Literature scan – climate change education

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1.1. Objective:

The objective is to produce a systematic mapping of the literature on climate change education.

1.2. Method:

Corpus construction

1. Six review addressing the objective were identified and summarised in Freebody…(2021).
2. The reference lists from these six reviews were obtained from Scopus along with their reference details and abstracts – this initial corpus consisted of ~550 references.
3. The list was filtered for those references without abstracts and duplicates – the resulting list consisted of 317 references. The full corpus is contained in the reference list. The table below contains some descriptive statistics of the corpus.

Year	**No.**
<2000	37
2000-2009	102
2010 - 2019	178
N	317
Citation information	
Average no. of citations	183.74
Min no. of citations	2
Max no. of citations	15162
Average of no. citations per year	14.30
Common sources	**No**.
Environmental Education Research	65
International Journal of Science Education	14
International Journal of Sustainability in Higher Education	16
International Research in Geographical and Environmental Education	9
Journal of Cleaner Production	9
Journal of Geoscience Education	17
Journal of Research in Science Teaching	8
Sustainability (Switzerland)	7
Other	172

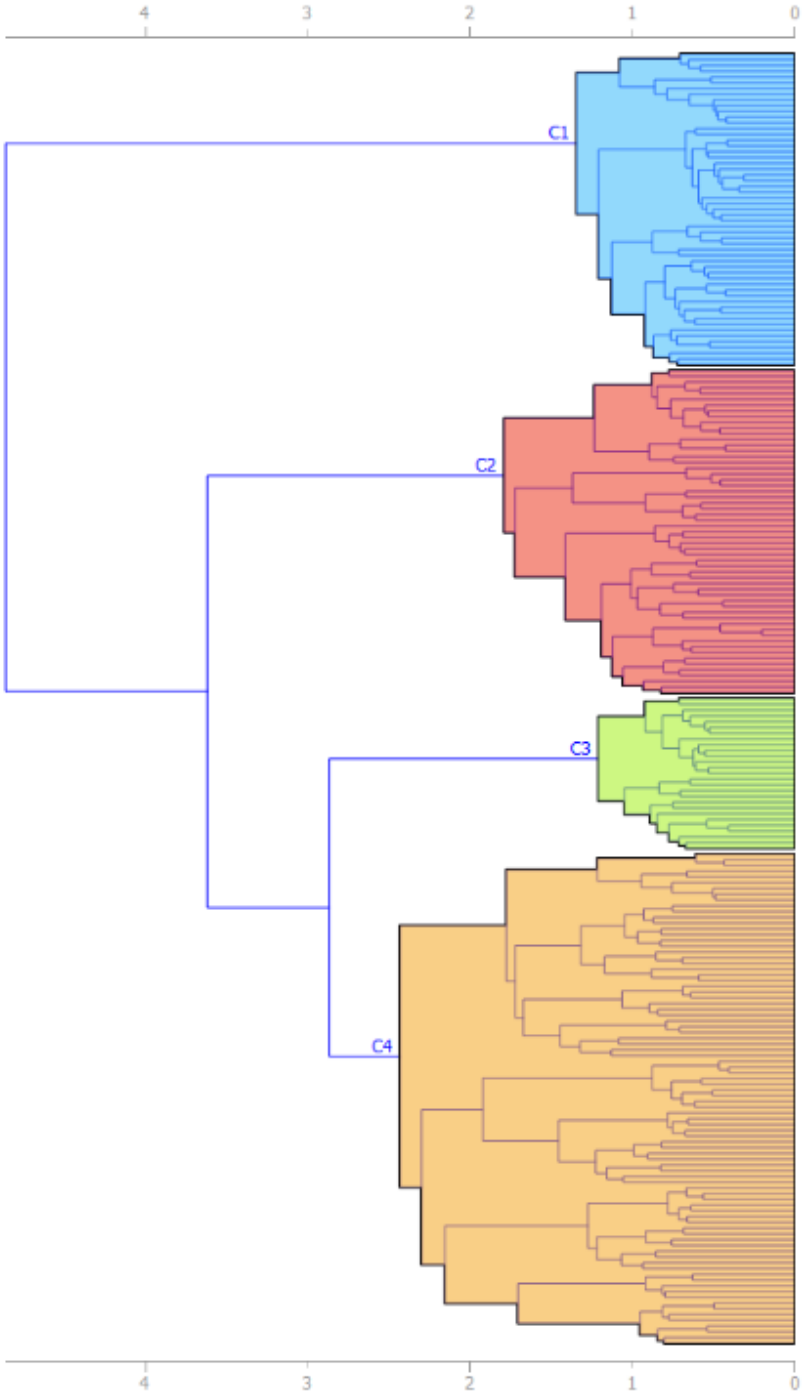
Text pre-processing

4. Standard pre-processing techniques were applied to the corpus - The abstracts of the corpus articles were tokenized and lemmatized and bigrams were identified. The article abstracts were then filtered of common English stop words (the standard Python NLTK stop word list with the addition of the words: study, research, result, paper, data, finding, analysis, implication, article,

method, methodology) and tokens that appeared in less than five percent or more than 90% of articles.

Cluster analysis

5. Hierarchical cluster analysis was performed using word counts and a cosine distance matrix. Ward's agglomerative method was used in the clustering algorithm. Visual inspection of the resulting dendogram and analysis of the clustered article abstract suggested a parsimonious four cluster solutions. The resulting dendogram is shown below (the dendogram has been pruned to show a maximum depth of 10):



1.3. Results

Cluster Descriptions

Some basic descriptive statistics generated from the four identified cluster are listed in the tables below:

C1	
Count published yrs 2000-2009	8
Count published yrs >2009	60
Avg. Citations	98.19
Avg. citations per year	12.46
Avg. Citations of top 10	504.30
Avg. citations per year of top 10	63.81
C2	
Count published yrs <2000	8
Count published yrs 2000-2009	17
Count published yrs >2009	36
Avg. Citations	52.07
Avg. citations per year	4.02
Avg. Citations of top 10	149.20
Avg. citations per year of top 10	10.54
C3	
Count published yrs <2000	14
Count published yrs 2000-2009	12
Count published yrs >2009	7
Avg. Citations	41.58
Avg. citations per year	2.85
Avg. Citations of top 10	106.80
Avg. citations per year of top 10	7.62
C4	
Count published yrs <2000	15
Count published yrs 2000-2009	65
Count published yrs >2009	75
Avg. Citations	303.37
Avg. citations per year	21.58
Avg. Citations of top 10	3,281.70
Avg. citations per year of top 10	225.12

Cluster content

To explore the content of the clusters, tokens with high predictive content for each cluster were identified by selecting those tokens with high frequency (p-value<0.05) and a low false discovery rate in comparison to the other clusters (FDR<0.2)

The list of tokens in order of predictive content for each cluster are presented below:

C1	C2	C3	C4
Climate Change	***Global Warming***	***environmental education***	***sustainability***
Climate Change Education	***Greenhouse Effect***		***sustainable development***
Climate Science	***Ozone layer***		***higher education***
impact	***student***		***practical***
risk	***depletion***		
science			

Key articles by cluster

Finally, the descriptor tokens for each cluster were used to identify articles that were relatively central in the content of their abstracts within each cluster. The five articles with the highest citation rate per year for each cluster are listed below.

Cluster	Title	Cit. per year	Year	Author/s
C1	Climate change impacts on global food security	128.1	2013	Wheeler T., Von Braun J.
	Cultural dimensions of climate change impacts and adaptation	70.2	2013	Adger W.N., etal.
	Communicating climate change risks in a skeptical world	11.1	2011	Sterman J.D.
	Climate change education through TV weathercasts: Results of a field experiment	4.9	2014	Zhao X., etal..
	Cooperative extension and climate change: Successful program delivery	3.0	2014	Morris H.L.C., etal.
C2	A Three-Tier Diagnostic Test to Assess Pre-Service Teachers' Misconceptions about Global Warming, Greenhouse Effect, Ozone Layer Depletion, and Acid Rain	10.5	2012	Arslan H.O., etal.
	Students' understanding of the greenhouse effect, the societal consequences of reducing CO2 emissions and the problem of ozone layer depletion	7.0	2000	Andersson B., Wallin A.
	Student teacher understanding of the greenhouse effect, Ozone Layer depletion and acid rain	4.4	1996	Dove J.
	An investigation of middle school students' alternative conceptions of global warming	4.3	1997	Rye J.A., etal.
	Models of students' thinking concerning the greenhouse effect and teaching implications	3.7	1999	Koulaidis V., Christidou V.
C3	Understanding behavior to understand behavior change: a literature review	20.7	2008	Heimlich J.E., Ardoin N.M.
	Land education: Indigenous, post-colonial, and decolonizing perspectives on place and environmental education research	18.1	2014	Tuck E., etal.
	On Learners and Learning in Environmental Education: Missing theories, ignored communities	3.4	2003	Dillon J.
	Schooling and environment in Latin America in the third millennium	1.9	2007	González-Gaudiano E.
	From environmental education to Education for Sustainable Development in Germany	1.4	2006	Bolscho D., Hauenschild K.
C4	Future-oriented higher education: Which key competencies should be fostered through university teaching and learning?	27.7	2012	Rieckmann M.
	Achieving transformative sustainability learning: Engaging head, hands and heart	24.0	2008	Sipos Y., Battisti B., Grimm K.
	Competencies in education for sustainable development: Exploring the student teachers' views	20.3	2015	Cebrián G., Junyent M.
	Learning outcomes for sustainable development in higher education	12.5	2008	Svanström M., etal.
	When sustainable development risks losing its meaning. Delimiting the concept with a comprehensive literature review and a conceptual model	11.4	2014	Bolis I., etal.