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Modelling pharmacy and pharmaceutical students' intentions to learn about their roles in environmental sustainability

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1. Introduction

The adverse health effects of climate change, such as the increasing prevalence of vector-borne diseases, heat stress, malnutrition, and exacerbations of respiratory and cardiovascular illnesses due to poor air quality, are likely to increase over time (Watts et al., 2015; Beechinor et al., 2022). Healthcare systems rely on intensive use of energy and resources and have been estimated to contribute about 5% of global greenhouse gases and air pollutants (Lenzen et al., 2020). Medicines alone cause 25% of the carbon emissions of the National Health Service (NHS) in England and Wales (NHS England and NHS, 2020). They also generate high levels of waste (Roschnik et al., 2017). Pharmaceutical products play essential roles in the treatment of diseases. However, residues of several pharmaceutical products can cause environmental problems that adversely affect human health (European Commission, 2019; NHS Scotland, 2022). Environmental residues of pharmaceuticals generally occur because of patient and animal excretion, aquaculture, disposal of unused or expired medicine, and direct emissions from drug manufacturing (UN Environment Program, 2020). These residues are harmful, especially to the water and soil systems, and accumulate in various products, such as drinking water, plants, meat, fish, and dairy (Keerthanan et al., 2021). Consequently, people who consume these products may encounter health problems because of increased exposure to pharmaceutical residues (Queirós et al., 2021). To prevent these negative situations, as stated by Kusturica et al. (2022), rational drug consumption, prescribing greener drugs, or designing benign and readily biodegradable pharmaceuticals are critical. To achieve this, pharmaceutical product manufacturers, consumers, and healthcare professionals must be aware of and sensitive to this issue.

Health professionals have key roles in educating patients and communities to increase the awareness and adoption of measures to mitigate against adverse effects of climate change and enhance environmental sustainability (Leffers et al., 2017; Braithwaite et al., 2017). According to Lemery et al. (2020) healthcare professionals have three primary roles related to combating climate change: (i) protecting individual and community health from the adverse effects of climate change, (ii) ensuring healthcare systems are resilient in the face of climate change, and (iii) bringing their voices and scientific expertise for advocating cross-sectoral solutions to the climate crisis. Similarly, the World Health Organization has stated the need for a climate-smart health workforce in their "Operational Framework for Building climate-resilient and low-carbon Health Systems" report (World Health Organization, 2023). While there are existing efforts in many nations to recruit health professionals as advocates for environmental sustainability, much more can and needs to be done (Maibach et al., 2020).

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Pharmacists and pharmaceutical scientists have many opportunities and even a moral obligation to contribute to climate action (Beechinor et al., 2022). Pharmacists have multiple opportunities to take positive climate action through greener pharmacy practice and medicines usage throughout the pharmaceutical supply chain, raising awareness and educating patients and communities, and responding to the health and patient needs emerging from the climate crisis (Singleton et al., 2014; Arslan and Şar, 2018; Derqui et al., 2021; International Pharmaceutical Federation, 2016). European Union's Strategic Approach to Pharmaceuticals in the Environment emphasizes the need for cooperation to engage environmental aspects in medical training and professional development programs. (European Commission, 2019) The International Pharmaceutical Federation (FIP) presents a SustainabilityRx program that supports the progress and implementation of sustainability in pharmacy, which includes three main areas: environment and planetary health, responding to disasters and pandemics, and sustainable services (International Pharmaceutical Federation, 2021). While environmental sustainability issues are currently not directly included in the (UK) General Pharmaceutical Council's Standards for the Initial Education and Training of Pharmacists in the UK, The British Royal Pharmaceutical Society Prescribing Competency Framework includes "Consider the impact of prescribing on sustainability, as well as methods of reducing the carbon footprint and environmental impact of any medicine." (Royal Pharmaceutical Society, 2021) Several universities have integrated environmental sustainability into their pharmacy curriculum through core and elective courses (Royal Pharmaceutical Society, 2021; Mathers et al., 2023; Siven et al., 2020; Gruenberg et al., 2017). In addition, the Planetary Health Report Card (PHRC) has been carried out by The Planetary Health Alliance since 2020 to address the current situation and raise awareness of sustainability and planetary health issues in health professional schools. Within the scope of PHRC, the following topics are addressed: (i) Curriculum, (ii) Planetary health research, (iii) Community outreach and advocacy, (iv) Support for student-led initiatives, and (v) Campus sustainability. In 2024, pharmacy faculties were also included in PHRC. The report emphasizes that sustainability and planetary health issues are just beginning to be integrated into pharmacy faculties and need improvement (PHRC, 2024).

The research literature on sustainability in pharmacy education is also increasing. Newberry Le Vay et al. stated that it is important to design climate change education for young people in a way that will enable them to influence society on sustainability (Newberry Le Vay et al., 2023). As stated by Liu et al. (2017) and Afanasjevaa and Gruenberg (Afanasjeva and Gruenberg, 2019) pharmacists and pharmacy students have essential roles in increasing general public awareness of pharmaceutical pollution. Hence, improving pharmacists' knowledge and perceptions of the effects of pharmaceuticals on the environment is critical. Gubae et al. pointed out that pharmacy students need to learn the effect of pharmaceuticals on the environment to provide their services in a more eco-friendly way (Gubae et al., 2023). Gruenberg et al., Mathers et al., Nguyen et al., Håkonsen and Hedenrud, and Domingo-Echaburu et al. emphasized the need for the integration of pharmacists' roles in environmental sustainability in pharmacy curricula to prepare them for the impacts of climate and environmental change (Mathers et al., 2023; Gruenberg et al., 2017; Nguyen et al., 2021; Håkonsen and Hedenrud, 2024; Domingo-Echaburu et al., 2023). However, according to Gupta et al., Chen et al., and Fens et al., there is still a consensus gap on how best to integrate sustainability issues into healthcare curricula (Gupta et al., 2022; Chen et al., 2011; Fens et al., 2024).

While the necessity of integrating environmental sustainability in pharmacy education is recognized in the literature, there is a gap related to students' intentions to learn about their roles in sustainability. The aim of the work reported herein was to address this gap, given that understanding students' concerns, attitudes, and intentions about learning about their role in environmental sustainability can lead to a better design of teaching and learning activities about environmental sustainability in pharmacy education. A theory-based approach, the Theory of Planned Behaviour (TPB), can be utilized to understand the relationship among students' concerns, attitudes, and intentions regarding learning about their roles in environmental sustainability. Therefore, the objective of this study was to model and predict pharmacy and pharmaceutical sciences students' intentions to learn about their roles in sustainability using the TPB.

2. Material and methods

2.1. Theoretical framework

Several psychometric theories have been postulated for modelling individuals' intentions and behaviours towards specific issues. One of the most popular is the TPB proposed by Ajzen in 1985. This was designed to explain human behaviours that occur in a specific context and includes three fundamental factors: attitudes toward behaviour, perceived behaviour control, and subjective norms that affect the intentions stated to form the basis of one's behaviour (Ajzen, 2005). According to Ajzen, an attitude is an individual's positive or negative evaluation of a specific behavior of interest. A subjective norm is formed by the perceptions of those (e.g., family, friends, colleagues, spouse) critical to the individual about how they should or should not behave. Perceived behavioural control refers to individuals' perceptions of how easy or difficult it is to perform the relevant behaviour (Please, see https://people.umass.edu/aizen/tpb.html for the details of the TPB). (Ajzen, 1991)

The TPB has been used in many different fields, such as environmental psychology, management, health, marketing, education, and consumer behaviour (Arslan and Şar, 2018; Arslan et al., 2017; Tarhan et al., 2017; Arslan, 2020). Additionally, extended versions of the TPB model have been proposed to explain specific intentions or behaviours (Hauslbauer et al., 2022; Alzubaidi et al., 2021; Foon et al., 2020; Chen and Tung, 2014).

The TPB model has been widely used to evaluate environmentally-friendly intentions and behaviour. Some studies indicate that this theory might be extended by considering the effects associated with environmental concerns (Hauslbauer et al., 2022; Schultz et al., 2005; Donald et al., 2014; Zhang et al., 2019). Therefore, in this study, an extended version of the TPB was used to measure pharmacy and pharmaceutical sciences students' intention to "*Learn About their Roles in Sustainability (LARS)*." The proposed research model, called the "*Intentions to Learn About their Roles in Sustainability (Intentions to LARS)*" is illustrated in Fig. 1.

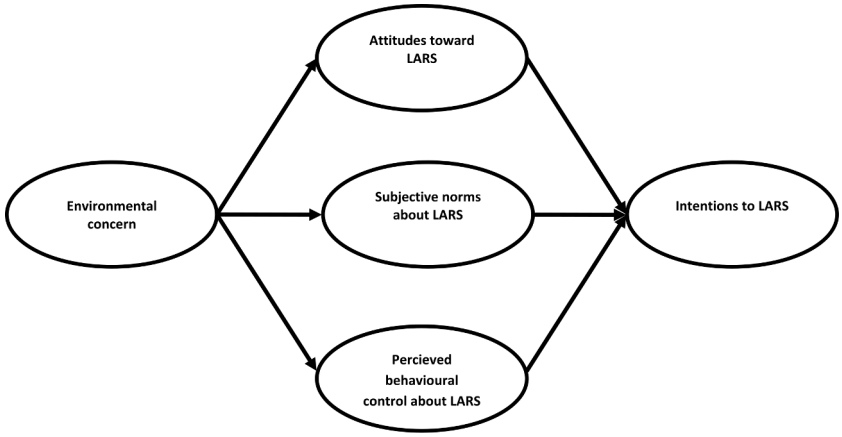

Fig. 1. Proposed Research Model (LARS: Learn about their roles in sustainability).

By this model, it is proposed that environmental concerns influence students' attitudes, subjective norms, and perceived behavioural control about LARS, which in turn influence their intentions toward LARS.

2.2. Research hypotheses

Based on the theoretical background and the overview of the proposed research model in Fig. 1, the hypotheses were derived as follows. Tang et al. and Kirmani and Khan observed that consumers' environmental concern influenced their attitudes toward environmentally friendly products in a positive way (Tang et al., 2014; Kirmani and Khan, 2016). According to Chen and Tung, more environmental concerns led to a more positive effect on attitude, subjective norms, and perceived behavior control (Chen and Tung, 2014). Paul et al. and Zhang et al. concluded that environmental concern was positively related to attitudes, subjective norms, and perceived behavioural control (Zhang et al., 2019; Paul et al., 2016). From these studies, the first three hypotheses of the study were established as follows.

H1. Environmental concern affects attitudes toward LARS

H2. Environmental concern affects subjective norms about LARS

H3. Environmental concern affects perceived behavioral control about LARS

The relationship between the attitudes and students' intentions regarding environmental sustainability has been evaluated in different fields and at varying educational levels, e.g., Swaim et al. (2014) Roy found that positive attitudes, subjective norms, and perceived behavioral control increase individuals' intention to act in a pro-environmental manner (Roy, 2023). Huang and Cheng showed that secondary school students' intentions to learn about sustainability were affected by their attitudes, subjective norms, and perceived behavioral control toward sustainability (Huang and Cheng, 2022). Accordingly, the last three hypotheses of the study were established as follows.

H4. Attitudes toward LARS affect intentions to LARS

H5. Subjective norms about LARS affect intentions to LARS

H6. Perceived behavioral control about LARS affects the intentions to LARS

2.3. Development of the measurement tool

Data collection was carried out using a questionnaire comprising three sections: (i) brief information and invitation to consent, (ii) measurement tool developed according to the TPB, and (iii) questions about demographics.

The items of the measurement tool were adapted from Ajzen et al., Alzubaidi et al., Chen and Tung, Huang and Cheng, Zhang et al., and the FIP Statement of Policy: Sustainability within pharmacy (Alzubaidi et al., 2021; Chen and Tung, 2014; Zhang et al., 2019; Huang and Cheng, 2022; Ajzen et al., 2011; International Pharmaceutical Federation, 2023). In the process of developing the measurement tool, first, an initial item pool was prepared to evaluate participants' intentions to learn about their roles in sustainability and its antecedents (environmental concern, attitudes, subjective norms, and perceived behavioral control). The measurement tool comprised 37 items and was grouped into five sections (environmental concern, attitudes, subjective norms, perceived behavioural control, and intentions) in English. Then, Lawshe's method was used to check the content validity of the measurement tool. According to Lawshe (1975), a minimum of four experts are needed for evaluation, although this number can be increased. Eighteen academic pharmacists from different disciplines who were interested in sustainability were invited to take part in the content evaluation panel, of whom twelve participated. The initial item pool was constructed to respond to items according to Lawshe's method as ''essential,'' ''useful, but not essential'' or ''not necessary''. Then, the Content Validity Ratio, which must be a minimum of 0.56 when a Content Evaluation Panel comprises twelve members, was calculated for all items (Lawshe, 1975). Consequently, seven items were eliminated

from the initial item pool. Items in the final version of the measurement tool were prepared with a 5-point Likert scale, rated from "1-strongly disagree" to "5- strongly agree." The questionnaire took its final form by adding four demographic questions to the measurement tool. Lastly, the developed questionnaire was piloted by ten PhD students with a first degree in pharmacy from the UCL School of Pharmacy. Following feedback from the pilot study, some of the items of the questionnaire were revised. The final version of the questionnaire (given in Appendix 1) took around 10 min to complete.

2.4. Sample size calculation

The study population (around 1000 individuals) comprised all students enrolled in a taught program at the UCL School of Pharmacy during the 2023–2024 academic year, which included the 4-year Masters of Pharmacy (MPharm) and several Master of Science (MSc) degrees. The minimum sample size was calculated to be 88 according to the Cochran sample size formula at 95% confidence level with a margin of error equal to 0.10 (Barttlett et al., 2001). To increase the reliability, the maximum number of students were invited to participate.

2.5. Data collection

Data collection was conducted online (via Qualtrics) between November and December 2023. Students were invited to take part, and teaching staff were encouraged to give students enough time (about 10 min) to complete the open survey during face-to-face teaching sessions to maximize participation. Students who did not have any face-to-face teaching sessions during the data collection period were invited to participate via email. The questionnaire comprised eight online pages (screens). On the first two screens, brief information about the study was provided, and students were invited to give consent. The subsequent screens included five or six questions per page. No incentive was offered to participants and students were told that their participation (or lack of) would not affect their studies and assessments in any way. Identifying information such as respondents' IP addresses, location data, and contact information were not recorded. A cookie was placed on the respondents' browsers when they submitted a response to prevent multiple responses from the same respondents. Participants were able to review and change their answers during the completion of the questionnaire.

2.6. Data analysis

IBM Statistical Package for Social Sciences (IBM SPSS® Software) version 22 and LISREL® 8.80 were used for data analysis. The level of significance was set a priori at $p \leq 0.05$.

Firstly, descriptive statistics were obtained. Subsequently, exploratory factor analysis (EFA) was conducted using principal component analysis with Varimax rotation. The Kaiser-Meyer-Olkin (KMO) value was calculated to determine whether the sample size was suitable for EFA. Factors were extracted according to the Kaiser criterion and scree plot.

The Kolmogorov-Smirnov normality test was used to check the normality of the factor scores. Subsequently, the Mann-Whitney *U* test and Kruskal-Wallis tests were used to analyze whether demographic characteristics had any effects on the factor scores.

Then, confirmatory factor analysis (CFA) was applied to confirm whether a relationship existed between the observed variables and their underlying latent constructs (environmental concern, attitudes, subjective norms, perceived behavioural control, and intentions). Here, *latent constructs (variables)* refer to those variables that are measured indirectly using *observed variables* (items of the measurement tool). Lastly, the structural equation model (SEM) was performed via the Maximum Likelihood method to investigate any direct and indirect relationships between the latent variables. SEM is a set of powerful statistical techniques used to measure and examine linear causal relationships among observed and latent variables while accounting for measurement error (Beran and Violato, 2010). The goodness-of-fit indices -i.e., Likelihood ratio chi-square statistics (χ^2), Non-Normed Fit Index (NNFI), Root Mean Square Residual (RMR), Standardized Root Mean Square Residual (SRMR), and Root Mean Square Error of Approximation (RMSEA)- were used to determine the fit of the CFA and proposed model. In the literature, it has been suggested that several indices may be presented together. In this study, Hu and Bentler's two-index strategy (Hu and Bentler, 1999) for delivering goodness of fit indices was selected.

In addition, factor loadings, average variance extracted value, square root of the average variance extracted value, composite reliability coefficient, and Cronbach's alpha (α) values were used to check the validation and reliability of the measurement tool according to Schreiber et al., Fornell and Larcker, and Hair et al. (Schreiber, 2008; Fornell and Larcker, 1981; Hair et al., 2010)

The results are presented according to the Checklist for Reporting Results of Internet Surveys (CHERRIES) (Eysenbach, 2004).

Ethical approval

This study was approved as an educational research project by the UCL School of Pharmacy (application number 12143/003).

3. Results

3.1. Demographic statistics

A total of 925 students were invited to participate in the study. 238 individuals started the questionnaires, and 184 completed them. The overall response rate was 20% (33% for Year 1 MPharm, 13% for Year 2 MPharm, 5% for Year 3 MPharm, 0% for Year 4 MPharm, and 44% for MSc students) and the overall completion rate was 79%.

The participants' demographic characteristics (n = 184) are shown in Table 1.

Table 1
Demographic properties of the participants (n = 184).

		Frequency	Percent (%)
Gender	Female	127	69
	Male	43	24
	Non-binary	10	5
	Prefer not to say	4	2
Home Status	Overseas student	112	61
	Home student	72	39
Program &Year	**MPharm (Year 1 to 4)**	**96**	**52**
	Year 1	*65*	*35*
	Year 2	*21*	*11*
	Year 3	*10*	*6*
	Year 4	*0*	*0*
	Master of Science	**88**	**48**
	Drug Discovery and Pharma Management	34	*18*
	Pharmaceutics	26	*14*
	Drug Discovery and Development	15	*8*
	Pharmaceutical Formulation and Entrepreneurship	12	*7*
	Clinical Pharmacy, International Practice & Policy	1	*1*

3.2. Exploratory factor analysis (EFA)

The sample size was deemed to be adequate for conducting EFA, given that the calculated KMO value was 0.905, i.e., it was higher than 0.5 (Tabachnick and Fidell, 2007). In the EFA, all standardized factor loadings should be at least 0.5 to indicate that observed indicators are strongly related to their associated factors (Hair et al., 2010). Hence, only those items with factor loadings of 0.5 or higher were retained, and those with lower loadings or cross-loadings were eliminated. After removing 6 items, a five-factor structure was obtained. The factors were labelled as *Environmental concern, Attitudes toward LARS, Subjective norms about LARS, Perceived behavioural control about LARS,* and *Intentions towards LARS*. The obtained five-factor structure explained 76% of the total variance. The factor structure, factor loadings, and median values of factor items are shown in Table 2.

3.3. Mann-Whitney U and Kruskal-Wallis tests

As the Kolmogorov-Smirnov normality test showed that factor scores were not normally distributed ($p < 0.05$), non-parametric tests were conducted to determine the effects of the degree program, the student's home/overseas status and gender on factor scores at the 95% confidence interval. Neither the nature of the degree program nor students' residence status created a statistically significant difference in the factor scores (Mann-Whitney *U* test, $p > 0.05$ for both). In contrast, participant gender did cause a statistically significant difference in the factor scores of the subjective norms about LARS (Kruskal-Wallis. $p < 0.05$). To investigate the differences more deeply, the Dunn-Bonferroni test was conducted. This showed that students who preferred to not reveal their gender had higher mean scores than males or females in subjective norms about LARS ($p = 0.007$ and $p = 0.003$, respectively).

3.4. Confirmatory factor analysis

The CFA was conducted to confirm whether there was a relationship between the observed variables and their underlying latent constructs (environmental concern, attitudes, subjective norms, perceived behavioural control, and intentions). As a result, the measurement model, also known as a confirmatory factor analytic model, was obtained. Two modifications were performed between the items sn5 and sn6 and between the items ec4 and ec5 in the model to provide a better fit. Fig. A1 gives a path diagram related to the obtained measurement model.

The fit of the model (*intentions to LARS*) with the five-factor structure was found to be acceptable, according to Hu and Bentler's two-index strategy (Hu and Bentler, 1999); see Table A1.

3.5. Validation and reliability of the measurement tool

Cronbach's alpha (α) values were calculated for testing the reliability of the measurement tool, according to Schreiber et al. (Schreiber, 2008) These values should be 0.70–0.95 for high reliability (Hair et al., 2010; Gliem and Gliem, 2003). As shown in Table 3, the calculated Cronbach's alpha values indicate a high level of reliability for these factors.

Additionally, factor loadings, average variance extracted values, and composite reliability coefficients were calculated to investigate the convergent validity of the measurement tool, as suggested by Schreiber et al., Fornell and Larcker, and Hair et al. (Schreiber, 2008; Fornell and Larcker, 1981; Hair et al., 2010) and are shown in Table 3.

As shown in Table 3, the average variance extracted values of all the factors are greater than 0.5, which is the threshold accepted in the relevant literature (Fornell and Larcker, 1981; Hair et al., 2010). In addition, the composite reliability coefficients of all factors are higher than 0.5, which is considered a sign of convergent validity (Fornell and Larcker, 1981; Hair et al., 2010). Also, as seen in Table 2, the standardized factor loadings of nearly all the items were above 0.65. For discriminant validity, the square root of the average variance extracted values was calculated and found to be greater than the correlation estimates between the related factors, as stated by Fornell and Larcker (1981). These findings show that the developed measurement tool has satisfactory convergent and discriminant validities according to the relevant literature.

Table 2
Results of exploratory factor analysis (LARS: Learn about their roles in sustainability a_j: jth item in the A factor, j = 1 to 5; ec_j: jth item in the EC factor, j = 2 to 5; sn_j: jth item in the SN factor, j = 1 to 6; pbc_j: jth item in the PBC factor, j = 1 to 4; i_j: jth item in the I factor, j = 1 to 6).

Items	Median	Factors and Factor loadings					*Variance Explained (%)*
		Subjective norms about LARS (SN)	Attitudes toward LARS (A)	Intentions to LARS (I)	Environmental concern (EC)	Perceived behavioural control about LARS (PBC)	
Subjective norms about LARS: I would like to learn about my role in sustainability because people who are important to me							
sn4. … expect me to do it.	3.00	0.842					
sn2. … encourage me to do it.	3.00	0.841					*19.2*
sn5. … think that it is good for environment.	4.00	0.837					
sn3. … support me to do it.	3.00	0.827					
sn6. … think that it is important for the environment.	4.00	0.776					
sn1. … think that I should do it.	3.00	0.744					
Attitudes toward LARS: I feel that learning about my role in sustainability is							
a1. … positive for the environment.	4.00		0.848				
a2. … beneficial for the environment.	4.00		0.842				
a5. … valuable for the environment.	4.00		0.834				*18.1*
a4. … desirable for the environment.	4.00		0.825				
a3. … I think about how the environmental quality of the world can be improved.	4.00		0.772				
Intentions to LARS:							
i2. I will try to learn about my role in sustainability.	4.00			0.792			
i3. I intend to learn about my role in sustainability.	4.00			0.766			
i4. I am willing to learn about my role in sustainability.	4.00			0.750			*15.0*
i5. I am likely to learn about my role in sustainability.	4.00			0.745			
i1. I am planning to learn about my role in sustainability.	3.00			0.738			
Environmental concern:							
ec4. I am worried about CO_2 emissions caused by pharmaceutical production.	3.00				0.787		
ec5. I am worried about CO_2 emissions caused by pharmaceutical products.	3.00				0.774		*11.6*
ec2. I am worried about pharmaceutical waste.	4.00				0.708		
ec3. I think about how the environmental quality of the world can be improved.	4.00				0.644		
Perceived behavioural control about LARS:							
pbc2. I have time to learn about my role in sustainability.	3.00					0.805	
pbc3. I have the skills to learn about my role in sustainability.	3.00					0.789	*11.6*
pbc1. It is easy for me to learn about my role in sustainability.	3.00					0.740	
pbc4. I have opportunities to learn about my role in sustainability.	3.00					0.735	

3.6. Results of structural equation model (SEM)

Parallel to the obtained measurement model, two modifications were made between items sn5 and sn6 and between items ec4 and ec5 in the structural equation model to provide a better fit. The path model obtained as a result of the structural equation modelling is given in Fig. A.2.

The goodness of fit indices for the Intentions to LARS Model presented in Fig. A2 are given in Table A2. The proposed *Intentions to LARS Model* shows acceptable modelling performance for the data. Standardized parameter estimation values for paths, *t*-values, structural equations, and reduced forms of equations related to the *Intentions to LARS Model* are given in Table 4.

In light of the structural equation model results in Fig. A2 and Table 4, all of the research hypotheses were confirmed. There was a statistically significant positive relationship between environmental concern and attitudes toward learning about sustainability. One unit increase in environmental concern leads to a 0.75 unit increase in the attitudes toward LARS and a 0.56 unit increase in the sub-

Table 3
Correlation matrix-related factor, average variance extracted, and composite reliability coefficients (LARS: Learn about their roles in sustainability).

	Attitudes toward LARS	Subjective norms about LARS	Perceived behavioural control about LARS	Intentions to LARS	Environmental concern
Attitudes toward LARS	1				
Subjective norms about LARS	0.37	1			
Perceived behavioural control about LARS	0.42	0.46	1		
Intentions to LARS	0.60	0.54	0.56	1	
Environmental concern	0.74	0.55	0.32	0.62	1
Average variance extracted	***0.775***	***0.688***	***0.558***	***0.671***	***0,622***
The square root of the average variance extracted	***0.880***	***0.829***	***0.747***	***0.819***	***0.789***
Composite reliability	***0.945***	***0.930***	***0.834***	***0.910***	***0.868***
Cronbach's alpha	***0.945***	***0.932***	***0.830***	***0.910***	***0.880***

Table 4
Results of structural equation model (EC: Environmental concern; A: Attitudes toward LARS; SN: Subjective norms about LARS; PBC: Perceived behavioural control about LARS; I: Intentions to LARS).

Hypotheses	Paths	Standardized parameter estimation values	t-values	Results
H_1	(EC) → (A)	0.75	10.26	Confirmed
H_2	(EC) → (SN)	0.56	6.76	Confirmed
H_3	(EC) → (PBC)	0.40	4.59	Confirmed
H_4	(A) → (I)	0.40	5.40	Confirmed
H_5	(SN) → (I)	0.29	4.01	Confirmed
H_6	(PBC) → (I)	0.29	4.09	Confirmed
Structural equations		A = 0.75*EC		R^2 = 0.57
		SN = 0.56*EC		R^2 = 0.31
		PBC = 0.40*EC		R^2 = 0.16
		I = 0.40*PBC+0.29*SN+0.29*A		R^2 = 0.53
Reduced structural equations		A = 0.75*EC		R^2 = 0.47
		SN = 0.56*EC		R^2 = 0.31
		PBC = 0.40*EC		R^2 = 0.16
		I = 0.58*EC		R^2 = 0.33

jective norm about LARS. These positive relationships were statistically significant for both attitudes and subjective norms. Similarly, the relationship between environmental concern and perceived behavioural control about LARS was statistically significant, with one unit increase in the environmental concern factor leading to a 0.40 unit increase in perceived behavioural control about LARS. Thus, the environmental concern factor seems to be a good indicator and predictor of attitudes, subjective norms, and perceived behavioural control in the proposed *Intention to LARS Model*.

The path coefficient between the intentions to LARS and attitudes toward LARS was 0.40. This positive relationship was statistically significant. Subjective norms and perceived behavioural control about LARS have the same positive direct impact on intentions to LARS, with the path coefficients being 0.29. Thus, it can be said that the attitudes toward LARS have a higher effect on intentions to LARS compared to subjective norms and perceived behaviour control.

Additionally, reduced structural equations, given in Table 4, show that environmental concern has a positive indirect impact on intentions toward LARS through the intervening variables “attitudes toward LARS,” “subjective norms about LARS,” and “perceived behavioural control about LARS.” One unit increase in environmental concern leads to a 0.58 unit indirect increase in intentions to LARS.

The coefficient of determination related to the structural equations was calculated as 0.57, 0.31, 0.16, and 0.53, respectively. These values show that independent latent variables “attitudes toward LARS,” “subjective norms about LARS,” and “perceived behavioural control about LARS” explained 53% of the variance in the dependent latent variable “intentions to LARS.” Finally, when the indirect effects were considered, it can be seen that the independent latent variable “environmental concern” explained 33% of the variance in the dependent latent variable “intentions to LARS.”

4. Discussion

Within the scope of this study, pharmacy and pharmaceutical sciences students' intentions to learn about their roles in environmental sustainability were modelled via an extended TPB approach. The main contributions of this study to the literature are developing a valid and reliable measurement tool to evaluate students' intentions toward LARS and modelling their intentions by extending the TPB framework with the integration of environmental concern. To the best of the authors' knowledge, this is the first study in the pharmacy and pharmaceutical sciences field investigating students' intentions to learn about sustainability in a theoretical manner.

The results can inform educators and policymakers about integrating environmental sustainability topics into pharmacy curricula by giving essential clues about students' intentions.

The presented *Intentions to LARS Model* shows that pharmacy and pharmaceutical sciences students have a moderate level of environmental concern, which affects their attitudes, subjective norms, and perceived behavioural control directly and intentions to learn about their roles in sustainability indirectly. This finding is supported by Newberry Le Vay et al., who also pointed out that if young people's awareness of climate change increases, their attention to climate change education will increase (Newberry Le Vay et al., 2023). The median values of the items in the environmental concern factor indicate that students are worried about pharmaceutical waste and CO_2 emissions from pharmaceutical products and production. This reflects Aditya and Rattan's study evaluating the role of pharmacists in minimizing pharmaceutical waste, where 58% of pharmacists were found to believe that drugs negatively affect the environment and ecosystems (Aditya and Rattan, 2014). Similarly, Håkonsen and Hedenrud reported that Swedish pharmacy students had environmental concerns about the harmful effects of medicines (Håkonsen and Hedenrud, 2024).

When the median values of the items in the attitudes toward the LARS factor are examined, it is seen that the students have positive attitudes. More or less, the same findings can be found in a recent paper by Domingo-Echaburu et al. (2023) In the presented *Intention to LARS Model*, attitudes toward the LARS factor had the most significant effect on intentions. Similarly, Gansser and Reich found attitudes as the most important variable influencing pro-environmental behavioral intention (Gansser and Reich, 2023). Swaim et al. stated that attitude is the strongest antecedent of intention and is critical to teaching environmental sustainability (Swaim et al., 2014). Chen et al. evaluated pharmacy students' perceptions of environmentally sustainable pharmacy practice. They found that 94% of the students saw undertaking sustainability initiatives in the delivery of pharmaceutical care as one of the responsibilities of pharmacists (Chen et al., 2011). In this context, it is clear that students' attitudes should be taken into account during the process of integrating environmental sustainability into pharmacy education.

Kotcher et al. reported that while health professionals believe that they should actively take part in environmental issues, nearly half of them saw time constraints and lack of knowledge as barriers (Kotcher et al., 2021). In the current study, barriers and facilitators were considered under perceived behavioural control. The median values of the items in the perceived behavioural control about LARS factor show that students also feel the existence of barriers. Swaim et al. put forth that to increase students' perceived control in environmental sustainability; educational programs need to be supported with activities where students' active participation can be ensured (Swaim et al., 2014).

The other factor that affects the intentions toward LARS is the subjective norms. In many studies related to environmental issues, the subjective norms factor was found to positively contribute to individuals' behavioural intentions (Chen et al., 2011; Arslan et al., 2017; Swaim et al., 2014; Gansser and Reich, 2023). It is a fact that apart from individual beliefs, the physical, social, and cultural environments that one lives in also play a critical role in one's learning (Wang et al., 2023). Supporting this, the median values of the items in the subjective norms factor show that students take into account the opinions of the people they value. Thus, it is thought that if pharmacy educators retain the ability to influence students' environmental sustainability intention, they can teach about sustainability in a more effective manner.

This study shows that students have positive intentions toward LARS. Similarly, Chen et al. previously reported that 62% of pharmacy students were interested in learning about environmentally sustainable pharmacy practice (Chen et al., 2011). Roy emphasized that teaching individuals' about environmental values encourages them to behave more environmentally (Roy, 2023). From a different point of view, Kotcher et al. evaluated health professionals' (nearly 4000 pediatricians, general physicians, and nurses) willingness to participate in environmental campaigns and found that only 26% of them were willing (Kotcher et al., 2021).

Last but not least, this study reveals that demographics generally do not show significant differences in factors. As a result of the Kruskal-Wallis test, students who preferred not to say their gender had higher mean scores in subjective norms about LARS. However, there were not any statistically significant differences between males and females. In contrast, in many studies, females are generally reported as having stronger pro-environmental attitudes and behaviours than males (Boeve-de Pauw et al., 2014; Olsson and Gericke, 2017).

4.1. Practical implications

Educating or training individuals is not enough to ensure environmental sustainability. However, it should be noted that, as stated in "UNESCO Education for Sustainability: from Rio to Johannesburg, Lessons Learnt from a Decade of Commitment Report," if education or training programs can increase respect for the environment's needs, it can contribute to sustainability (UNESCO, 2002). In this regard, the contents of educational/training programs for environmental sustainability need to be considered and designed very carefully. The results of the current study support this. The results indicate that pharmacy educators should aim to increase students' awareness and sensitivity to environmental issues by taking their environmental concerns into account when developing training programs. Furthermore, the results inform pharmacy educators to focus on creating supportive environments and promoting students' motivation and values to foster their intentions to learn about environmental sustainability. In this way, students' intention to participate in learning activities related to environmental sustainability can be increased by improved attitudes, subjective norms, and perceived behavioural control.

4.2. Strengths and limitations

Student's intentions to learn about environmental sustainability have been investigated using a theoretical framework and modelled using advanced statistical analyses. The TPB, a frequently applied framework in environmental research, was used, which means it may be easier to compare with other studies. This pioneering study is the first to investigate pharmacy and pharmaceutical

sciences students' intentions to learn about sustainability in this way. This work adds to the limited literature on healthcare students' intentions toward environmental behaviours.

There are also several limitations in this study. Overall, the sample size was lower than expected, although it did not affect the data analysis as it was above the required minimum, and the KMO value was found appropriate for conducting the EFA. Due to time constraints, the survey could only be conducted over a period of five weeks. This meant that the survey was conducted with students on the MPharm and only five of the eleven Master of Science programs offered at the UCL School of Pharmacy. During the survey period, about half of the MPharm students did not have face-to-face lectures, and they could only be invited to participate via email; this absence of in-person teaching sessions during which the survey could have been administered and time made available for survey completion resulted in a low response rate. Consequently, because response rates varied by the MPharm year of study, it was not possible to study any influence of year group.

The validity and reliability of the developed measurement tool were tested in only one university. Hence, the generalization of the findings should be done with caution. More studies are required to refine items and generalize the findings to universities in the UK and abroad. Additionally, repeating the study in several universities will be helpful in determining any similarities and differences in students' intentions toward LARS. Finally, this was only a quantitative study where data was gathered using a self-administered questionnaire. Further work, including focus groups and interviews with students, is needed to identify the issues impacting students' desire to learn about environmental sustainability.

5. Conclusion

This study proposed a validated five-construct model based on the extended TPB through confirmatory factor analysis and structural equation modeling. The proposed "*Intentions to LARS Model*" could measure students' intentions to learn about environmental sustainability in the pharmaceutical sciences. The "*Intentions to LARS Model*" clearly showed that students' attitudes toward the LARS were the strongest predictor of their intentions toward LARS. Additionally, environmental concern positively and directly affects the antecedents of the intentions to LARS and indirectly affects the intentions to LARS in a positive manner. The outputs of this study is helpful, especially for pharmacy and pharmaceutical sciences educators, in understanding how they can raise students' intentions to LARS.

CRediT authorship contribution statement

Miray Arslan: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Bryony Dean Franklin:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Sudaxshina Murdan:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.scp.2024.101639.

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