Understanding and attitude toward upcycling according to the survey of students of various specialities

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Understanding and attitude toward upcycling according to the survey of students of various specialities

T M Derkach[1], M M Bilianska[1] and O G Yaroshenko[2]

[1] Kyiv National University of Technologies and Design, 2 Mala Shyianovska Str., Kyiv, 01011, Ukraine

[2] Institute of Higher Education of the NAES of Ukraine, 9 Bastionna Str., Kyiv, 03056, Ukraine

E-mail: derkach.tm@knutd.edu.ua, mary_skiba@ukr.net, yaroshenko_o@ukr.net

Abstract. The attitude to upcycling technologies of undergraduate students of five specialities (design, clothing industry technology, vocational education and training, industrial pharmacy and psychology) and their teachers was investigated using the questionnaire method. Students' preferences practically do not depend on specialities. For all students, subgroups of upcycling enthusiasts and sceptics are observed which regularly resort to upcycling or almost do not use it. An almost complete misunderstanding and imperception of the benefits and importance of upcycling is a key and common problem. Social factors have a minimal influence on the opinion of respondents, which may indicate a lack of understanding in society of the role and importance of waste management. All the shortcomings and problems in understanding upcycling are common to students and teachers. In general, the positive attitude towards upcycling and the intention to use upcycling in life in the answers most likely has an unconscious and artificial character (like a fashion trend) because the attitude towards other formative factors does not support it. The identified problems are related to the shortcomings of secondary school and undergraduate curricula, which hinder the formation of the necessary competencies for sustainable development. Methods of their solution are proposed and discussed.

1. Introduction

More than 300 universities in Ukraine educate students in more than 210 specialities (according to 2021 data) [1]. The wide variety of educational programs is due to the dynamics of economic development, which requires specialists with a high level of specialisation in various fields. At the same time, the modern world is developing towards globalisation in its various manifestations – economic, political, and cultural. An increase in the load on the environment and nature as a whole accompanies the development of industrial technologies and the constant growth of production volumes. Destruction of forests [2, 3], pollution of water [4, 5], soil and plants [6, 7] for some time was considered as an undesirable but inevitable price for rapid economic growth.

Forming a responsible attitude towards the environment has become one of the priorities in global challenges. If environmental problems were a priority only for professional ecologists a few decades ago, there has been a change in value orientations in recent years.

The concept of sustainable development was gradually developed, and the goals of sustainable development were defined at the UN level [8]. Thus, the list of spheres of human activity on which the planet's ability to support life depended significantly expanded. It, in turn, strengthened the importance of environmental literacy of the population. Ukraine supported the announced goals and adopted them, considering national interests. At the state level, it is recommended to view them in determining the directions of scientific research until 2030 [9].

A tool for achieving sustainable development goals is education for sustainable development and lifelong learning, which is focused on the formation of values and motivation to act for sustainable development [10, 11]. Such transformations concern both personal life and societal actions on a global scale. The consequence of education for sustainable development should be to increase knowledge about the problems of sustainable development, educate people who can think critically and systematically [12], implement innovations and propose solutions for more sustainable models of life.

Since educational activity is very broad, forming an attitude towards sustainable development should begin from childhood, initially focusing on constructing basic concepts. For many years, this issue was not given enough attention in Ukraine. Only in 2020, a new standard [13] was adopted, which provides for the necessary elements in the secondary school curriculum, including the formation of environmental competence as one of the key ones [14]. However, the consequences of its implementation will be analysed no earlier than five years when the first graduates will appear.

Continuing education for sustainable development should take place in higher education. Depending on the field of study, immediate attention should be paid to those sustainable development goals that are a priority for that field. Two previous works were devoted to the problems of engineering education for sustainable development [15–17], and this work further develops the obtained results. Sustainable technologies and materials are a priority for engineering education. Accordingly, the focus should be on the economical production and consumption of resources and energy, waste management, and sustainable consumption and production models.

Attention has been paid to the problem of waste management for a long time. But, with the development of the concept of sustainable development, the focus of research has shifted towards better and more efficient consumption of waste. The standard term recycling, i. e. waste processing, has been divided into two or even three terms, recycling, downcycling and upcycling [18]. At the same time, the term recycling continues to be used in a general sense to define the processing of products without specifying the technology used.

In general, downcycling means reducing quality and cost, recycling in a narrow sense corresponds to keeping them at the same level, and upcycling means increasing quality. In the first case, the price of processed waste is lower than the original cost of the processed material. In the latter case, on the contrary, the cost of recycled materials may be higher than the original cost. The last type of processing has a significant advantage over the first but simultaneously requires using more complex technologies and developing the latest technological processes.

For example, the processing of plastic waste has long followed downcycling technologies, which include, for example, grinding the waste into pellets and its subsequent use as backfill and other simpler applications. In the case of upcycling, the use of biotechnology in combination with chemical technologies makes it possible to increase the value of the used product during the recycling process, for example, to obtain valuable chemical compounds from plastic waste [19,20].

Waste recycling is critical for the textile and clothing industry [21]. The textile industry ranks fourth in terms of environmental impact after the housing, transport and food sectors [22]. Among the industrial sectors, the textile sector ranks second in the world in terms of global carbon emissions (10%) and volume of wastewater (20%) [23]. Global fibre production has recently doubled, from 58 million tons in 2000 to 109 million tons in 2020 [24]. Approximately 63% of world consumption is synthetic fibres, 25% cotton, 7% and 5% wood, and other natural fibres [23].

Two types of textile waste are usually distinguished: those generated during production (pre-consumer waste) and those generated after consumer use (post-consumer waste). Pre-consumer waste is believed to be easier to recycle because its nature and form of existence, fibre, yarn or fabric scraps are known precisely.

Post-consumer waste is usually more complicated due to textile waste's heterogeneity and complex nature. Different substances (natural, synthetic, organic and inorganic fibres) make processing economically tricky. Therefore, there are several ways to recycle [23]. In some cases, it is possible to use facilities for processing waste before consumption. The second approach is mechanical processing, which includes grinding without considering the type of fibres that make up the fabric. The third is chemical treatment aimed at depolymerisation and obtaining oligomers and monomers for further use as raw materials. Finally, energy recovery is one way of recycling, and it seeks to restore the energy content of fibre by burning or fermenting some types of textile waste.

New technologies open up new prospects for waste disposal, as they allow one to obtain more valuable products, that is, to implement the ideology of upcycling. This problem is still among the primary issues and awaits its solution by involving various chemical and biochemical processes, such as pyrolysis [25]. For example, biotechnology and advanced chemical technologies, including green chemistry technologies, transform cotton textile materials into glucose and further into biobased building blocks [26]. Textile fibrous waste is transformed into a harmless secondary raw material for potential environmentally friendly applications in building materials, and geotechnical engineering [23].

However, only a tiny percentage of textile industry waste is reused or recycled worldwide [24]. For example, in the United States of America, only 15% of fibre waste is reused; in China and Japan, it is about 10% and 13%, respectively. In Europe, the situation is better; Germany recycles almost 66% of used textile fibre.

Clothing industry waste (primarily post-consumer waste) feels additional pressure from this market's supply and demand balance. Supply and demand are constantly balanced at an increasingly high level, and demand is continuously increasing due to population growth and living standards improvement. In addition, the demand is accelerated due to the annual market entry of cheap textile products (artificial fibres and materials already account for two-thirds) and the fashion industry's influence, when fashion trends change faster and faster. As a result, over-consumption becomes increasingly apparent, with some textile items ending up in landfills before at least one use [27]. Excessive consumption contrasts with the goals of sustainable development. However, it takes a long time to solve this problem.

In turn, growing demand accelerates supply. However, waste management in the ways described above takes some clothing products out of circulation, diverting recycled materials to other industries. Therefore, designer upcycling is promising, so to speak, when a used thing does not go out of circulation but continues to serve its original purpose without additional energy and material costs [28]. To implement such an approach, when opportunities for further upcycling are laid at the design stage, it is necessary to develop the appropriate competencies of future specialists at the training stage.

As mentioned above, the problems of engineering education for sustainable development, namely the perception of upcycling by students of various specialities in the clothing industry, were considered in previous works [16, 17]. The current research is expanded the started topic for students of other specialities not related to the study of textiles, as well as for teachers. The work aimed to identify the problems junior students face in understanding the benefits and prospects of upcycling, research teachers' attitudes to waste management and formulate ways to overcome identified problems.

2. Materials and methods

2.1. Sample of respondents

In previous studies [16, 17], the focus was on studying the change of attitude towards the waste management problem with years of study for students specialising in vocational education and training (VET) for the clothing industry. In contrast, this study covers more majors but only concerns junior students who have not yet had special classes to develop an understanding of the importance of waste management.

One hundred thirty-two teachers and students of Kyiv National University of Technologies and Design (KNUTD) took part in the survey (table 1). The students belonged to junior undergraduate courses (mostly 1 and 2 years of study) and did not listen to special lectures related to waste management. In terms of study fields, the interviewed students belonged to five specialities. Three (design, technology and VET) belonged to education in various aspects of the clothing industry. The other two specialities were not related to the textile and clothing industry.

In addition to students, 17 teachers (professors and associate professors) who teach mainly at the Faculty of Arts and Fashion were also interviewed.

Table 1. Respondents by specialities and years of study.

Speciality	1st year	2nd year	3rd year	Subtotal
Design	21	0	0	21
Technology	35	0	0	35
VET	1	8	5	14
Pharmacy	0	35	0	35
Psychology	10	0	0	10
Teachers	–	–	–	17
Total	67	43	5	132

2.2. Survey methodology

The questionnaire used in the survey was developed in [29] according to the principles of the Theory of Interpersonal Behavior [30] and the Theory of Planned Behavior [31]. According to these models, a person's attitude to waste processing is determined by the complex action of 9 influencing factors. To assess the effect of individual elements, respondents answered 62 questions. Factors of influence and the corresponding number of questions for their determination are illustrated in table 2. A 7-point Likert scale was used to quantify the responses. A 7-point Likert scale ranges from one extreme to another, from "strongly disagree" (1 point) through neutral "neither agree nor disagree" (4 points) to "strongly agree" (7 points).

The influencing factors form an interconnected scheme that illustrates the mutual dependence of the elements on each other and the order of their action. In more detail, the procedure and assessment of the influence of individual factors are described in [16, 17].

In addition to assessing the importance of factors, respondents directly answered questions about the frequency of their use of upcycling technologies in their lives, which determined the so-called frequency of upcycling or upcycling behaviour (UB) factor. Possible choices consisted of 8 options ranging from the most frequent use (less than once a week) to the option "never". Works [16, 17] show that answers 1-3 from "less than once a week" to "once a month" are characteristic of upcycling optimists. On the contrary, answers 5-8 from "never" to "once every six months" are typical of respondents who are sceptical about applying upcycling practices.

Table 2. Cronbach's Alpha to test the reliability of a scale.

Factors	Number of items	Cronbach's Alpha
Perceived benefits (PB)	15	0.944
Attitude (At)	5	0.892
Subjective norm (SN)	3	0.669
Personal norm (PN)	3	0.794
Role beliefs (RB)	4	0.851
Social factors (all 3 factors together)	10	0.861
Perceived behaviour control (BC)	4	0.867
Intention (In)	3	0.914
Perceived facilitating conditions (FC)	15	0.894
Perceived habits (PH)	10	0.811

2.3. Statistical processing of results
Statistical analysis of the results was performed using the software package IBM SPSS version 21 [32]. Descriptive statistics were applied for the results' general descriptions, calculating the mean and median values, standard deviations and standard errors (SE). The significance threshold in all tests was taken as $p < 0.05$. As a preliminary step, the survey questions' consistency and the survey results' reliability were investigated by Cronbach's alpha test (table 2). Cronbach's alpha measures internal consistency between elements in a group of questions describing an influencing factor. Cronbach's alpha is a coefficient of reliability (or consistency) that indicates how closely a set of elements is linked as a group. For the factor of subjective norms (SN), Cronbach's Alpha value is close to 0.67. For all other factors, Cronbach's alpha exceeds the value of 0.79. Acceptable internal consistency is suggested for the scale if Cronbach's Alpha varies between 0.6 and 0.79. A Cronbach's Alpha value above 0.8 indicates excellent reliability. High values of Cronbach's Alpha allow us to analyse not only the results of answers to individual questions but also to operate with average values of individual factors.

Correlation analysis methods analyse the presence or absence of correlations between individual factors. As virtually all indicators are rank variables and not all factors obey normal distribution, Spearman's rank correlation coefficients were calculated in the correlation analysis.

In the analysis, the total sample of respondents was divided into separate subgroups depending on the speciality. The Mann–Whitney U test (if two groups were compared) or the Kruskal–Wallis H test (if three or more groups were compared) was used to assess the presence or absence of a statistically significant difference between the rates of individual groups. The mentioned tests are non-parametric tests for two (or more) independent ordinal type variables that allow one to determine if the distributions of both populations are equal or not.

Fitting experimental curves using nonlinear curves with the fitting parameters, function expression, constraints and determination coefficients R^2 was performed using the software package OriginLab, version 8.

3. Results
3.1. Frequency of upcycling
The only direct source of information regarding the frequency of application of upcycling methods and technologies in real life is the respondents' answers regarding the UB factor (figure 1). Respondents were offered eight options for answering this question. These responses formed a bimodal curve with two peaks corresponding to the frequency of upcycling annually

and within 1 to 3 months. Similar results were obtained in [16, 17]. The positions, heights of the peaks, and ratios vary slightly and depend on the interviewed contingent.

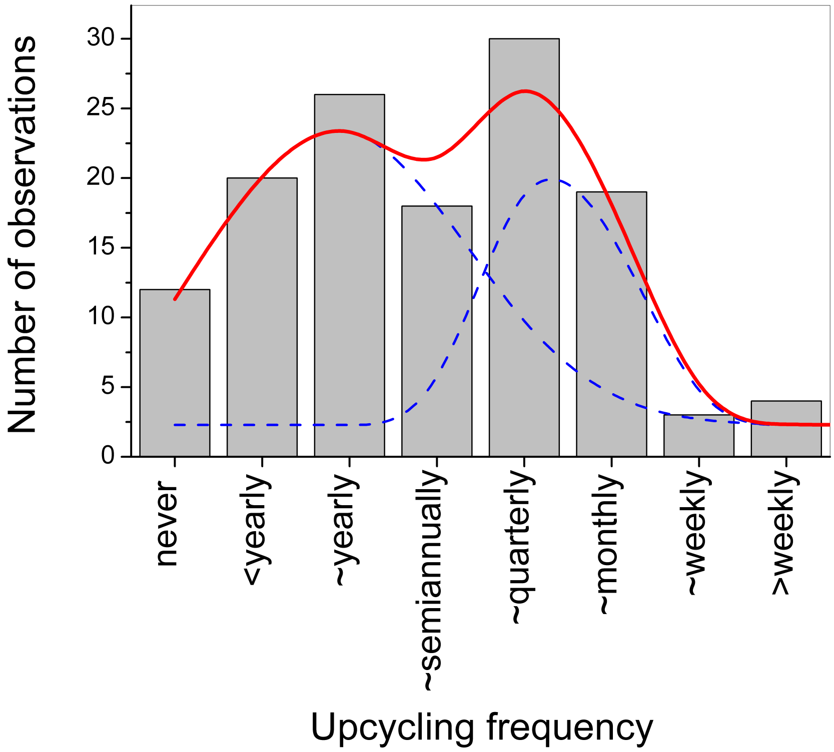

Figure 1. The number of observations vs the frequency of upcycling.

The determination coefficients of two Gaussian curves, approximating both extremes, have high values of R^2=0.98 for a left peak and R^2=0.68 for a right peak, which indicates a good agreement of the experimental data with fitting curves.

The most likely explanation for this observation is the existence of two subgroups of respondents. They are approximately equal in size in the studied cases and can be conventionally called upcycling enthusiasts and sceptics. Enthusiasts practice upcycling at least once every 1-2 months or more, and sceptics say to use it once a year or less. One can talk about some episodes, not constant meaningful use. Between these two groups, a small group of respondents claims to use upcycling once every six months. Most likely, these people have not yet fully decided on their attitude. Analysis of their behaviour may have additional complications due to the incomplete certainty of their position. The conclusion regarding the presence of different subgroups has great practical significance, as it indicates with whom educators will deal at the beginning of forming the necessary attitude to waste management. Significantly different initial beliefs of students require the use of different education methods.

The distribution of other factors according to the characteristics of respondents' answers does not show bimodality. The answers were distributed according to the strength of agreement or disagreement with the statements in the questions. So, the responses have no direct relation to the actual frequency of upcycling practices. Therefore, even if a respondent entirely agrees with the idea of starting to practice upcycling (Intension factor), this does not mean he will do it often. Thus, there is no direct agreement in the distribution of the UB factor and other factors among the individual responses. However, this does not mean that the applied model cannot correctly describe the frequency of upcycling practices. It is evidenced by the presence of

Table 3. Spearman rank correlation coefficients ρ and levels of statistical significance p (two-sided).

Factor	Value	UB	At	SN	PN	RB	BC	In	FC	PH	PB
UB	ρ	1.000	.241**	.323**	.195*	.168	.358**	.392**	-.276**	.118	.040
	p		.005	.000	.025	.054	.000	.000	.001	.178	.648
At	ρ	.241**	1.000	.339**	.285**	.461**	.460**	.467**	.132	.209*	.010
	p	.005		.000	.001	.000	.000	.000	.130	.016	.905
SN	ρ	.323**	.339**	1.000	.402**	.484**	.456**	.493**	.022	.273**	-.011
	p	.000	.000		.000	.000	.000	.000	.800	.002	.904
PN	ρ	.195*	.285**	.402**	1.000	.504**	.415**	.465**	-.029	.054	.037
	p	.025	.001	.000		.000	.000	.000	.742	.536	.677
RB	ρ	.168	.461**	.484**	.504**	1.000	.422**	.514**	-.017	.214*	-.083
	p	.054	.000	.000	.000		.000	.000	.847	.014	.343
BC	ρ	.358**	.460**	.456**	.415**	.422**	1.000	.681**	-.144	.161	.043
	p	.000	.000	.000	.000	.000		.000	.100	.065	.624
In	ρ	.392**	.467**	.493**	.465**	.514**	.681**	1.000	-.098	.180*	.110
	p	.000	.000	.000	.000	.000	.000		.265	.039	.208
FC	ρ	-.276**	.132	.022	-.029	-.017	-.144	-.098	1.000	.455**	-.043
	p	.001	.130	.800	.742	.847	.100	.265		.000	.628
PH	ρ	.118	.209*	.273**	.054	.214*	.161	.180*	.455**	1.000	-.135
	p	.178	.016	.002	.536	.014	.065	.039	.000		.123
PB	ρ	.040	.010	-.011	.037	-.083	.043	.110	-.043	-.135	1.000
	p	.648	.905	.904	.677	.343	.624	.208	.628	.123	

** The correlation is significant at $p < 0.01$.
* The correlation is significant at $p < 0.05$.

statistically significant correlations between various factors – the average values of 9 influencing factors and the upcycling behaviour of UB (table 3).

Altogether, the model predicts the presence or absence of pairwise correlations between 90 pairs of factors. Statistically significant correlations are present in 52 cases, while those are absent in the remaining 38 cases. It should be noted that the values of the correlation coefficients are usually not very high, which indicates the presence of relatively weak correlations. However, we note that the applied nine influence factors are calculated based on answers to 62 questions. Although the degree of consistency of the answers to the questions is relatively high (table 2), the correlation coefficients significantly improve when analysing the existing correlations between individual queries and not between the average values for the factors.

Some factors show a correlation with other elements in most cases. For example, the factors At, In, and SN are correlated with others for 7 of the available nine comparison pairs. Factors PN, RB, BC and UB – for 6 of the available 9 pairs. The PH factor shows the presence of correlations in 5 pairs out of 9. In contrast, the two factors show no correlations in most cases. The factor FC correlates with only two out of 9, and the factor PB shows no correlation with other elements in all cases.

As shown in [17], the factors with the most significant pairwise correlations with other factors make the main contribution to the model's predictive power. Conversely, factors with a lack of correlations can be considered as a field for analysing model weaknesses.

3.2. Individual influencing factors by specialities

This section is devoted to the central question of the article – how different aspects of attitudes towards upcycling are sensitive to the speciality studied by the respondents. The average scores of respondents grouped into subgroups by speciality were calculated for all ten factors based on the questionnaire results to clarify this issue. A general illustration of the results is provided in figure 2 – figure 5. A neutral line of 4 points is also marked for clarity, corresponding to the respondents' neutral or uncertain attitude.

The previous section proved that different factors show a different degree of correlation between themselves and the frequency of upcycling. Therefore, nine influencing factors are grouped into three groups with a high, medium, and low number of correlation (figures 2–4). The results of UB, which in their meaning differ from the influence factors, are shown separately (figure 5).

The general form of the obtained dependencies does not allow us to determine in which cases the differences between the average factors are statistically significant. The Kruskal–Wallis H test was performed to answer this question, and its results are shown in tables 4–7. The null hypothesis of the H test was that the average value for a factor has the same distribution among students of all subgroups under comparison. On the contrary, factors depend on the study's speciality if the null hypothesis is rejected (at significance $p < 0.05$).

The average values of the so-called social factors and the Kruskal–Wallis H test results are shown in figure 2 and table 4, respectively. The statements in the questionnaire are formulated in a positive tone. Therefore, respondents' agreement with the opinion developed in the question (corresponding to 5-7 points) indicates their positive attitude towards this or that aspect of upcycling. This answer hints at negativity if they do not agree (1-3 points). Thus, if the average score is above the neutral line of 4 points, we can talk about a positive perception of the effect of this factor (the higher scores, the stronger the perception). And vice versa if the average score is below the mark of 4 points.

Table 4. Testing the null hypothesis that the SN, PN and RB factors have identical distributions for the Speciality category using the Kruskal–Wallis H test.

Factor	Significance, p	Decision
SN	0.966	The null hypothesis accepted
PN	0.151	The null hypothesis accepted
RB	0.012	The null hypothesis accepted

Asymptotic significance levels are derived. The significance level is 0.05

No statistically significant difference was found between students of different specialities for all three factors. The SN values vary near the mark of 4 points, indicating an uncertainty regarding this factor's influence. Regarding the PN and RB factors, there is a slight optimism in the responses in most of the subgroups. In these cases, the respondents, to some extent, agree with the expressed opinion. The most sceptical are psychologists who take an uncertain position on all three social factors. Again, it should be remembered that the difference between

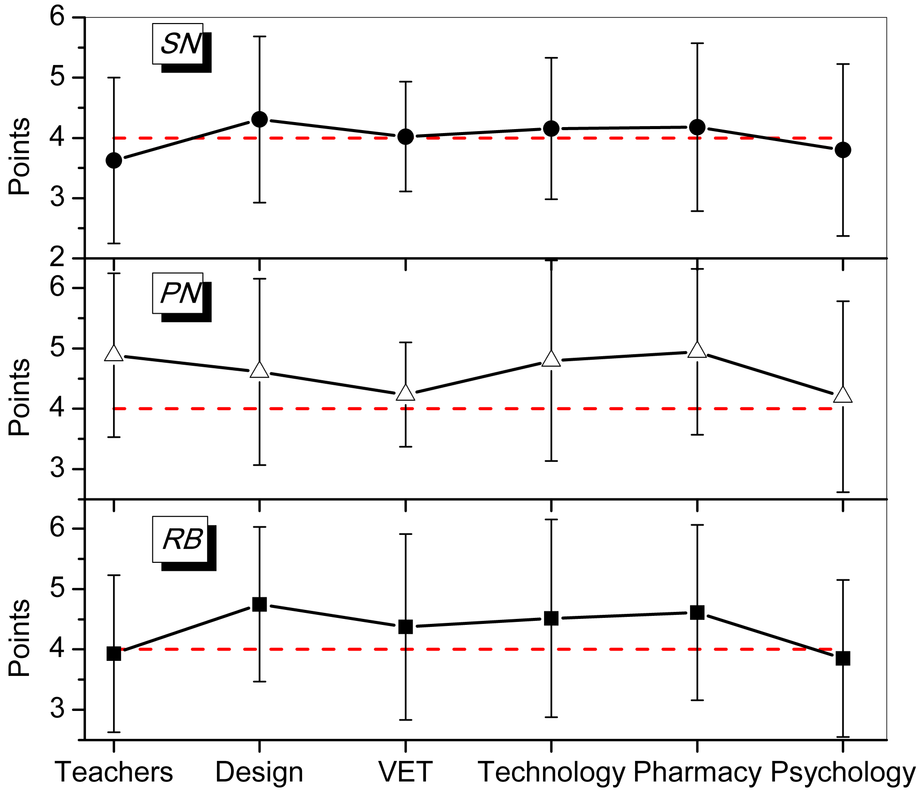

Figure 2. Average values of points for SN, PN and RB factors by specialities.

specialities is not statistically significant; therefore, the observed differences cannot be considered reliably established.

The average values of the factors PH, FC and PB, together with the Kruskal–Wallis H test results, are shown in figure 3 and table 5, respectively. These factors are characterised by the lowest correlations with other factors (table 3). For PH and FC factors, the advantage of a positive attitude is very insignificant (next to neutral). In most cases, the average score for the PB factor falls below the mark of 4 points. In addition, a statistically significant difference between the characteristics of individual specialities was found for this factor.

Table 5. Testing the null hypothesis that the PH, FC and PB factors have identical distributions for the Speciality category using the Kruskal–Wallis H test.

Factor	Significance, p	Decision
PH	0.966	The null hypothesis accepted
FC	0.151	The null hypothesis accepted
PB	0.012	The null hypothesis is rejected

Asymptotic significance levels are derived. The significance level is 0.05

The average values of factors In, At and BC and Kruskal–Wallis H test results are shown in figure 4 and table 6, respectively. These factors indicate the most significant correlations with others (table 3).

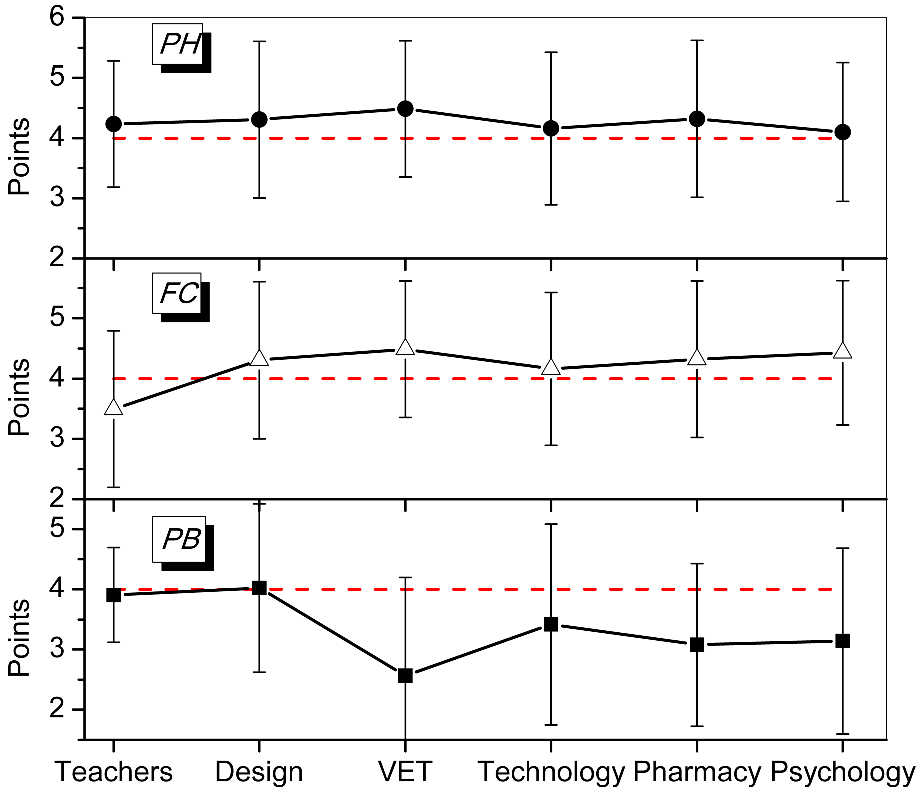

Figure 3. Average values of points for PH, FC and PB factors by specialities.

Table 6. Testing the null hypothesis that the In, At and BC factors have identical distributions for the Speciality category using the Kruskal–Wallis H test.

Factor	Significance, p	Decision
In	0.170	The null hypothesis accepted
At	0.001	The null hypothesis is rejected
BC	0.599	The null hypothesis accepted

Asymptotic significance levels are derived. The significance level is 0.05

All three elements are characterised by a considerable excess of the limit of 4 points. In other words, students of all specialities agree with the statements in questions, indicating a positive impression of these statements. In addition, for the At factor, a statistically significant difference was found between the values of individual specialities. Future designers demonstrate the highest values of At, while teachers have the lowest. In contrast, designers and teachers exhibit the highest values of In. Most sceptical matters concerning intentions, attitude and behaviour control among all subgroups show psychologists.

The UB factor is unique because, unlike the impact factors, it describes the actual frequency of application of upcycling methods in practice (figure 5 and table 7). In addition, 4 points are a neutral indicator for all impact factors in the Likert scale. In contrast, it is a conditional neutral level for UB resulting from the experimental data.

The results show that the frequency of upcycling, characterised by the UB values, does not

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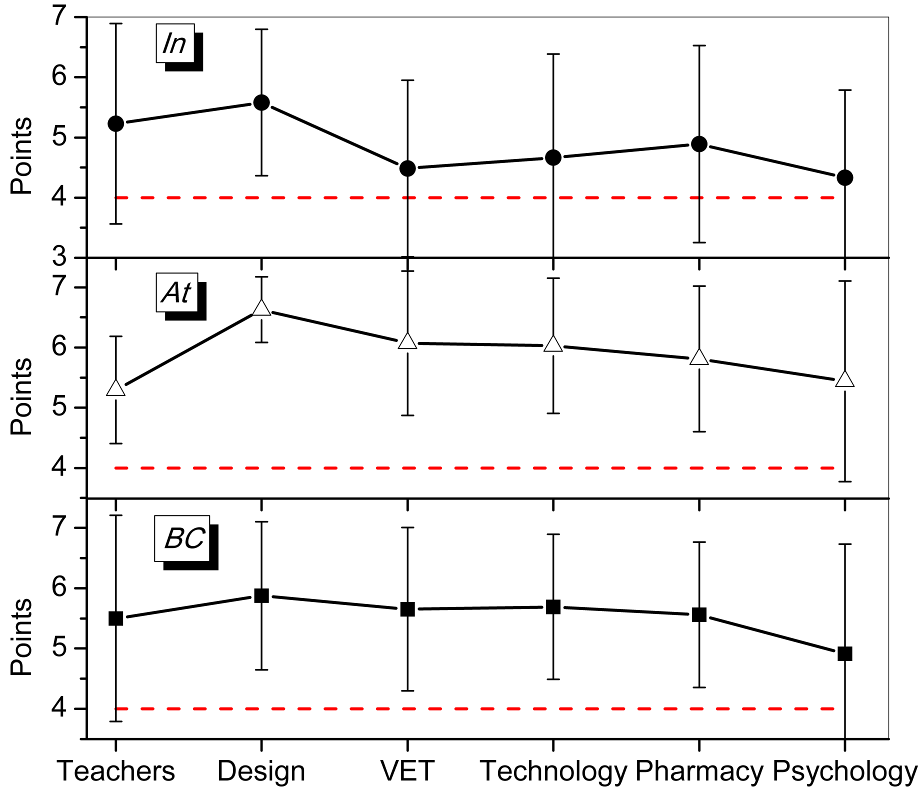

Figure 4. Average values of points for In, At and BC factors by specialities.

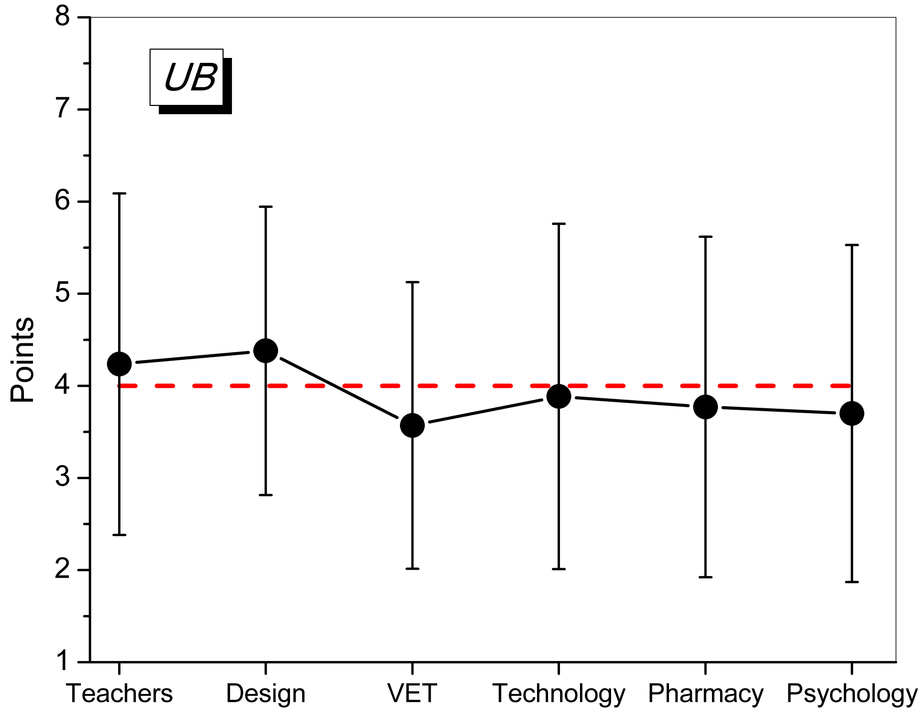

Figure 5. Average values of points for UB factor by specialities.

Table 7. Testing the null hypothesis that the UB factor has identical distributions for the Speciality category using the Kruskal–Wallis H test.

Factor	Significance, p	Decision
UB	0.755	The null hypothesis accepted

Asymptotic significance levels are derived. The significance level is 0.05

change significantly from subgroup to subgroup, and UB fluctuates close to the neutral line of 4 points. There is no significant difference between the values of UB among specialities. However, teachers and designers can be formally classified as weak upcycling optimists, while students of other specialities are sceptics.

4. Discussion

4.1. Identified problems in understanding and applying upcycling technologies

The survey results and analysis of the obtained results allow us to formulate several problems in mastering upcycling technologies that correspond to Ukraine's current level of education.

First, the presence of two subgroups among students, which can be conventionally called upcycling enthusiasts and sceptics, seems characteristic. The former actively use upcycling technologies in everyday life, while the latter hardly do it. Different practical experience, in turn, forms a different attitude to upcycling in different manifestations. From such conditions, developing various pedagogical approaches and training forms for the groups' representatives is necessary.

Secondly, the existing preferences in various aspects of the relation to upcycling remain practically the same for students of different specialities. It should be noted that the interviewees were students who might have a professional interest in upcycling (designers, technologists) and VET students who will educate future professionals in the field. Thus, they also have something to do with promoting or rejecting the idea of upcycling. Along with this, future psychologists are not directly related to the application of waste management methods. Industrial pharmacy students face waste management challenges, albeit in a slightly different format than upcycling (for example, following the principles of green chemistry). Students with no professional interest in upcycling technologies may be interested in using the relevant technologies in life as a hobby. Thus, the problem of ensuring an understanding of the benefits and mastery of available upcycling technologies is not limited to the training of clothing industry specialists but has a more global nature.

Thirdly, the attitude towards upcycling of teachers is not very different from that of students. Thus, all the shortcomings and problems in understanding upcycling are inherent to teachers. Accordingly, without solving this problem, it is impossible to hope for an improvement in the perception of upcycling by students.

Fourthly, there is a complete lack of understanding of the benefits of using upcycling technologies (figure 3). The responses of only teachers and designers are close to the neutral mark, and other groups of students are sure that upcycling has no benefits. The results of the Kruskal–Wallis H test (table 5) indicate a significant difference between different specialities in terms of PB. Additionally, the Mann–Whitney U test demonstrates that a substantial difference is observed in 5 of the 15 available pairs, namely between the following groups:

- teachers > VET at p=0.017,
- teachers > pharmacy at p=0.006,

- design > VET at p=0.003,
- design > pharmacy at p=0.013,
- technology > VET at p=0.05.

A lack of understanding of the benefits involved seems to be a key and common problem in the uptake of upcycling. According to the model from [29], perceived benefits directly form an attitude to upcycling $PB \rightarrow At$. The lack of perceived benefits deforms the perception of upcycling and does not allow one to take a conscious, positive attitude.

Fifth, according to the respondents, social factors have a minimal influence (figure 2). If the SN factor shows even a tiny level of perception, then the other two factors, PN and RB, vary practically at the zero level. At the same time, social factors, according to the [29] scheme, are among the main factors that shape human intentions. It can be assumed that the mentioned situation indicates a lack of understanding in society (respondents show similar behaviour from entirely different spheres of activity) of the role and importance of waste management. We are talking about public opinion, which currently does not see the importance of using upcycling technologies.

In the sixth, factors At and In unexpectedly reached a rather high level of approval by respondents (figure 4). It is really unexpected because such a result is not supported by other related factors, such as PB and social factors. According to the behavioural scheme used, the following links should be held: $PB \rightarrow At$ and $SN, PN, RB \rightarrow In$. The respondents demonstrate a perception of factors At and In but do not indicate the basis for such perception. In this case, we probably should not talk about a conscious choice but only about following fashion trends. Such imitation is as easy to appear as it is to disappear.

Thus, "I'm good at upcycling and intend to use upcycling in the future" is groundless and unconscious. It is evidenced by the experimentally confirmed misunderstanding of the benefits that upcycling can provide and the generally indifferent attitude towards the introduction of upcycling both on the part of society and on the part of personal preferences.

It should be determined that the At factor shows a statistically significant difference when switching from one speciality to another (table 6). Additional Mann–Whitney U test indicates that a significant difference is observed in 7 out of 15 available pairs, namely between the following groups:

- design > teachers at p=0.001,
- VET > teachers at p=0.006,
- technology > teachers at p=0.003,
- pharmacy > teachers at p=0.027,
- design > technology at p=0.041,
- design > pharmacy at p=0.002,
- design > psychology at p=0.035.

As we can see, the desire of future designers to express a positive attitude to upcycling is significantly higher than that of all other subgroups except VET students. This fact makes the greatest contribution to forming a statistically significant difference concerning At among all subgroups.

4.2. Ways to solve the identified problems

The results of our research testify to a certain lack of awareness and unreasonableness of the position, sometimes a certain indifference regarding the implementation of upcycling. As a result, there is a need to rethink existing and develop new approaches to methods and training forms for different groups of respondents.

We single out several possible reasons for such low awareness among students of various specialities who participated in our survey. The first is insufficient attention to sustainable development in the State Standard of Basic and Comprehensive General Secondary Education issued in 2011 and, accordingly, in the curricula of various educational fields. The respondents who took part in the study studied under these programs. Optimistic is the built-in competence potential in a new edition of the State Standard [13]. It has been operative since 2020 and pays attention to forming environmental competence in natural, social and health-preserving, technological educational fields. It also supports the construction of basic knowledge, skills and values regarding sustainable development.

We consider the second reason to be a lack of awareness of some teachers. They influence their consciousness in working with students, so they should explain to students during classes and involve them in other forms of work.

The third reason can be considered low attention from society, particularly parents, friends, peers and the community in general. In part, this can be justified by social conditions – the COVID-19 pandemic and Russian military invasion in 2022 brought the issue of preserving one's life and health to the fore, and the rest of the problems are of secondary importance [33].

Regarding ways to solve this problem, we fully agree with [34] about the possibilities of implementing the concept of sustainable development in separate courses and integration into various disciplines, as well as in the process of non-formal education [35].

According to the results of our research, it was found that the most sceptical about the introduction of upcycling is a group of psychologists who take an uncertain position regarding three social factors. In its specialisation and future profession, this student group is not related to the production of products or teaching activities. Therefore, we consider it reasonable to use informal education opportunities, particularly participation in project activities and training [36].

One of the ways is the participation of students in group activities. At the Department of Professional Education in Technologies and Design of KNUTD, a student scientific society, "Education for Sustainable Development", has been operating since September 2022. It focuses on spreading educational activities regarding sustainable development and the formation of awareness of ecological and ethical norms, values, lifestyle, household and production, which are required to ensure sustainable development. Future teachers of VET and practical psychologists participate and work in the following scientific areas:

(i) Reorientation of goals, content and methods of the educational process of training specialists in the field of technology and design in the context of the concept of sustainable development.
(ii) Ecological trends and possibilities of their use in the field of technology and design.

The society uses various forms and methods of work [37] and covers the following topics:

- seminar "Reduce-Reuse-Recycle concept (consume less – reuse – recycle)",
- discussion "Ways and possibilities of using the ideas of education for sustainable development in professional activity" (Interactive exercise "Mat of ideas", solving situational problems),
- round table "How to get rid of unnecessary clothes without harming the environment? Ecological trends: recycling, upcycling and freecycling", and
- training "Ideas of recycling".

The influence of societal activities on the awareness of upcycling usage can be checked by conducting a repeat survey.

A meaningful way to overcome the identified problems is the study and application of the best European practices in the organisation of sustainable education. We consider it a priority to introduce appropriate changes in the training of future VET teachers because the graduates will go to vocational training institutions and teach skilled workers in addition to being industrial technologists.

Some work has been done in this direction. Several changes have been made to the educational programs of the VET speciality at KNUTD, which contribute to the formation of competencies of critical importance for the training of a future specialist in sustainable education. Program learning outcomes have been developed for such competencies, which are strictly measurable, and new educational modules have been developed for three disciplines. Teaching is based on pedagogical approaches that optimise forms, methods and means of learning following the characteristics of the profiles of educational preferences of student groups [38, 39]. Such approaches ensure the achievement of the stated competencies of sustainability:

1. Project/problem-based learning (in an organisation/community),
2. Integrative learning (inter- and transdisciplinary),
3. Project/problem-based learning (in class),
4. Active learning (in class),
5. Research-based learning,
6. Critical text/information analysis/interpretation,
7. Reflexive learning, and
8. Collaborative learning.

The applied approach gives positive results and provides an opportunity to form the necessary knowledge in graduates of KNUTD, as well as in students of vocational schools due to interaction with university students during the latter's pedagogical practice [40]. The new task of the interns is to prepare and conduct two lectures for vocational training students on sustainable clothing production. Such measures contribute to the involvement of a wide range of future workers in the textile industry in European practices. It improves their professional prospects in terms of employment and organisation of the competitive business.

We believe that implementing a new bachelor's program, Sustainability Education for Clothing Manufacturing and Design, and incorporating it into Ukrainian professional education [41] would allow for more comprehensive and practical training of professional education specialists. Three new compulsory and one optional discipline with all the necessary educational resources based on the best practices of EU universities [42] are being developed for the implementation of such a program.

It is planned to introduce a short course of lectures for teacher training courses to solve the problem of inadequate training of university teachers. It is intended to use the format of organising and holding annual one-day workshops for better interaction and involvement of educators and industry producers. The platform for their organisation will be the International Scientific Conference "KyivTex&Fashion", which has been held annually at KNUTD for many years.

5. Conclusions

1. The problems faced by junior year students of various specialities of KNUTD in understanding the advantages and prospects of upcycling have been studied. It is shown that the existing educational programs do not motivate and do not develop among students a thrifty attitude to resources and a careful attitude to reducing the environmental burden on the environment. Such a situation does not give reason to expect specialists capable of working effectively in accordance with sustainable development goals.

2. Several problems in mastering upcycling technologies are formulated, which are appropriate to Ukraine's current level of education. It is shown that the issue of ensuring an understanding of the advantages and mastery of available upcycling technologies is not limited to the training of clothing industry specialists but has a global character. The general preferences in various aspects of the relationship to upcycling remain practically the same for students of different specialities. Teachers show indifference and ignorance in understanding upcycling. Most respondents do not understand the benefits of using upcycling technologies, although some express a desire to use recycling technologies. According to respondents, social factors have minimal influence. It is evidenced by the experimentally confirmed misunderstanding of the benefits that upcycling can provide and the generally indifferent attitude towards the introduction of upcycling both on the part of society and on the part of personal preferences.
3. Possible ways to overcome the formulated problems in the training of future engineering specialists have been determined by: implementing the concept of sustainable development both in the form of developed new educational programs and programs of individual courses; integration of new modules in various disciplines; in the process of informal education using the example of group activities; appropriate professional development of teachers.

ORCID iDs
T M Derkach https://orcid.org/0000-0003-1087-8274
M M Bilianska https://orcid.org/0000-0001-6916-8993
O G Yaroshenko https://orcid.org/0000-0003-1555-0526

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