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VALIDATION OF THE TOOL FOR MEASURING ESD AND PREPAREDNESS OF PROSPECTIVE TEACHERS' AS SUSTAINABLE LEADERSHIP

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Abstract
The study was focused on developing and validating instrument on several aspects of education for sustainable development in teacher education of Pakistan and its role in making prospective teachers more sustainable. For this purpose, quantitative ex-post facto research focusing exploratory survey was adopted. The quantitative data was collected from 3 public and 3 private universities containing 732 prospective teachers with specially designed questionnaire in the light of literature review. The instrument contained 34-item with 5 major factors The instrument was validated and proposed a fit model for future implementation in another educational context. Five major factors were extracted validated, and model fit with diagram, all education for sustainable development practices were significantly correlated with each other. It was recommended to use this validated instrument for more heterogeneous populations.

Keywords: Instrument development, Instrument Validation, Education for Sustainable Development, Sustainable Leadership, Prospective Teachers

Introduction

It has been said that forming a generation which will be having a feeling of concern for future issues and the environment is more essential in an era where global education is the order of the day and new revolutions are quickly filling the gap (Ives et al. 2023). There is no shortage of information on how classroom teachers play a prominent role in the improvement of the existing education standards. In the development of new courses or enhancements of well-established ones, such work has always been important. However, there has been considerable debate over the quality of ESD education taught in such teacher training programs for the upcoming educators (Wamsler & Bristow, 2022). The study in hand seeks to develop a tool for assessing the extent of teacher education program to equip future educators in becoming sustainable leaders. It is assumed that sustainable leaders can effectively practice ESD principles for the benefits of local communities.

Any social disorientation observed today, for instance, can only be explained as the phenomenon of relationship breakdown (Examples include self, others, shared world) (Bentz et al. 2022) The problems follow two concentric and mutually reinforcing circles, namely individual and societal levels of disconnection which are common in today's societies society interference of global crises. Indeed, broad defines as especially civilization separates, escalates and increases among all population contributing against the efforts of sustainability at any scale that is individual, systemic, or collective extent (Figueres & Rivett-Carnac, 2020; Ives, et al. 2020, 2023; Scott, et al. 2021; Wamsler, et al. 2021; Woiwode, et al. 2021; Bentz, et al. 2022; Wamsler & Bristow, 2022).

At the same time, mounting scientific evidence shows that this ability to establish deep conscious connections is ascribable to all human beings, and it can be reclaimed or intensified through various modes, at certain periods of their lives (Kegan & Lahey, 2009; Hunecke, 2018; Scott, et al. 2021; Waldinger & Schulz, 2023). For instance, mindfulness elements incorporated a range of skills and techniques currently popularized in this area. They are directed towards transformation of consumerism systemic ideology into more relational one, coupling them with a growing interest in their prowess in sustainability (Thiermann & Sheate, 2021; Bristow, et al. 2022; Wamsler, et al. 2021). Despite this, the related techniques have not been adequately utilized or modified to suit the area of sustainability leadership and education (Liao, 2022).

This paper investigates the opportunities offered by leadership and capacity building programs for sustainability transformation. Attention is focused on Programs that are meant to develop the inner self to effect market-oriented changes. Given the growing access to these types of programs to different audiences within and outside the collegial environment, a thorough assessment of their impact is needed (Woiwode, 2020; Wamsler, et al. 2021; Liao, 2022).1 This study addresses the existing gap.

This study focuses on the role of the teachers in relation to problem-solving and problem countering during the implementation phase of the Education for Sustainable Development (ESD) as an educational reform. To become proper educators of tomorrow, future teachers should obtain knowledge of the subject matter and acquire management abilities in order to promote sustainability in education. The also developed and validated instrument will assess the level of six teacher education institutes in relation to raising the students' competencies to be leaders in sustainable development education. This type of work on the development of teacher education institutes is centered around the core ideas of ESD, its specific components – environment, economy, and society, values and culture within the perspective of the faculty and student teachers.

Methods and Procedures

This research is streamlined around the pathways teachers undertake in addressing the challenges and opportunities that are related to the integration of the Education for Sustainable Development (ESD) model as an educational reform. This is targeted at equipping aspiring teachers who are graduating with both content-based knowledge and leadership on how to realise sustainability in education systems. This instrument will measure the status of six teacher education institutes in relation to education for sustainable development in preparing students as sustainable leaders focusing on the six teacher education institutes. Teacher education institutes status information focuses on the aspects of education for sustainable development (ESD) concepts residing in the pillars of environment, economy, society, and culture and values, as perceived by both the faculty and the teacher trainees. The framework of ESD in this particular study hence the prospective teachers' preparedness to assume the role of sustainable leaders is considered within the context of transformative learning theory. This theoretical lens is called at this point in time due to the tenets of transformative learning theory developed and propounded by Jack-Mezirow (2000) including the following factors:

- Searching for, or construct, and analyzing the so-called trigger
- It supports reflection on the context of the problem
- It proposes learning quite different connections, roles, and actions.
- It fosters questioning about the limitations (generated by gaps between beliefs and practices)

- It permits one to offer one's views, from the treatment outcomes returned.

This study includes an exploratory survey hybridized with ex-post facto research design because an instrument on this area was not available prior, The variables were wide and uncategorized, and an applicable theory or model for guideline didn't exist in the present time. The ex-post facto research aims at addressing a situation where an experiment has a dependent variable but manipulating it as the study is impossible due to circumstances out of the researcher's control. It captured an understanding of the meaning of ex-post facto, which is an English transliteration of the French. This is a certain type of study when the researcher cannot truely [sic] manipulate one or more of the variables of interest because the variable would be or would be some experience in the life of the subjects that would be impossible to manipulate. It attempts to establish the relationship of cause and effect of two or more variables in the natural setting (Gay et al, 2011).

Population

Researcher-developed a questionnaire for the main targeted population i.e. prospective teachers selected for generalizing the findings and validation of the tool.

According to the HEC 5th ranking list provided on its official website www.hec.gov.pk for university/degree awarding institutions recognized by Higher Education Commission. A total of 27 public and 24 private universities/DAIs were found in the list located in Punjab while only 3 public and 4 private universities could be found that were constituting education department and situated in Lahore. For private institutions following conditions were determined by the researcher:

1. Included in HEC ranking list
2. Registration of Teacher Education Program not cancelled

Sampling

The final sample of prospective teachers was of 732. At this point, following stages were determined by the researcher:

1. At this stage, universities were selected as per existence in HEC ranking list (6 universities; 3 public & 3 private)
2. Department was selected (i.e. teacher education department)
3. Prospective teachers were selected from simple random sampling (N= 732)

Table 1. *Sampling Distribution*

Sector	Universities	Departments
Public	University of Education, Lahore	Division of Edu, LMC, BRC & TC
	University of the Punjab, Lahore	Institute of Education & Research
	Lahore College for Women University	Institute of Education
Private	University of Management and Technology	Arts & Social Sciences
	University of Lahore	Faculty of Social Sciences
	Al-Minhaj University, Lahore	Faculty of Humanities

Development of the Instrument

The instrument for prospective teachers was designed based on the results of the qualitative research phase, specifically on the identified research questions. In order to

generalize what was narrated about the lived experiences of ESD researcher attempted to explore the phenomenon of preparedness as sustainable leaders on the larger sample In the present study, the researcher has practiced the practices of ESD from the general economic, social and ecological and sustainable development orientated perspectives as these findings were from the qualitative phase so it was decided by the researcher to categorize those indicators into five main sections of the questionnaire. A 34-item questionnaire with 5 major factors: ESD in Courses, ESD in institution/campus life, Sustainable Leadership Learning, Campus-based sustainable leadership practices and Sustainable Leaders Leading Community was designed.

The first factor of the questionnaire consisted of 6 items related to the education for sustainalbe development priciples/role/guidance/practices in courses of teachers education programs, the second factor included 6 items in which ESD principles/values/guidelines/practices were applied to the institute's campus life of participants. The third part of the questionnaire was about, i.e., eight items related to the sustainable leadership learning/values/practices/principles. The fourth area covered 7 items practicing campus based sustainable leadership practices. The fifth part involved seven items on practicing sustainable leadership in the society at large after completing teacher training or on the attainment of certification.

The scale used in the questionnaire was a 5-point Likert one that ranged from not at all to a very large extent. It was also expected that they would be able to rate their satisfaction as well as the extent to which they actually are ready to lead as creating screenshot of a sustainable leader. The research tool was preceded by a cover letter containing a short profile of the researcher, request for permission and explanation of the reason for the study. However, the questionnaires also had some open-ended questions where further explanation was required but were optional for the participants' to answer or leave.

The Factors, Items and Pillars of ESD

With the goal to test the language and applicability of the instrument and ensure its consistency, a pilot study was performed on 55 students of higher education. As for the analysis of the pilot study, some small revisions were made, were additionally checked for internal consistency; as for the results of the pilot study, it was determined that the internal consistency was good enough to apply the instrument onto the bigger sample (r=0.910). Part wise reliability of the instrument was also determined presented below:

Table No 2. *Reliability of the Instrument*

Parts	Items	Cronbach Alpha
Total Items	34	0.91
ESD in courses	6	0.80
ESD in Institution	6	0.80
Sustainable Leadership Learning	8	0.86
Campus-based Sustainable Leaders' Practice	7	0.84
Sustainable Leaders Learning in Community	7	0.84

The self-assessment questionnaire designed to determine the impact of ESD on readiness of prospective teachers as sustainable leaders contained 34 items and was highly reliable with an alpha value of r= .91. This module comprised 6 items related to ESD in courses (satisfaction coefficient r=0.80), this one included 6 items that focused on ESD in institution (r=0.80), this one included 8 items regarding CLL (r=0.86), this one included 7 items pertaining to campus based SL practice (r=0.84) and the last module comprised of 7 items with respect to sustainable leaders off campus practices (r=0.84).

Data Administration and Analysis

To determine the extent of ESD practices running in the teacher education institutions and the level of vulnerability of prospective teachers as sustainable leaders, data was collected from 732 prospective teachers with the help of survey questionnaire made upon 5-point Likert scale ranging from not at all to a very large extent. Data collection was solicited from the concerned university and from the respective campuses. Distribution of questionnaires involves visiting each campus and distributing among selected participants after introducing oneself. To enhance proper understanding of the distribution of instruments, the investigator briefly explained the objectives of the study. There was a deadline of three days for participants to hand back the filled in the questionnaire to the university authority, after which she went and collected from the authorities. It took rather more than one month to be able to issue and recall such completed instruments and the completed ones back to the respective university campuses. After each collection researchers give an ID number to each instrument received, to track the instrument on entering it into MS. Excel or SPSS spreadsheets.

Validation of the Instrument

Once the data was gathered, it was coded and entered the computer-based spreadsheet, after which validation was conducted. One of the objectives of utilizing exploratory sequential research was to validate pre-existing instruments that had been developed through qualitative research for expansion to include more extensive audiences. The general view, the content concerning validation and validation outcomes are outlined below. Validation was completed using some factor analysis by way of exploratory as well as confirmatory factor analysis in SPSS v. 24 and AMOS v.20 for structural equation modeling of CFA.

Factor Analysis

The most suitable methods of establishing construct validity literature had proclaimed to be the employment of factor analysis, (Pallant, 2010). Among the purposes for which factor analysis was applied in this study was, as a means of cross verifying the construct validity and reliability of the instrument that was used in this study. There are two stages when factor

analysis is applied the first one is factor analysis and that is exploratory, and the second one is confirmatory which brings it to the last phase.

Exploratory factor analysis is performed mainly to find out the interrelationships of the variables in the given data set (Pallant, 2010) and also Kerlinger & Lee (2000) emphasized that EFA's purpose is influenced by the underlying structure present in the variables themselves. The procedure involved in EFA strives to collapse the large number of items into fewer number of grouped constructs and information wastage is minimal as the grouping is done with efficiency (Wang & Wang, 2012).

Accordingly, primary factor analysis was firstly implemented by the use of the factors which had been extracted beforehand (Keith, 2014). This factor extraction was achieved from linear regression of the variables regarding the principal axis technique used. Through this, there is the possibility of assessing common and unique variances. The factors can be extracted by simple inspection of Eigenvalues. Only Eigenvalues greater than 1 were regarded as relevant for the extracted sleeves. This factor states the spasmodic values of subjects/variables whose diversity out truns within a single factor and it is up to few exceptions wherewe one snr defines what type of rotation he/ chooses to employ n center ed factor utstrra. For factor extraction purposes, orthogonal rotation had been the choice in this article. The use of orthogonal rotation has been known to lead to interpretational and reporting efficiencies of the results Anne. In the orthogonal rotation for this study, the Varimax method was used. Varimax rotation method had been used so much for the total number of items of the instrument has been reduced under the factors of those having significant loads (Pallant, 2010).

Preliminary Analysis for Factor Analysis

To prepare the data for factor analysis, the authors check for missing values and the normality of the data. The Data Normality is discussed as per Kolmogorov-Smirnov & Shapiro-Wilk tests of Normality.

There was an evaluation of descriptive statistics and frequencies to analyze if any of the values were missing and if so how many. Missing values were found within the available data set: there were two items with 5 missing values in total but it was found by the researcher that these missing values were simply due to technical error and to overcome this, mean values bias has been reported to explain this problem and a solution of how to do it is offered by Lattin, Carroll & green (2003). The data was normalized and ideas were put forth regarding what the prerequisites to factor analysis would be: normality; linearity; homogeneity; outliers.

Table No. 3. *Tests of Normality*

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Total	.040	732	.008	.993	732	.002

a. Lilliefors Significance Correction

The normality tests were included as a must before performing factor analysis as well as SEM analysis. Both the Shapiro-Wilks test and Kolmogorov – Smirnov have been performed and Yes from the above both set table values were statistical significant i.e. $p<.05$ however Pallant (2010) claimed that the value of p (>0.05) is a good indication of normality which was the opposite in our case, both the values are significant. According to Pallant

(2010), however, this is not often the case, where it is well known that large sample sizes in the region of our N= 732 almost always breach the citrus normality assumption.

For this purpose, further analysis of the data and the graphs are taken into consideration.

Table No. 4. *Summary of Descriptive Statistics of the Data*

Total ESD practices Perceived		***Statistic***	***Std. Error***
Mean		3.3038	.01886
95% Confidence Interval for Mean	Lower Bound	3.2668	
	Upper Bound	3.3408	
5% Trimmed Mean		3.3105	
Median		3.3514	
Variance		.260	
Std. Deviation		.51016	
Minimum		1.86	
Maximum		4.73	
Range		2.86	
Interquartile Range		.73	
Skewness		-.175	.090
Kurtosis		-.387	.180

The statistics shown in the above table indicated that, overall, Mean M=3.30 with the standard deviation S.D= 0.018 with the interpretation of the mean range being in the mid-range of perceptions which is moderately low and moderately high. Also, if one examines the 5% trimmed mean, he will see that taking away extreme scores, that is, 3.31, is very low. It may be noted that the difference between the actual average and that which is a 5 percent trimmed average is not critical and according to Pallant for large differences then the concerns would be the outliers because such data points would be most influential. Here it is seen that the extreme mean scores of the data do not have such a high effect and therefore the data can be applied for further investigation.

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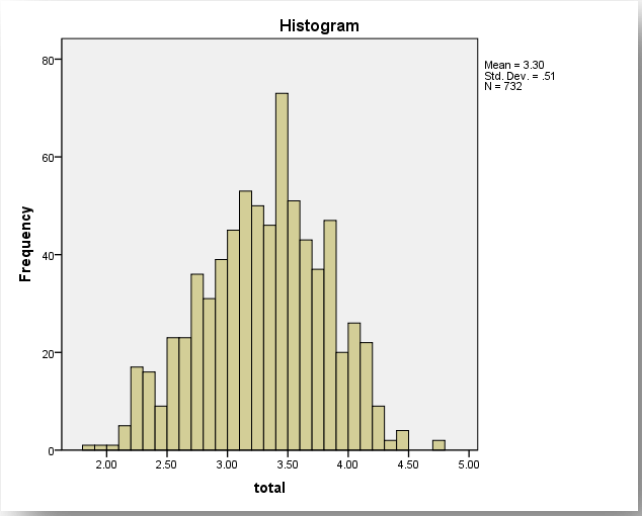

Figure. 1 Histogram of Normality

The general shape of the distribution of overall students' data can be seen in the above histogram. The scores appear to be reasonably normally distributed. This is also supported by the next graph i.e. Q-Q Plot.

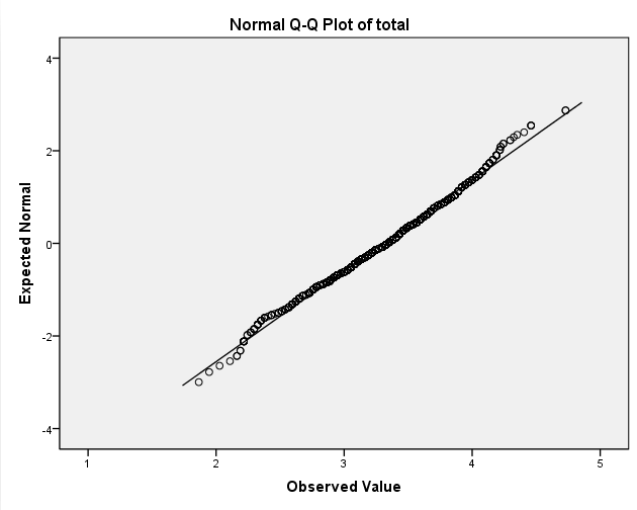

Figure. 2. Q-Q Plot of Linearity

In the above graph, the observed value for each score had been plotted against the expected value of the normal distribution. A reasonably straight line indicated a normal distribution (Pallant, 2010).

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Analyzing Outliers

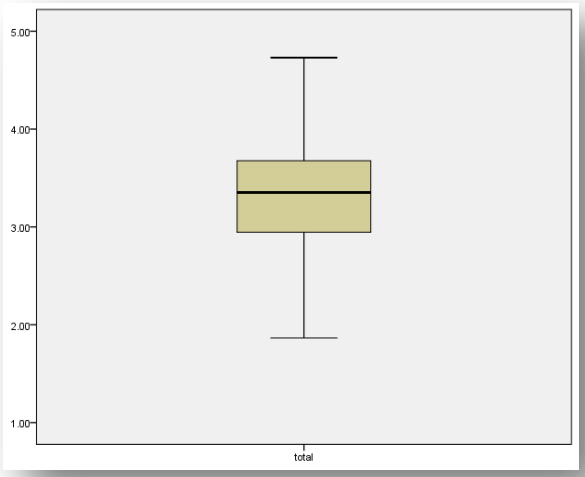

Figure. 3. Boxplot of Outliers

The figure included in the above table illustrated a boxplot depicting the distribution of the variables for both groups. The rectangle showed 50% of the cases and the extending lines from the box/rectangle were extended out to the lowest and the highest scale values. This has indicated that the mean scores are estimated to be in the region of 1.80 to 4.75 on the average where the rectangle indicated about the mean overall average of the data ranging from 3.00 to 3.50. The ranges indicated in the above boxplot do not have outliers. From all the above table and graphs meant for producing normality of the data, it is demonstrated that the distribution was fairly normal and even if it was skewed or the normality tests showed it was not significant, this is not perceived as a problem with the instrument. For this Pallant (2010) in the SPSS survival manual such issues whereas target behavior might possess all the factors explained and, therefore, depended on the instrument from the framework could be dismissed (Khan & Adil, 2013).

Exploratory Factor Analysis

Primarily, such analysis tries to reduce the number of factors influencing ESD procedures and correlate them into categories that possess similar characteristics (Bollen, 1984). The focus here is on determining the strong and relevant factors (Cohen, Cohen, West, & Aiken, 1983) to be included in the model, and the weak and irrelevant ones to be excluded, thus arriving at a model with the least number of most influential factors (Wang & Wang, 2012). The sequential presentation of EFA is outlined in the figure below.

Factor Extraction-- This stage is aimed at determining the least number of factors that may use or show how the groupings of the variables are related (Brown, 2003). Such techniques of factor extraction include (Pallant, 2005). In this work, it is attempted to use Principal Component Analysis Brief PCA to determine the latent structure. This investigation encompassed three methodologies for factor retention:

1. Kaiser's Criterion-- This is sometimes called as Eigenvalue principle. This criterion indicates that only factors having an eigenvalue of atleast 1 will be retained and serves as a rule of thumb. It explains the amount of total variance of the system which is attributable to the particular component only.

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2. Screen Test-- According to Cattell's (1966). This procedure is carried out by plotting all the defining factors and all the factors eigenvalues' associated with it (in this case an automated procedure in SPSS) and analyzing the graph looking for the point when the curve beings to grow and then flattens quite clearly forming a non-growing curve. In the scree plot which consists of all the factors obtained from above the inflection point of the curve it is assumed that any variance above them has to be incorporated in that data set.
3. ***Parallel Analysis***-- According to Horn's (1965). For this application a set of eigenvalues of a matrix are analyzed and compared with a set of equivalent size but generated at random. In this procedure, it is easy to use coping strategy. Only eigenvalues masked above the random dataset values are held. This procured represents the definite number of factors which has been cross checked with the factors obtained through the Kaiser's Criterion and Scree plot (Hubbard & Allen, 1987). The below table and scree plot represent the ESD procedures which were Eigens from the analyses carried out in this study.

Table No. 5. *Factor Organization with Eigen Value*

	Initial Eigenvalues			***Extraction Sums of Squared Loadings***			***Rotation Sums of Squared Loadings***		
Factors	Total	Variance %	Cumulative %	Total	Variance %	Cumulative %	Total	Variance %	Cumulative %
1	9.857	28.992	28.992	9.857	28.992	28.992	4.076	11.989	11.989
2	2.998	8.817	37.809	2.998	8.817	37.809	3.812	11.212	23.202
3	2.149	6.319	44.128	2.149	6.319	44.128	3.706	10.899	34.101
4	1.561	4.593	48.721	1.561	4.593	48.721	3.334	9.805	43.906
5	1.243	3.656	52.377	1.243	3.656	52.377	2.773	8.155	52.061
6	1.045	3.073	55.45	1.045	3.073	55.45	1.152	3.389	55.45

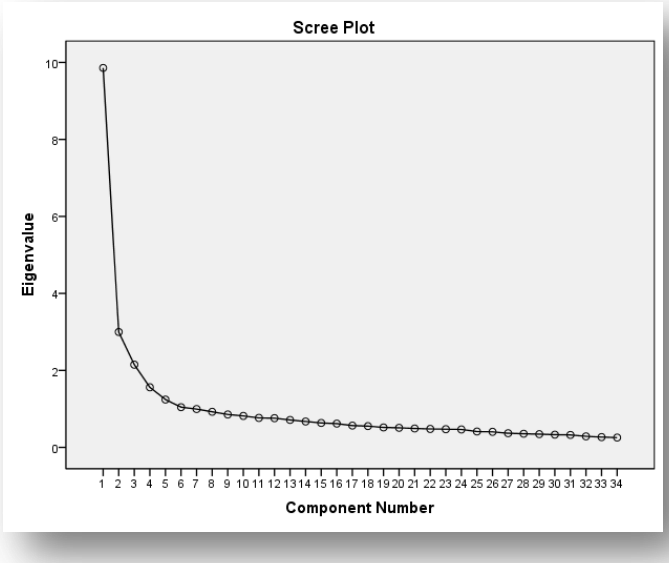

Figure. 4. Scree Plot of Extracted Factors

The above table and scree plot displayed the factor organization and structure with the help of Eigenvalues. All the Eigenvalues greater than 1 were identified for ESD practices in the instrument. 6 main components were identified containing Eigenvalue> 1.

Table No. 6. *Principal Component Factor Analysis*

Component Matrix(a)						
Items	**Component**					
	1	**2**	**3**	**4**	**5**	**6**
PrR	0.65					
GeR	0.64					
CMR	0.62					
OLL	0.62					
Ppsj	0.61					
SY	0.61					
SSot	0.61					
BSR	0.60					
CD	0.59					
PrE	0.59					
GC	0.57					
CMR	0.57					
VP	0.57					
EcE	0.57					
Less	0.56					
MP	0.56					
BRDM	0.55					
Maybe	0.55					
EcS	0.54					
SAR	0.53					
QPSS	0.52					
BG	0.52					
CGN	0.49					
As	0.47					
EcEc	0.46					
RGD						
Awi		0.61				
TO		0.59				
Uwbp		0.52				
PO		0.50				
PC		0.50				
Ahs	0.44					
RP	0.44		0.53			
PE	0.51		0.53			

a. 6 components extracted.

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Extraction Method: Principal Component Analysis.

The table mentioned earlier was in relation to ESD practices. These were suppressed due to their low coefficient value and indicated in *italic* as values less than 0.30 were omitted form the component matrix tables.

Rotation and Interpretation of the Factors-- After deciding on Eqs and elements from the eigenvalues, another order was taken to their analysis and comprehension. Towards this end, it will be worthy to rotate the factors; this is not meant to alter the fundamental solution but to shed more light on how the factor is produced thereby making the analysis easier (Pallant, 2010). The study also applied the Varimax rotation, since it is the commonest (Pallant, 2010) rotation method among social science investigators. It is one of the techniques of reducing the number of factors that have high loadings on any one factor. Subsequent tables demonstrate the process of rotation:

Table No. 7. *Rotation in Principal Component Factor Analysis*

Rotated Component Matrix(a)						
Items	**Component**					
	1	2	3	4	5	6
EcEc	0.71					
SAR	0.70					
EcEc	0.67					
EcS	0.67					
QPSS	0.67					
GeR	0.63					
SY	0.59					
PPSJ		0.69				
CMR		0.69				
LMSS		0.68				
SSOT		0.66				
CER		0.63				
Mpyb		0.56				
OLL		0.55				
Awi			0.79			
Ahs			0.74			
UWbp			0.72			
PC			0.70			
TO			0.68			
AS			0.64			
PO			0.49			
PE				0.73		
RP				0.69		
GC				0.68		
MP				0.67		
CG				0.62		

RGD	0.53		
BeG		0.72	
PrE		0.65	
CD		0.56	
VaP		0.56	
BSR		0.55	
BRDM		0.44	
PrR			0.46

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 6 iterations.

The table above indicates that the practices were suitable: all the practices were successfully loaded. Six practices were successfully loaded. Therefore, two practices were reevaluated because of the subcomponents resolved into cross-loadings, and the investigator concluded that those components that contributed large percentages within cross-loadings would be selected for those things. For all practices together 32 out of 34 were successfully loaded attachments, there were no cross-loadings, and differences in standard errors were also absent. Therefore, the super transportation ESD techniques have been conveniently condensed down to six basic features as mentioned earlier. The only item which is mentioned as 'resource endangerment, but capable of protecting resources' was kept in the 6th component and will not be covered in assuring the reliability co-efficient.

Reliability Coefficients

This section shows the reliability coefficient of overall ESD practices of students and for factors too. Cronbach alpha was computed for the purpose of measuring the internal consistency of the instrument. The details are shown in the table below:

Table No. 8. *Reliability Coefficient of New Factors*

Factors	**No. of Items**	**Cronbach's Alpha**
ESDC	7	0.844
ESDI	7	0.843
SLL	7	0.843
CSLP	6	0.795
SLLC	6	0.796
Component 6	Deleted	--
Total	**34**	**0.923**

The table above shows the Cronbach alpha value of all items after loading. The total reliability coefficient r =0.923 states that the items exhibited high internal dependability. Also shown in the above table is the reliability of each component after loading, with component 1 having the highest reliability value of r = 0.844 while components 2 and 3 had a reliability coefficient of 0.843 respectively. Component 4 and component 5's values were 0.795 and 0.796 respectively which still correspond dependable coefficient. Since changing some of the loadings resulted in the elimination of component 6, only one item was left. By Pallant (2010) in SPSS Survival Manual, it is preferable that all the components should have three or more loadings focused on one or more variables.

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Confirmatory Factor Analysis

Confirmatory factor analysis (CFA) seeks to test specific hypotheses regarding relationships among observed variables and underlying constructs, as planned and pertained to development (Lee et al, 2013). It argues that latent variables influence other latent variables within a value model with respect to changes that occurs either directly or through mediation (Schumacker & Lomax, 2004). Confirmatory factor analysis was done through AMOS version 18. Five factors were extracted from the EFA which can be defined in detail includes: Sustainable Leadership Learning, Sustainable Leadership Learning in Courses, Content of Sustainable Leadership in Programs, Education for Sustainable Leadership Commitment and Education for Sustainable Development Initiatives analyzed with 34 observed variables. Finally, Confirmatory factor analysis analyses the acceptability of observable variables and interrelation for every latent factor (Joreskog & Sorbom, 1989, Daniel, 1989).

Reliability of Observed Variable-- The extent to which the variance is explained by a construct as opposed to some random error. The extreme value of squared factor loadings obtained through EFA should be above 0.50. On the other hand, the cut-off for low loadings is usually between 0.30 and 0.50, which are regarded as average loadings, whereas anything below that is considered below average (Holmes-Smith, 2002). Therefore, all data considered in the present model that are marked as less than 0.30 are removed.

The validity of Observed Variable-- is the extent of accuracy to what they are expected to measure (Hair *et al*, 1998). It is drawn by determining the significance level between the observed and latent variable (Anderson & Gerbing, 1988).

Model Evaluation-- The model fit test is done to determine if the model in question is statistically null or, in other words, whether the estimated model is as good as the null model in the part where an index does away with the negative of a sample, which is the use of use, variance analysis in sample (Bentler, 1990). If both are not different and different, then it suggests that the data collected supports the model and therefore the proposed relationships among the parameters of interest are there. On the other hand, if they do not, it means that the relationship between the data collected, and the model does not hold and the assumption must be rejected. A number of experts have suggested that when assessing model fit, it should not be the case that a single measure is used but more than one index should be looked at in order to reduce arguments based on wrong model fit discussions and arguments (Bentler, 2010; Wang & Wang, 2012). Other reporting indices in these specialist reports comprise of Chi-squared statistics, RMSEA, CFI, TLI, and SRMR that have been classified as reporting indices.

i. ***Chi-Squared Statistics***-- The most used approach to fit a statistical model is to compare the obtained chi-square measure with the corresponding degrees of freedom, which requires for acceptable levels that this difference should equal or be less than 3.0 (Hu & Bentler, 1999). Also, the degree-of-freedom-corrected chi-square is completely dependent on the normality of the distribution and may be affected by larger sample sizes (Schumacker and Lomax, 2004), therefore it shouldn't be used unsupported for model fitness evaluation (Wang & Wang, 2012). The chi-squared statistic is given in the following equation:

$$\chi^2 = f_{\mathrm{ML}}(N-1)$$

Where the following table illustrates the x^2 statistics for the model fit evaluation of this study:

Table No. 9. x^2 Statistics in Model Fit

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Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	104	1038.374	360	.000	2.884
Saturated model	464	.000	0		
Independence model	58	8251.985	406	.000	20.325

The above table indicated the Chi-square minimum value in accordance with the degree of freedom equals to be 2.88 i.e. < 3.0, which showed that the model is acceptable enough to be considered fit. Further indices are also evaluated below.

ii. ***CFI (Computer Fit Index)***-- This test, created by Bentler (1990), is designed to compare the suggested model with the null model, which assumes zero covariances among the observed variables. The CFI index value ranges from 0 to 1, with values over 0.90 indicating a satisfactory fit (Hu & Bentler, 1999). The formula for the Comparative Fit Index (CFI) is as follows:

$$CFI = \frac{d_{null} - d_{specified}}{d_{null}}$$

iii. ***TLI (Tucker-Lewis Index)*** -- Initially proposed by Tucker and Lewis in 1973, it was subsequently called the Non-Normed Fit Index (NNFI) by Bentler and Bonett in 1980. The given model should be compared to a null model, such as the CFI, which should not be less than 0.90 to indicate a satisfactory match (Wang & Wang, 2012). The statistical formula for TLI is as:

$$TLI = \frac{\left(\frac{\chi^2_{null}}{df_{null}} - \frac{\chi^2_{specified}}{df_{specified}}\right)}{\left(\frac{\chi^2_{null}}{df_{null}} - 1\right)}$$

The subsequent table indicates the Computer Fit Index (CFI) and Tucker-Lewis Index (TLI) for the model fit evaluation of this study:

Table No. 10. *Computer Fit Index and Tucker-Lewis Index for Model Fit*

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.874	.858	.914	.902	.914
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

The above table demonstrated the Computer Fit Index value to be 0.914 i.e. greater than 0.90 and Tucker-Lewis Index value equals to 0.902 i.e. also not less than 0.90; ultimately showed a good model fit.

iv. ***RMSEA (Root Mean Square Error of Approximation)*** -- It is one of the contemporary model fit indexes established by Browne and Cudeck (1993). It illustrates the inaccuracy relative to the degrees of freedom within the population data and the proposed or designated model. The RMSEA value should range from 0.05 to 0.10; values below 0.05 suggest a good match, 0.08 an acceptable fit, and 0.10 a moderate fit, while values over

0.10 are deemed unacceptable (Browne & Cudeck, 1993). The statistical formula for RMSEA is as:

$$RMSEA = \sqrt{\frac{(\chi_S^2 - df_S)/N}{df_S}} = \sqrt{\frac{(\chi_S^2/df_S) - 1}{N}}$$

v. *RMR (Root Mean square Residual)* -- It is a model fix index based on residual. It was introduced by Joreskog & Sorbom (1984). This is meant to draw a difference among the elements of the specified model with that of the null model. The statistical formula for RMR is as:

$$RMR = \left(\sum_j \sum_k (s_{jk} - \hat{\sigma}_{jk})^2 \Big/ e \right)^{1/2}$$

The subsequent table indicates the RMSEA and RMR for the model fit evaluation of this study:

Table No. 11. *Root Mean Square Error of Approximation for Model Fit*

Model	RMSEA	RMR	PCLOSE
Default model	.051	.047	.357
Independence model	.163		.000

The above table indicated the RMR = 0.047 and RMSEA value equals 0.051 indicating to be a good fit as specified by Browne & Cudeck (1993). Following is the diagrammatical illustration of the final model after evaluating fitness in CFA.

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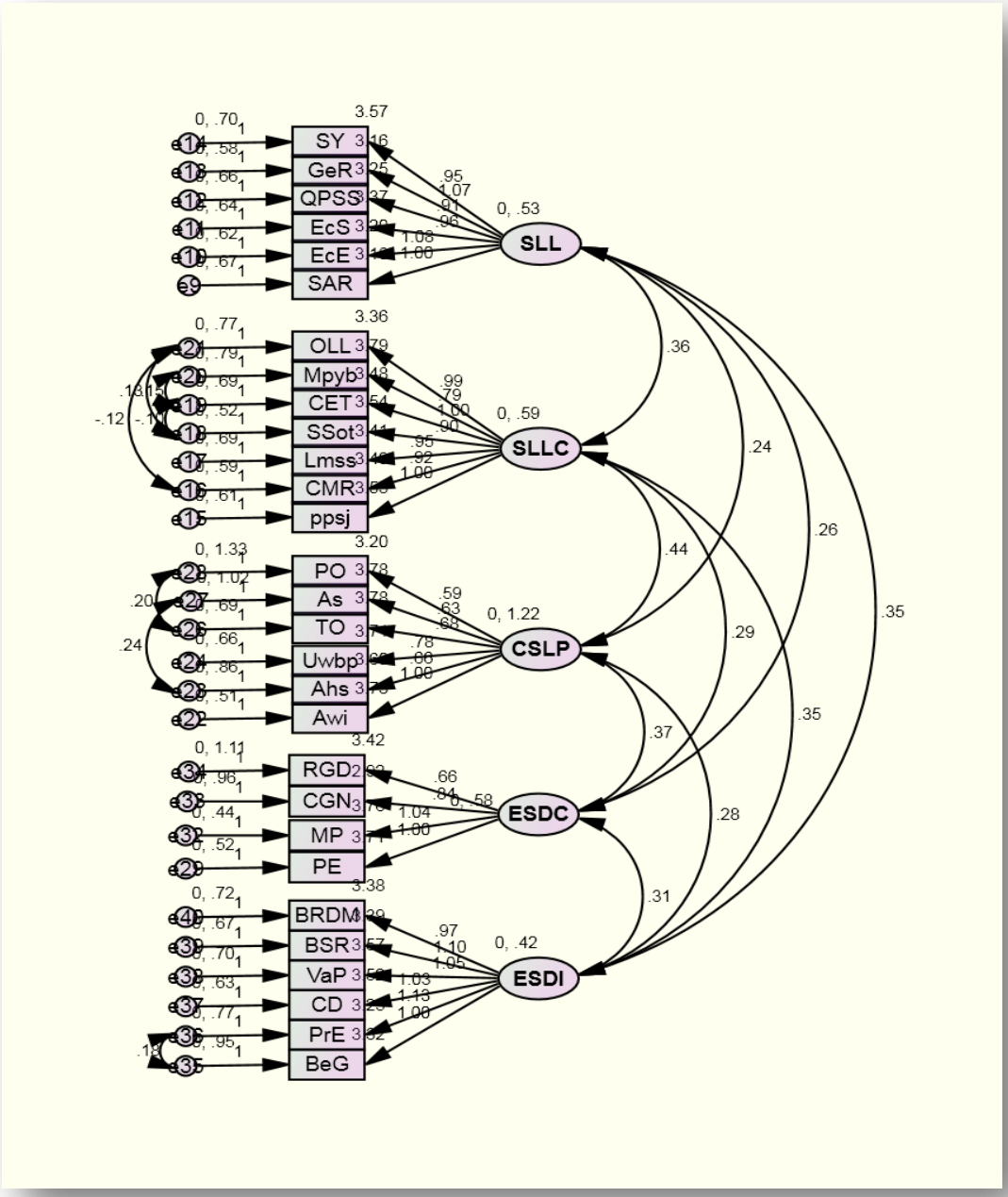

Figure. 5 CFA Model

Descriptive Statistics for New Factors

Means, standard deviations and other descriptive statistics always give a broad overview of the data. This study constituted the Likert scale items which pertain to the mean responses of students and teachers on ESD practices and the student's future roles as sustainable leaders. Standard deviation has always served the purpose of indicating the average deviation from the mean. Higher mean scores will lead to lower standard deviations and vice versa. Minimum and maximum scores were used to indicate the range of perceptions participants were having.

According to the loadings, which are presented in the next table, we can observe that the values of all mean scores are more than 3.00 on a Likert scale in the opinion of prospective teachers regarding the ESD practices and the future practices of ESD where community-based practices are focused on sustainability leadership. The mean is within the range of 3.28 to 3.70 which implies that levels of practice are moderate. The standard deviation measures for all ESD practice measures range between 0.76 and 0.85. The Pearson correlation used; demonstrated the degree to which factors are related to each other linearly and where a slop is inclined either upward or downward illustrated the degree where factors are related.

Table No. 10

Descriptive Statistics after Factor Loadings

Correlations

Factors	Mean	St. Dev		One	Two	Three	Four	Five
One	3.29	0.787	Pearson Correlation	1				
Two	3.517	0.781	Pearson Correlation	.537**	1			
Three	3.66	0.865	Pearson Correlation	.249**	.476**	1		
Four	3.477	0.777	Pearson Correlation	.387**	.426**	.362**	1	
Five	3.45	0.77	Pearson Correlation	.600**	.571**	.337**	.521**	1

The above table indicated the high degree of correlation between the factors which increased the probability of an elevated level of multicollinearity. All of the practices were found to be significantly correlated with each other.

Conclusion and Discussion

Attempting to measure the preparedness of prospective teachers as sustainable leaders, the researcher tried to construct sharable questionnaire. Her questionnaire was divided in to 5 main sections such as ESD in coursework, ESD in institution, Learning Sustainable Leadership, Campus based sustainable leadership activities and sustainable leadership off campus. Questionnaire was distributed among practices for many prospective teachers. The instrument was validated qualitatively with the aid of exploratory and confirmatory factor analysis and presented with a model fit diagram as evidence to prove that the instrument could be used in statistical analysis of data on its collected attributes. Factor analysis yielded the following thoughtful results: matching methods were used to fix missing data, which were

determined to be a technical issue. Although kurtosis and skewness were shown to be statistically significant (they ought to have been negligible), neither the 5% trimmed value nor the accompanying visual representation of the data showed any outsized impact on the component variables. Prospective educators' data did not contain any outliers. The use of eigenvalue allowed for the identification of six distinct components. Finally, only five can be included in the form. In all, 32 out of 34 items were loaded without any cross-loadings. The items' high level of internal dependability was supported by the overall reliability coefficient of 0.923. We deleted from the model all values that were determined to be less than 0.30. The model was deemed appropriate since the minimal Chi-square value, according to the degree of freedom, was 2.88, which is less than 3.0. A excellent model fit was demonstrated by the Computer Fit Index value of 0.914, which is more than 0.90, and the Tucker-Lewis Index value of 0.902, which is also greater than 0.90. It seems like an excellent fit, with an RMR of 0.047 and an RMSEA of 0.051. The moderate practices are indicated by a range of the mean between 3.28 and 3.70. Significant correlations were seen between all of the activities.

The findings successfully concluded that the instrument is considerably valid to be used on the larger sample. The construct validity of this instrument is ample and thus a trustworthy tool to measure the concepts of ESD and sustainable leadership in educational institutes of Pakistan.

Based on the findings, it can be concluded that Pakistan requires improvement in the number of researchers in the area of sustainable development, education for sustainable development and sustainable leadership. Certainly, the country has to move in this direction if it wants to keep up with the world. Researchers And research at national level should assist the government and international organizations producing and executing policies and plans to enable the country to achieve sustainable development through educating its people.

References

Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychological bulletin*, *107*(2), 238.

Bentler, P. M. (2010). SEM with simplicity and accuracy. *Journal of Consumer Psychology*, *20*(2), 215-220.

Bentler, P. M., & Bonett, D. G. (1980). Significance tests and goodness of fit in the analysis of covariance structures. *Psychological bulletin*, *88*(3), 588.

Bentz, J., O'Brien, K., & Scoville-Simonds, M. (2022). Beyond "blah blah blah": exploring the "how" of transformation. *Sustainability Science*, *17*(2), 497-506. https://doi.org/10.1007/s11625-022-01123-0

Bollen, K. A. (1984). Multiple indicators: Internal consistency or no necessary relationship? *Quality and Quantity, 18*(4), 377-385.

Bristow, J., Bell, R., & Wamsler, C. (2022). Reconnection: Meeting the climate crisis inside out. https://www.themindfulnessinitiative.org/Handlers/Download.ashx?IDMF=8d56bcb4-15a0-4b39-9236-064eb302ef99.

Browne, M. W. (1993). Testing structural equation models. *(No Title)*, 136.

Cattell, R. B. (1966). The scree test for the number of factors. *Multivariate behavioral research*, *1*(2), 245-276.

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (1983). *Applied multiple regression/correlation for the behavioral science*s.

Daniel, L. G. (1989). *Comparisons of Exploratory and Confirmatory Factor Analysis*.

Figueres, C., & Rivett-Carnac, T. (2020). The Future We Choose: Surviving the Climate Crisis (Illustrated Edition).

Gay, L. R., Mills, G. E., & Airasian, P. W. (2011). *Educational research: Competencies for analysis and applications*: Pearson Higher Ed.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2006). Multivariate data analysis (Vol. 6).

Holmes-Smith, P. (2002). Applied structural equation modeling. *Feburay, Canbera*.

Horn, J. L. (1965). An empirical comparison of methods for estimating factor scores. *Educational and Psychological Measurement*, *25*(2), 313-322.

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural equation modeling: a multidisciplinary journal*, *6*(1), 1-55.

Hubbard, R., & Allen, S. J. (1987). An empirical comparison of alternative methods for principal component extraction. *Journal of Business Research*, *15*(2), 173-190.

Hunecke, M (2018) *Psychology of sustainability: psychological resources for sustainable lifestyles*. In: Hunecke M (ed) *Personal sustainability: exploring the far side of sustainable development*. Routledge, London, pp 33–50

Ives, C. D., Freeth, R., & Fischer, J. (2020). Inside-out sustainability: The neglect of inner worlds. *Ambio*, *49*, 208-217. https://doi.org/10.1007/s13280-019-01187-w

Ives, C. D., Schäpke, N., Woiwode, C., & Wamsler, C. (2023). IMAGINE sustainability: integrated inner-outer transformation in research, education and practice. *Sustainability Science*, *18*(6), 2777-2786. https://doi.org/10.1007/s11625-023-01368-3

Jöreskog, K. G., & Sörbom, D. (1984). Analysis of linear structural relationships by maximum likelihood, instrumental variables, and least sqsuares methods. *(No Title)*.

Kegan, R., & Lahey, L. L. (2009). *Immunity to change: How to overcome it and unlock the potential in yourself and your organization*. Harvard Business Press.

Keith, T. Z. (2014). *Multiple regression and beyond: An introduction to multiple regression and structural equation modeling*: Routledge.

Kerlinger, F. N., Lee, H. B., & Bhanthumnavin, D. (2000). Foundations of behavioral research: The most sustainable popular textbook by Kerlinger & Lee (2000). *Journal of Social Development Volume*, *13*(2), 131-144.

Khan, M. N., & Adil, M. (2013). Data analysis techniques in service quality literature: Essentials and advances. *Serbian Journal of Management, 8*(1), 95-112.

Lattin, J. M., Carroll, J. D., & Green, P. E. (2003). Analyzing Multivariate Data: Brooks. *Cole, an imprint of Thomson Learning, United States of America*.

Li, H. C. W., Williams, P. D., Williams, A. R., Chung, J. O., Chiu, S. Y., & Lopez, V. (2013). Confirmatory factor analysis of the Chinese version of the Pediatric Quality-of-Life Inventory cancer module. *Cancer Nursing*, *36*(6), E66-E72.

Liao, Y. (2022). Sustainable leadership: a literature review and prospects for future research. *Front Psychol 13*. https://doi.org/10.3389/fpsyg.2022.1045570

Mezirow, J. (2000). *Learning as Transformation: Critical Perspectives on a Theory in Progress. The Jossey-Bass Higher and Adult Education Series*. Jossey-Bass Publishers, 350 Sansome Way, San Francisco, CA 94104.

Pallant, J. (2005). SPSS survival guide. *Crow's Nest, NSW: Allen & Unwin*.

Schumacker, R. E., & Lomax, R. G. (2004). *A beginner's guide to structural equation modeling*. psychology press.

Scott, B. A., Amel, E. L., & Manning, C. M. (2021). *Psychology for sustainability*. Routledge.

Thiermann, U. B., & Sheate, W. R. (2021). The way forward in mindfulness and sustainability: a critical review and research agenda. Journal of Cognitive Enhancement, 5, 118-139. https://doi.org/10.1007/s41465-020-00180-6

Tucker, L. R., & Lewis, C. (1973). A reliability coefficient for maximum likelihood factor analysis. *Psychometrika*, *38*(1), 1-10.

Waldinger, R., & Schulz, M. (2023). *The good life: Lessons from the world's longest scientific study of happiness*. Simon and Schuster.

Wamsler, C., Bristow, J., Cooper, K., Steidle, G., Taggart, S., Søvold, L., ... & Legrand, T. (2022). Theoretical foundations report: Research and evidence for the potential of consciousness approaches and practices to unlock sustainability and systems transformation. Report of the UNDP Conscious Food Systems Alliance (CoFSA), United Nations Development Programme UNDP. https://www.contemplative-sustainable-futures.com/_fles/ugd/4cc31e_143f3bc24f2c43ad94316cd50fbb8e4a.pdf. Accessed 23 May 2023

Wamsler, C., & Bristow, J. (2022). At the intersection of mind and climate change: integrating inner dimensions of climate change into policymaking and practice. *Climatic Change*, *173*(1), 1-22. https://doi.org/10.1007/s10584-022-03398-9

Wamsler, C., Osberg, G., Osika, W., Herndersson, H., & Mundaca, L. (2021). Linking internal and external transformation for sustainability and climate action: Towards a new research and policy agenda. *Global Environmental Change*, *71*, 102373. https://doi.org/10.1016/j.gloenvcha.2021.102373

Wamsler, C., & Osberg, G. (2022). Transformative climate policy mainstreaming–engaging the political and the personal. *Global Sustainability*, *5*, e13.. https://doi.org/10.1017/sus.2022.11

Wamsler, C., Schäpke, N., Fraude, C., Stasiak, D., Bruhn, T., Lawrence, M., ... & Mundaca, L. (2020). Enabling new mindsets and transformative skills for negotiating and activating climate action: Lessons from UNFCCC conferences of the parties. *Environmental science & policy*, *112*, 227-235. https://doi.org/10.1016/j.envsci.2020.06.005

Wang, J., & Wang, X. (2012). *Structural equation modeling: Applications using Mplus*: John Wiley & Sons.

Woiwode C, Schäpke N & Bina O et al (2021) Inner transformation to sustainability as a deep leverage point: fostering new avenues for change through dialogue and refection. Sustain Sci 16:841–858. https://doi.org/10.1007/s11625-020-00882-y

Woiwode, C. (2020). Inner transformation for 21st-century futures: the missing dimension in higher education. *Environment: Science and Policy for Sustainable Development*, *62*(4), 30-38. https://doi.org/10.1080/00139157.2020.1764299