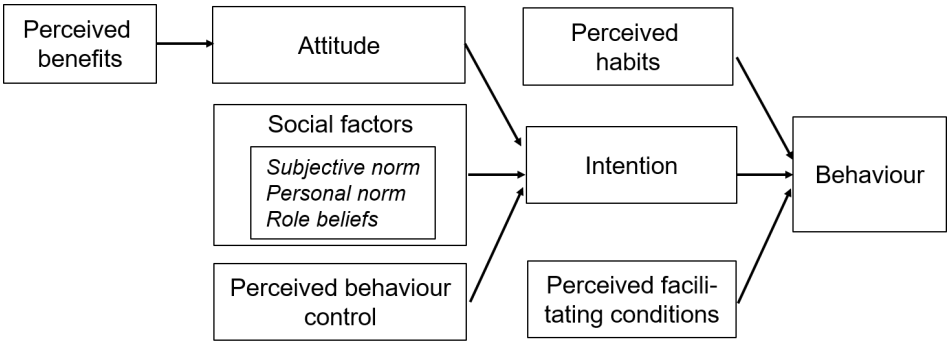

Figure 2. Combination model of Theory of Interpersonal Behaviour and Theory of Planned Behaviour after [31, 32, 34].

The TIB model illustrates social factors with three elements: subjective norms, personal norms, and role beliefs (figure 2). Subjective norms are the belief that a particular behaviour is correct, appropriate, or desirable. Roles are sets of behaviours considered acceptable to those who hold certain positions (e.g., parents, leaders, etc.) in the group. Personal norms are a person's idea has about oneself. In other words, it is a self- concept.

Behaviour intentions are also formed under the influence of perceived behaviour control, as it follows from the model [30] and is taken into account in the modernised scheme in figure 2. This factor refers to the control over the implementation of certain behaviours.

Obviously, concerning waste recycling, the factors influencing behaviour will include the benefits that recyclers receive, the social factors they consider relevant, the emotions associated with recycling, the experience of previous activities. The benefits can be economical (cost savings), environmental (waste reduction), psychological (well-being) and socio-cultural (recognition and evaluation by others). It is also essential to have favourable conditions, such as access to tools or lack of appropriate means. Social factors included social norms such as ecological awareness, roles such as being "helping and correcting", and self-identification as an ecologist.

A survey of future technologists and designers of the light industry was performed to determine the probable behaviour in upcycling matters and the main factors that shape this behaviour. The questionnaire was developed for use within the scheme in figure 2 in [32]. The questionnaire questions are grouped into ten blocks according to figure 2. The answers allow us to assess the attitude of respondents to the following factors:

- Perceived benefits;
- Attitude;
- Subjective norm - social factor 1;
- Personal norm - social factor 2;
- Role beliefs - social factor 3;
- Perceived behaviour control;
- Intention;
- Perceived facilitating conditions;
- Perceived habits;
- Frequency of upcycling as a measure of expected behaviour.

Respondents' attitudes towards upcycling, i.e. their expected behaviour, were determined using the indicator of respondents' frequency of upcycling practices. The results in the number of observations as a function of the frequency of upcycling are shown in figure 3. Shapiro-Wilk tests of upcycling frequency allow us to state the presence of a normal distribution of results with a probability of $p_{SW} < 0.00152$.

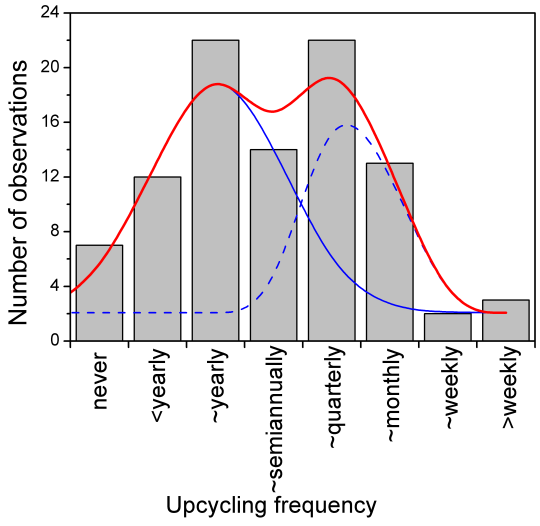

Figure 3. Distribution of the number of observations on the frequency of application of upcycling.

The bimodal nature of the distribution curve in figure 3 is evident. In other words, the sample of respondents contains two branches that partially overlap. The branch that accumulates respondents with less upcycling practice, which can be conditionally called a group of negative attitudes (n-group), is more numerous. It includes 41 respondents who, on average, practice upcycling about once a year (spread from never to once every six months). The group following active upcycling includes 40 people with an upcycling frequency of once every 1-3 months or less (positive attitude group or p-group). The remaining 14 people in their answers indicate the frequency of upcycling is about six months (0-group). So it is difficult to attribute them to supporters or opponents of upcycling. Accordingly, such respondents are grouped into a group with an as yet unformed attitude to upcycling.

The study allowed us to assess the significance of the influence of various factors on the expected behaviour. For six of the seven influencing blocks (figure 2), conclusions are made based on analysing answers to several (from 3 to 15) homogeneous or complementary questions. It gives grounds to calculate the average response rates for each block and then operate with the averages for each of the three identified groups of respondents.

The questionnaire used 15 disparate questions to assess the impact of the remaining seventh factor, namely the perceived benefits. They cannot be combined and therefore cannot be operated by averages. In this case, the analysis was performed for 15 individual questions. The most influential questions are revealed, and the characteristic answers to them are specified. We consider influential those questions, the typical responses to which exceeded the border 4 points and tended to 5-7 points.

The average survey results for the three groups (p, n and 0) are shown in figure 4a. The most influential factors were attitude, perceived behaviour control and intentions. Attitude and control factors, according to figure 2, directly affect the formation of the respondents' intentions. Their estimates of the strength of influence vary between somewhat agree and strongly agree. The greatest strength of agreement is demonstrated by group p, followed by group 0. The power of the consent of group n is always lower. In the case of assessing the factor of intent, it almost disappears to zero. It is not surprising, as this group brings together respondents with the most sceptical about upcycling.

The strength of the influence of the other three factors is much lower. Estimates of social and habitual factors are a little short of the "somewhat agree" assessment. There is no agreement for group n. The situation is reversed for the facilitating condition factor. The importance of the presence of facilitating conditions is indicated by the respondents of groups 0 and n. At the same time, the facilitating conditions are not crucial for the respondents of the group p.

The values of the expected benefits of upcycling came as a surprise. Any of the 15 benefit options did not receive at least minimal support among the group of students as a whole (figure 4b). The answers to the questions about the availability of benefits ranged from "neither agree nor disagree" to "somewhat disagree". The division of students into three traditional groups also did not reveal a significant difference between the groups and perceived benefits of upcycling.

More clear results can be obtained by identifying a group of strong recyclers, i.e. respondents who practice upcycling weekly or even more often. However, only five people can be included in this group (i.e. about 5%) out of 95 surveyed students. In other words, the vast majority of students are not aware of the possible benefits of using upcycling. At the same time, according to figure 2, perceived benefits form the value of the attitude to upcycling. If there is a positive attitude (figure 4a), most students' lack of perceived benefits looks rather strange (figure 4b).

According to the scheme in figure 2 and the obtained survey data (figure 4), the attitude and control of behaviour to a greater extent form the intentions, which in turn implies the probability of behaviour. According to the results, the role of other factors, namely social and facilitating conditions and acquired habits, is slightly smaller. Social factors and acquired habits still play a role for groups n and 0 but are almost invisible in group p. The lack of facilitating conditions is essential for groups with unformed (group 0) or restrained (group n) attitudes to upcycling but is not critical for persistent supporters (group p).

There are probably two reasons that may explain the discrepancy between the high level of attitude and the low assessment of perceived benefits. First, it is insufficient attention, unformed infrastructure and legislation on waste recycling in Ukrainian society. Accordingly, people who, for personal reasons, do not practice upcycling often and regularly do not feel the public need and are not aware of the potential benefits of such activities. Those who resort to upcycling often and regularly have realised the benefits with the help of their own experience.

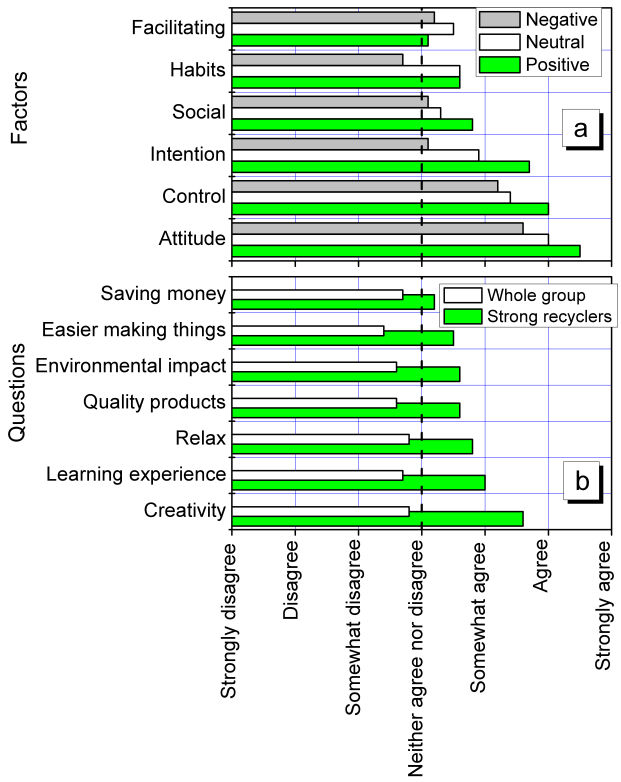

Figure 4. Degree of agreement or disagreement of respondents with the impact assessment of: a - some factors on the propensity to upcycling, b - some questions about the expected benefits.

The second reason concerns students who, by their speciality, are related to industries that produce a lot of waste. As mentioned earlier, the fashion industry belongs to such sectors. For such people, a lack of understanding of the potential benefits of upcycling indicates an education gap. In other words, the list of competencies that future technologists and designers must master does not involve the development of knowledge and skills needed to understand the importance and mastery of upcycling techniques.

3.2. Necessary changes of educational programs

Upcycling can exist on different scales, i.e. at the industrial, small business or individual level. At the personal level, upcycling is mainly becoming a way of life. It is becoming part of a variety of movements aimed at reducing waste and achieving sustainable consumption. As a result, the number of people who share information and physical resources, both online and offline, is increasing.

There are like-minded people with similar values that promote the exchange of resources, skills and knowledge on waste reuse and product development and manufacturing. Such communities form new organisational forms. Examples are training in upcycling for ordinary citizens [33], master classes for students [40], the creation of upcycling stations [41]. The upcycling station combines the functions of hazardous and bulky waste disposal, an exchange platform that allows citizens to exchange items in good conditions. In addition, such stations are permanent workshops where processing and repair work is carried out.

Due to the specifics of clothing products, upcycling in design and production is mainly applied to unique products or for minimal series by tailors or small companies. However, in organisations and communities that professionally discuss the problems of upcycling, the focus is gradually shifting from individual upcycling to the development of forms of small or medium scale [33]. New opportunities open up if we apply upcycling in the mass production of companies interested in a more environmentally sustainable solution to their problems with textile waste.

The results of several studies [42–44] indicate that there are significant differences between traditional fashion clothing and recycled clothing. These differences are formed at the stages of design and production. For effective advanced fashion design, fabric supply must occur much earlier than in standard design and production. Pattern cutting methods should take into account the variability of the fabrics supplied. Information on the availability of raw materials should be available from the outset to achieve design consistency throughout production. In addition, it is necessary to take into account the features of the national waste disposal system, which may change over time and countries [45, 46].

Establishing sustainable production can provide several competitive advantages if you integrate the value created into a single vertical chain by strengthening creativity, improving

clothing design and participating in marketing and sales. The strategy of integrating design and retail can lead to a more flexible design process and, consequently, to increased productivity.

It becomes apparent the need to create different design processes and methods for recycling and reuse of waste [33]. The integration of waste and recycling into the design process requires a change of thinking and approach. The design process depends on the type of waste collected and therefore requires constant adaptation and experimentation. In addition, the reuse of waste faces problems related to the search, transportation, treatment and storage of waste before use in the production process.

Thus, more experiments, wider use of the method of "trial and error" are fundamental conditions for the creative recycling process. For young technologists and designers to be ready for these new challenges, some changes need to be made in their training programs. This specific problem is part of a more general problem of forming the necessary competencies for students to work in the era of sustainable development [47, 48].

At this stage of development of Ukrainian education, the competence "ability to generate new ideas (creativity)" is absent in the current, approved from 2018 to 2020 state standards of higher education for bachelors and masters majoring in 022 Design, 182 Technology of Light Industry Products, and 015 Professional Education (for similar specialisations). This competence is absent in the list of general, special, professional and subject competencies. This situation means that educational components may not support the formation of creativity.

Although in the preparation and discussion of new Ukrainian standards, attention was paid to the importance of such competence [49, 50]. In particular, in the list of competencies according to employers and graduates, "the ability to generate ideas (creativity)" is referred to as general system competencies [49]. All stakeholders call it one of the most important and necessary, along with "developing an entrepreneurial spirit", "the ability to act in unusual situations", and "concern for quality".

Table 1 shows examples of the author's experience of implementing new methods and tasks to form creativity and organising sustainable production using upcycling techniques in students majoring in 015 Professional Education (minoring in Design and Technology of Light Industry Products) at KNUTD.

In the vast majority of cases, students learn upcycling at home or work. As an example, we can cite a design studio that practices waste-free production. From the remnants of fabric, employees make various items of home decor in the style of patchwork. Small remnants of materials are not thrown away but transferred to children in schools. There they are engaged in creativity in lessons of labour training or needlework circles.

The formation of the competence of graduates to work in the era of sustainable development can occur during the study of various disciplines. The analysis of foreign experience allowed one to specify the number of possibilities of introducing upcycling in the educational process. Among them are holding separate one-day workshops; development of student projects using upcycling within the study of some academic courses, such as sustainable design or apparel design [17, 33, 40–42].

Reducing waste and creating new products does not require high additional costs. However, one needs to consider the following:

1. Companies that will use upcycling technologies should worry about upgrading and using the appropriate software.
2. They should encourage the creative activity of their designers.
3. They need to enter the market and promote their products through a marketing policy that attracts environmentally sensitive customers.
4. As part of this strategy, designers need to develop a "clothing roadmap" that will offer environmentally friendly clothing and textile waste solutions.

Table 1. Examples of components of educational programs of the speciality 015 Professional education (minoring in Design and Technology of Light Industry Products) at KNUTD.

Type of activity	Description of students' activity	Purpose
Discipline:	Methods of professional training	
Practical lesson: "Setting didactic goals of professional training"	Students formulate didactic goals of vocational training on the topic, while they need to take into account the level of students' mastery of educational material	Learn not to limit the goals to the third level of knowledge; plan tasks so that students try to make non-standard solutions
Discipline:	Fundamentals of engineering and	pedagogical creativity
Practical lesson: "Methods of solution of creative problems: SCAMPER"	Students choose a garment and make sketches of possible uses for another purpose	Development of creative thinking to predict possible transformations and new applications of products
Homework: "Sewing Upcycling"	Students choose a used garment or knitwear and change it to meet current fashion trends	Get experience in upcycling a garment or knitwear
Individual task: Development of a project to organise upcycling light industry products in the community	Students study the complete cycle of individual project development incl. purpose, tasks, plan, terms of realisation, budget, result publishing	To form skills and abilities to develop projects aimed at upcycling light industry products in different types of communities
Discipline:	Fundamentals of clothing design	
Individual task: Development of a fashionable image for participation in the Chestnut Constellation competition	Students develop a fashionable image following the requirements of the Chestnut Constellation competition. Participate in the one image contest	To form abilities and skills of development of a fashionable image, using techniques of upcycling
Discipline:	Creative learning technologies	
Practical work: Development and implementation of webinars	Students develop a script and independently conduct a training webinar - a master class on using one upcycling technique	Develop skills and abilities to arrange webinars to teach a range of upcycling techniques

3.3. Example of a start-up project

The content of previous considerations concerns an individual - from the motives of his behaviour to the acquired skills and abilities. Accordingly, the acquired knowledge is essential for understanding human behaviour, for example, in the development of its social activity, participation in social movements and activities in social networks [33].

However, the acquisition of personal skills is one thing, and another is the acquisition of skills in real life and the implementation of these skills in business projects. Upcycling is essentially a social movement that can be converted into a means of achieving sustainable development. However, it needs support from below at the level of individuals and above at the government and business levels. It is necessary to create a prototype of the proposed interventions that would help

scale up the movement for textile waste processing at the next stage. In this case, upcycling, in addition to the popular social activity, will increasingly acquire the features inherent in business models. The main advantage of such constructions is the possibility of embedding upcycling technologies in business models capable of working in a circular economy (figure 5).

Under the conditions of higher education institutions, continuing education is carried out during the students' independent research. Student research allows one to acquire the knowledge and experience needed to scale upcycling from a social activity to independent business projects.

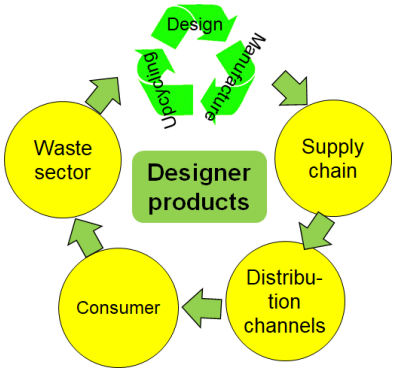

Figure 5. Circulating business model using upcycling of textile waste.

Opportunities for the development of student research are illustrated by the example of the start-up project "Designer Products from Textile Waste: Creation and Sale". The initial goal was to assess the possibility of creating a company that focuses on the processing of used clothing and textiles to develop new products. To achieve this goal, the essence of textile waste and critical problems in this area were identified.

The Lean Canvas business plan template created by Ash Maurya was used to develop the project's business model. The template helps to state the main idea in its fundamental assumptions, using nine basic blocks [51].

This template was adapted from Alex Osterwalder's Business Model Canvas [52]. It was optimised for the Lean Startup methodology with a strong emphasis on finding customer issues that need to be addressed.One of the main advantages of Lean Canvas templates is their excellent flexibility allowing quick changes and updates of business project parameters. Blocks 2, 4, 7 and 8 characterise the product under development (figure 6). The expected market conditions are described in blocks 1,3, 6 and 9. Block 5, one of the key ones in the scheme, is relevant to both the product and the market environment.

<table>
<tr><th colspan="3">Product</th><th colspan="2">Market</th></tr>
<tr>
<td rowspan="2">2. Problem
97% of textile waste goes to landfills and remains a source of pollution. There are thousands of vulnerable people in Ukraine: women with disabilities and unemployed young single mothers</td>
<td>4. Solution
The organisation of sewing workshops where unemployed and other vulnerable people will work and create new products by recycling textile offcuts</td>
<td rowspan="2">5. Unique value proposition
Reducing the amount of textile waste that goes to landfills. Providing work for people in need of special social protection</td>
<td>9. Unfair advantage
Special technologies, affordable prices, the client database</td>
<td rowspan="2">1. Customer segment
Clients aged 35 - 60 years, primarily female gender who concerned about the environment and ethical products</td>
</tr>
<tr>
<td>7. Key metrics
Sales revenue, net profit, employee happiness, customer acquisition cost, monthly website traffic</td>
<td>6. Channels
Social networks, online store, retailer network</td>
</tr>
<tr>
<td colspan="3">8. Cost structure
Purchase of equipment, rental of premises, marketing channels, staff salaries, costs for carriers and textile waste suppliers</td>
<td colspan="2">3. Revenue streams
Revenue from sales of products, repair and reuse service, participating in new projects, government subsidies and private grants</td>
</tr>
</table>

Figure 6. The Lean Canvas business model plotted using the template from [51]. It illustrates the implementation of the project "Designer Products from Textile Waste: Creation and Sale".

According to the business plan, a line of products for different target segments of customers is planned for production by recycling textile waste and used textiles. The product line includes:

1. Designer clothes: dresses, skirts, blouses, bathrobes, uniforms.
2. Designer accessories: bags of different sizes, organisers for bags, aprons, garden and oven gloves, scarves, shawls, smartphone cases, etc.

A temporary or preliminary solution is opening a garment workshop to upcycle clothes and textile waste to create new products. The first stage of the project - to start sewing products from textile cuts; promote these goods on the market (social events, fashion shows); study sewing technologies from textile scraps; sell textile scrap products through online channels.

The long-term solution is to create a company that can provide a full-cycle process from collecting and upcycling textile waste to creating designer environmentally friendly recyclable products at reasonable prices, design and quality. The undeniable advantage of such products will consist in reducing the amount of textile waste. In addition, people who need special social protection will be able to get a job.

The development and subsequent implementation of similar projects will play an essential role in gaining professional experience by future technologists and designers of the textile industry in the functioning of circular economy models.

4. Conclusions

1. Through a survey according to the combined model of Theory of Interpersonal Behaviour and Theory of Planned Behaviour, the personal motives of students of technology and designers regarding their participation in activities related to the processing of raw materials are determined. According to the frequency of application of upcycling techniques, all respondents have divided approximately in half. The division is between those who practise them regularly (once per 1-3 months or more often) and those who use them infrequently (once a year or less). About 15% of respondents did not decide on their preferences.
2. Regarding the prospects of introducing upcycling technologies in future professional activities, there are problems at three levels - personal perception of upcycling, the formation of relevant skills and knowledge and lack of experience in scaling personal expertise to the level of business startups.
3. Factors influencing the commitment to the use of upcycling are identified. The most influential is one's attitude, control of behaviour and formed intentions. These factors shape the behaviour of all defined groups, regardless of the frequency of application of upcycling techniques. The influence of social factors, perceived habits and facilitating conditions is more moderate. It affects the behaviour of people who are more prone to upcycling and has almost no effect on indifferent people.
4. The contradiction between the high level of attitude and low evaluation of students' perceived benefits is revealed. Most students have a poor understanding of the benefits of upcycling. People who, for personal reasons, do not practice upcycling often and regularly do not feel the public need and are not aware of the potential benefits of such activities. An important reason for this attitude is the education gap.
5. A lack of attention to the development of competence "creativity" presents in the current higher education standards in the relevant fields of knowledge. Meanwhile, generating ideas is key to mastering upcycling technology by textile industry specialists.
6. Examples of possible changes in the curricula of disciplines "Methods of professional training", "Fundamentals of engineering and pedagogical creativity", "Fundamentals of clothing design", "Creative learning technologies", aimed at the formation of creativity, have already passed practical testing at KNUTD.
7. The main reasons that complicate the scaling of acquired skills and knowledge in developing business startups with upcycling are analysed. An example of the developed startup project "Designer Products from Textile Waste: Creation and Sale" is given.

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