

Youth environmental sustainability education and practices at home: Longitudinal evidence from Namibia

Samantha Lindgren, Assistant Professor, University of Illinois Urbana-Champaign
(corresponding author)

salindgr@illinois.edu

1310 S. 6th Street
Champaign, IL 61820

Ghaida Alrawashdeh, Doctoral Student, University of Illinois Urbana-Champaign

Cecilia Vaughn-Guy, Doctoral Student, University of Illinois Urbana-Champaign

Viktoria Keding, Director, Namib Desert Environmental Education Trust

Abstract

Sustainability approaches to education are seen as holistic ways to empower communities and promote resiliency. A study was conducted to examine the outcomes of a short-term residential Education for Sustainable Development experience at a camp in the Namib Desert in Namibia. Twenty school groups of children in grades 5 and 6 attended the programming in 2019 and took a series of surveys. The surveys sought to understand the extent to which students retained place-based sustainable lifestyle behaviors after camp and six months later. Open-ended survey responses were analyzed using topic modeling and thematic coding. The two approaches to the data analysis revealed similar findings with different degrees of specificity. The topic modeling yielded patterns in the survey responses that informed the qualitative thematic analysis which provided context and deeper meaning. The findings show that participants identified actions such as recycling, conserving water, and using alternatives to charcoal and firewood as the most relevant behaviors after attending the educational programming and ones that they were able to implement in their own homes. Six months later, the participants reported a continuation of these behaviors, which suggests that this type of education is an important tool in sustaining our planet's resources and people.

Introduction

Education is seen as an essential tool in sustaining our planet's resources while developing the well-being of every human¹. As the international community adopted sustainable development through the Millennium and the Sustainable Development Goals (SDGs), Education for Sustainable Development (ESD) was launched to empower people to make changes to their own behaviors and take action on issues such as climate change, poverty reduction, biodiversity, and sustainable consumption². ESD focuses on a "holistic interdisciplinary perspective of content and pluralistic learner-centered democratic teaching strategies"³ underpinned by culture such that the quality of local and global life is improved on terms relevant to each place⁴. By definition then, ESD is realized and implemented differently in every instantiation.

¹ McKeown et al., *Education for Sustainable Development Toolkit*; Boeve-de Pauw et al., "The Effectiveness of Education for Sustainable Development."

² United Nations Education Scientific and Cultural Organization, "ESD - Building a Better, Fairer World for the 21st Century."

³ Boeve-de Pauw et al., "The Effectiveness of Education for Sustainable Development."

⁴ United Nations Educational Scientific and Cultural Organization, "Decade of Education for Sustainable Development."

The driest country south of the Sahara, Namibia is one of the most vulnerable countries to the impacts of climate change⁵. Since its independence from South Africa in 1990, Namibia has been committed to sustainability and conservation, and formalized these commitments to future generations in its constitution⁶. A global leader in mainstreaming ESD, Namibia is one of few countries with a national environmental education policy. This policy empowers Namibian people to “assume responsibility for creating and enjoying a sustainable future, and to act for positive environmental and social change,” and emphasizes the need for ESD to occur at all levels of education in both formal and informal settings⁷.

The SDGs mention youth as critical agents of change because of their potential for large scale action and impact⁸. The use of youth-oriented ESD, taken here to also encompass the related fields environmental education and education for sustainability, as an approach to improving sustainability or sustainability consciousness has been successful across a variety of contexts and settings⁹.

This study was undertaken at the Namib Desert Environmental Education Trust (NaDEET), a sustainability nongovernmental organization that operates an ESD camp in the heart of the Namib Desert in the Hardap Region of Namibia. NaDEET has been serving communities from across Namibia since 2003, especially those from the rural Hardap. The Hardap is one of the poorest regions in Namibia; a quarter of all dwellings are improvised, half of its residents burn solid fuels for their energy needs, and less than half have access to waste management services¹⁰. In response to Namibia’s unique social and environmental sustainability challenges, NaDEET Centre invites groups of schoolchildren to its camp to participate in a week-long program at its centre in the desert. The Centre’s program is loosely structured along four primary themes: energy, water, waste, and Namib Desert biodiversity. Since 2003, more than 10,000 school children have attended camp at NaDEET Centre.

At NaDEET Centre children learn to live within the Anthropocene. Pedagogically, NaDEET takes a culturally-relevant approach to the sustainability topics taught at the camp. Activities such as learning to cook on efficient biomass cookstoves and solar cookers are situated in Namibia’s issues of post-Apartheid energy justice. Other activities, including investigations of endemic species of the Namib Desert are meant to foster a more-than-human relational

⁵ Allen et al., “Technical Summary: Global Warming of 1.5° C. An IPCC Special Report on the Impacts of Global Warming of 1.5° C above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat”; Inman, Hobbs, and Tsvuura, “No Safety Net in the Face of Climate Change: The Case of Pastoralists in Kunene Region, Namibia”; Crawford and Terton, “Review of Current and Planned Adaptation Action in Namibia.”

⁶ Republic of Namibia, “Namibian Constitution.”

⁷ Republic of Namibia, “National Environmental Education and Education for Sustainable Development Policy.”

⁸ United Nations, “Transforming Our World: The 2030 Agenda for Sustainable Development.”

⁹ Boeve-de Pauw et al., “The Effectiveness of Education for Sustainable Development”; Ajiboye and Silo, “Enhancing Botswana Children’s Environmental Knowledge, Attitudes and Practices through the School Civic Clubs”; Kioko and Kiringe, “Youth’s Knowledge, Attitudes and Practices in Wildlife and Environmental Conservation in Maasailand, Kenya”; Okyere et al., “The Impacts of Household Water Quality Testing and Information on Safe Water Behaviors: Evidence from a Randomized Experiment in Ghana.”

¹⁰ Namibia Statistics Agency, “Namibia 2011 Population and Housing Census Main Report.”

ontology¹¹. All activities, from direct instruction to implicit environmental learning are social and experiential in nature, both of which have a long tradition in ESE efforts globally¹².

In 2019, twenty groups of secondary school-aged children visited NaDEET for a week-long immersion in the Namib Desert. The objective of this study was to measure the extent to which youth retained, and continued to engage in, sustainability practices and activities learned at NaDEET Centre. Because experiential learning has often been described as “learning by doing with reflection”¹³, a sustained period of time between learning activities and evaluation of their meaningfulness was observed.

Methods

All children from the 20 groups who attended NaDEET Center in 2019 ($n = 617$) were surveyed to answer the following research questions: Which sustainability practices did the participants find most meaningful during their experiential learning experience at NaDEET? To what extent did participants retain or continue to engage in these practices at home with their families six months later?

Participants were given a pre- and post-surveys as well as a follow-up survey six months after their attendance at NaDEET Centre. Questionnaires asked about water usage, energy practices, and waste management options available at the students' homes. The post- and follow-up surveys asked a series of open-ended questions to elicit the topics that resonated most or were implemented at home. We hypothesized that the social and experiential pedagogy central to NaDEET's philosophy would yield sustained engagement with the practices learned at NaDEET.

The pre-survey, intended as a baseline for the other surveys, asked just one open-ended question, *What do you do at home to save water?* At the time of data collection, Namibia was in a multi-year drought and water saving techniques (e.g., collecting water from showers) are commonplace. The post- and follow-up surveys' open-ended questions asked about the participants' experience at NaDEET Centre. This study focuses specifically on two questions, *List 3 things that you learned at NaDEET Centre* and *What did you learn at NaDEET that you are now doing at home?*

All surveys were couriered to the schools so that the children took the surveys outside of the NaDEET context to minimize social desirability bias. The pre-surveys were given two weeks or more before NaDEET attendance, and the post-surveys were given two weeks after leaving NaDEET Centre. This study was approved by the University of Illinois's Institutional Review Board as well as the Namibia Commission for Research, Science, and Technology and Hardap Ministry of Education.

Analysis and Findings

The open-ended questions were analyzed using two methods: topic modeling and thematic analysis. These methods allowed us to examine patterns in responses and changes over time and to develop a deeper understanding of what practices resonated most with participants.

¹¹ Taylor, “Beyond Stewardship: Common World Pedagogies for the Anthropocene.”

¹² Orr, *Earth In Mind: On Education, Environment and the Human Prospect*; McKeown et al., *Education for Sustainable Development Toolkit*; Sauv , “Currents in Environmental Education: Mapping a Complex and Evolving Pedagogical Field.”

¹³ Priest and Gass, *Effective Leadership in Adventure Programming*, 3E.

Specifically, topic modeling served as a starting point for exploring participants responses. Thematic analysis allowed us to refine and explain the topic models and develop a more detailed understanding of what practices resonated most with participants and were retained over time.

Topic Modeling. We conducted text mining to gain insight into whether participants' knowledge and attitudes towards energy and water consumption changed following participation in NADEET's program, and whether this knowledge was transferred into practices that were retained six months after the program ended. This is the process of extracting unknown information from unstructured text¹⁴. To transform the unstructured text into a format that may be analyzed, we applied a method in Natural Language Processing (NLP) called text pre-processing. In this process, tokenization, stemming, and lemmatization were used to break text into smaller units, and transform and reduce inflected words to their root form¹⁵. The pre-processing of the dataset was done using the R software program (version 4.0.2). To remove words that were too frequent or too infrequent, we used Term Frequency-Inverse Document Frequency¹⁶.

To identify the main topics in the dataset, we used a three-level hierarchical Bayesian mixture model called Latent Dirichlet Allocation (LDA) with Gensim implementation. This model creates topics by analyzing patterns of word co-occurrence in a given document¹⁷. The LDA model resulted in 537 documents that were pulled based on respondent ID for the three surveys, and 341 terms based on probable bigrams for the pre-survey data, 403 terms for the post-survey, and 271 terms for the follow-up survey with 99% sparsity¹⁸. LDA models require a fixed number of topics k ¹⁹. We estimated k with a cross-validation model fit and k was set to five. To validate the grouping of words into topics, we applied semantic validation²⁰.

A summary of the top five words of each topic arranged in descending order by their phi-value, and the goodness of model measured by R-squared (R^2) is shown in Table 1, along with two metrics for determining topic quality: coherence and prevalence. Coherence captures how associated words are in a topic after controlling for statistical independence, whereas prevalence is meant to reflect the frequency with which topics appear in the 537 documents. Table 1 also offers naïve topic labeling based on probable bigrams. Based on this analysis and the semantic validation, the following themes emerged for each survey:

1. (Pre-survey) Water saving practices. This theme relates to the practices participants reported to conserve water in their household prior to treatment, such as closing or fixing the water faucet, using a bottle or cup to collect water/ brush teeth, and showering with less water.
2. (Post-survey) Water, energy, and pollution reduction practices. This theme deals with practices participants reported learning to save water and energy after treatment, such

¹⁴ Kobayashi et al., "Text Mining in Organizational Research."

¹⁵ Daenekindt and Huisman, "Mapping the Scattered Field of Research on Higher Education: A Correlated Topic Model of 17,000 Articles."

¹⁶ Kim and Gil, "Research Paper Classification Systems Based on TF-IDF and LDA Schemes."

¹⁷ Blei, Ng, and Jordan, "Latent Dirichlet Allocation."

¹⁸ Alvarez-Melis and Saveski, *Topic Modeling in Twitter: Aggregating Tweets by Conversations*.

¹⁹ Zarrinkalam, Kahani, and Bagheri, "Mining User Interests over Active Topics on Social Networks."

²⁰ Asmussen and Møller, "Smart Literature Review: A Practical Topic Modelling Approach to Exploratory Literature Review."

as switching to solar cooking and reusing items. Participants also reported learning practices to reduce water, light, and air pollution.

3. (Follow-up survey) sustainable household practices. The theme addresses reported practices retained six months post-treatment that are related to sustainable living, such as using raw materials for fireballs, recycling and composting, as well as water saving practices reported before treatment, such as closing the faucet or using a bucket when washing clothes/dishes.

It bears noting that even after naïve labeling and semantic validation, the topic models remained conceptually vague, and their interpretation was highly context-dependent. Only by conducting manual thematic analysis could we gain insight into how the participants used the words reported in Table 1.

Table 1. The LDA topics ordered by coherence for each survey

Topic	Label	Coh	Prev	Top Terms				
Pre-Survey								
1	Making sure	0.41	4.05	make sure	tap	food	put water	bottle
2	Brushing teeth	0.41	6.81	close tap	brush teeth	cup	tap tightly	bucket tap
3	Leaving tap	0.39	4.45	leave tap	open	running	fix leak	bath water
4	Using less	0.33	4.39	use less	water	shorter	always keep	bath shower
5	Leaking tap	0.32	5.31	leak	broken	fix tap	collect	water
<i>R</i> ² : 0.45								
Post-Survey								
1	Saving	0.36	24.9	save water	save electricity	environment	energy	litter
2	Solar	0.28	21.4	water	solar cooker	use	animals	save
3	Stopping pollution	0.20	15.1	pollution	stop	water	air	light
4	Wasting water	0.16	18.5	water	waste	environment	clean	keep
5	Water & energy	0.12	20.1	saving	water	energy	reuse	reduce
<i>R</i> ² : 0.11								
Follow-up Survey								
1	Closing tap	0.41	4.94	close tap	use	wash	bucket	switch
2	Using less	0.33	5.91	use	less water	recycle	less electricity	compost
3	Saving	0.29	5.76	saving	water	electricity	clean environment	littering
4	Saving	0.27	8.30	saving	water	electricity	littering	fire balls
5	Saving	0.21	8.13	saving	water	electricity	energy	littering
<i>R</i> ² : 0.46								

Note. Coh= Coherence; Prev = Prevalence.

Thematic Analysis

Inductive qualitative analysis was implemented to help with deeper meaning making in the responses from participants. While it also had the overall goal of identifying patterns in the data, it also considered drawing meaning from the responses in consideration of the same with respect to culture of participants as well as the context of data gathered to make meaning of responses²¹.

A second goal of the inductive qualitative analysis was to consider responses over time. In this way, meaning making could take place; rather than simply looking at the qualitative results, story-telling is possible through the analysis and interpretation of open-ended responses²². Specifically, we could ask: How has the way participants talked about sustainability practices changed over time? How did NaDEET's programming impact participants' reported behaviors at home?

All data were entered into a spreadsheet and then imported into MAXQDA v2022 Analytics Pro to facilitate data analysis. The first round of coding was completed manually to create codes related to sustainable development goals and curriculum at NaDEET. Hierarchical codes were created, with a main, or umbrella code (e.g., energy) and then a more specific code (e.g., solar cooking) under the main umbrella topic. Topical areas were color-coded in the software, as were the different survey points to follow change over time (Figure 1). Memoing was completed throughout the data analysis process to allow for the researchers to keep track of evolving thoughts/themes that emerged through the data analysis process²³.

The findings from this analysis reveal that the water saving strategies participants reported on the pre-survey were maintained on later surveys, commensurate with the topic modeling results. On the post-survey, participants reported additional behaviors around topics of energy and waste, which may have implications related to household income. Participants also noted increased sensitivity to sustainability issues such as environmental pollution, including water, air, and light. As identified in the topic modeling, participants noted the usefulness of making recycled fireballs as an alternative to using charcoal or firewood in their cooking fires at home. The terms "recycling" and "reusing" were used in several ways in both post-survey results. On the pre-survey these terms were commonly used to describe water behaviors in the home. In the post-survey and six-month follow-up these terms were applied to other contexts and topics learned at NaDEET, specifically making recycled fireballs out of paper-based waste (aligned with NaDEET's energy and waste curricular goals) and in terms of household rubbish (waste).

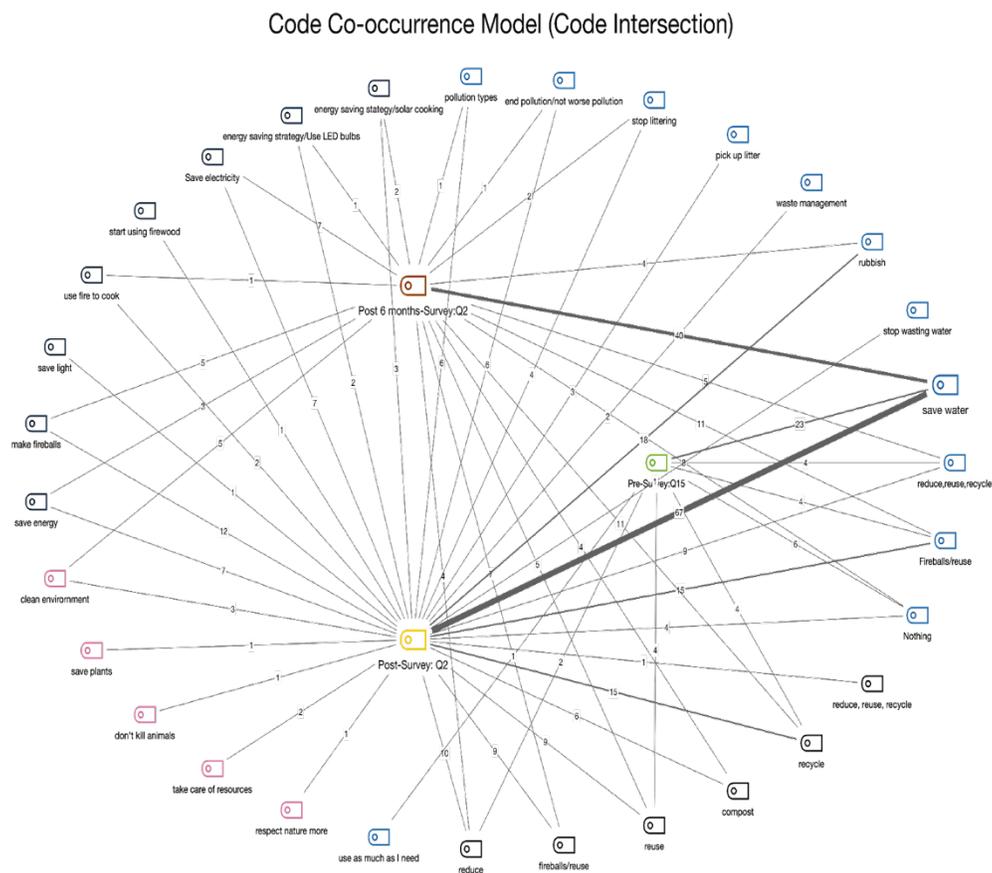
For the six-month follow-up surveys collected ($n = 209$), findings indicate that the practices students identified as meaningful and implementable in the post-survey continued to be practiced six months later. Specific topics retained included using raw materials to make fireballs, consistent recycling, and composting of organic material at home. Participants were also more invested in water saving practices and more willing to pick up litter in their home environments.

²¹ Anfara, Brown, and Mangione, "Qualitative Analysis on Stage: Making the Research Process More Public"; Glesne, *Becoming Qualitative Researchers: An Introduction*; Maxwell, *Qualitative Research Design: An Interactive Approach*.

²² Fielding, Fielding, and Hughes, "Opening up Open-Ended Survey Data Using Qualitative Software."

²³ Maxwell, *Qualitative Research Design: An Interactive Approach*.

Figure 1. Code Intersection for Qualitative Data Analysis



Limitations

The onset of the global COVID-19 pandemic disrupted the last round of data collection which prevents a full understanding of the programs impacts six-months later. Because of the scale of this study, a nationwide survey with vast geographical distances between schools, particularly in rural areas, the triangulation of data through direct observation was not possible. Therefore, survey results are based on self-reported responses. However, even if participants may not be practicing the behaviors at home, they are still reporting what they believe they should be reporting, which indicates they understand the sustainable behaviors taught at NaDEET, a primary objective of ESD.

Discussion

Through the application of automated and manual approaches to data analysis, this research has made two substantial practical contributions to the body of knowledge. The results demonstrate how an experiential learning opportunity that is place-based and culturally-relevant can afford young learners the opportunity to practice sustainable living suitable to their homes and communities. Specifically, the post-survey results indicate that the young participants learned practices to conserve water and energy, and that they were able to apply these practices within their homes. Further, participants reported sensitivity to environmental pollution,

including water, air, and light, and were attuned to their household's behaviors and contributions to each. These practices are directly related to the activities at NaDEET Centre that the participants reported as enjoyable or relevant. The follow-up survey revealed that some practices are retained six months later. The retention of these practices supports ESD as a tool for promoting community resiliency and planetary health.

The results also suggest that automated methods like topic modeling have the benefit of allowing large-scale exploratory analysis to be carried out quickly and effectively. While both approaches to data analysis yielded almost identical results, topic modeling proved to be a useful first-order analysis tool. It identified patterns in the dataset and suggested a group of words that represented themes more quickly and as effectively as manual coding. Qualitative Data analysis also offered deeper insights into the importance of place and cultural factors that might impact the adoption and implementation of strategies identified in the data, suggesting future opportunities for continued research.

The Development of topic models and the validation of results took a fraction of the time we spent on the traditionally hand-coded thematic analysis. Nonetheless, combining both approaches resulted in a more refined understanding of participants' responses that was informed by a greater insight into the context, and linguistic semantics.

References

- Ajiboye, Josiah O, and Nthalivi Silo. "Enhancing Botswana Children's Environmental Knowledge, Attitudes and Practices through the School Civic Clubs." *International Journal of Environmental & Science Education* 3, no. 3 (2008): 105–14.
- Allen, M, P Antwi-Agyei, F Aragon-Durand, M Babiker, P Bertoldi, M Bind, S Brown, et al. "Technical Summary: Global Warming of 1.5° C. An IPCC Special Report on the Impacts of Global Warming of 1.5° C above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat," 2019.
- Alvarez-Melis, D, and M Saveski. *Topic Modeling in Twitter: Aggregating Tweets by Conversations*, 2016.
- Anfara, V.A., K.M. Brown, and T.L. Mangione. "Qualitative Analysis on Stage: Making the Research Process More Public." *Educational Researcher* 31, no. 7 (2002): 28–38.
- Asmussen, C.B., and C Møller. "Smart Literature Review: A Practical Topic Modelling Approach to Exploratory Literature Review." *Journal of Big Data* 6, no. 1 (2019): 93.
- Blei, D.M., A.Y. Ng, and M.I. Jordan. "Latent Dirichlet Allocation." *Journal of Machine Learning Research* 3, no. Jan (2003): 993–1022.
- Boeve-de Pauw, J, N Gericke, D Olsson, and T Berglund. "The Effectiveness of Education for Sustainable Development." *Sustainability* 7, no. 11 (2015): 15693–717.
- Crawford, A, and A Terton. "Review of Current and Planned Adaptation Action in Namibia," 2016.
- Daenekindt, S, and J Huisman. "Mapping the Scattered Field of Research on Higher Education: A Correlated Topic Model of 17,000 Articles." *Higher Education* 80, no. 3 (2020): 571–87.
- Fielding, J, N Fielding, and G Hughes. "Opening up Open-Ended Survey Data Using Qualitative Software." *Quality & Quantity* 47, no. 6 (2013): 3261–76.
- Glesne, C. *Becoming Qualitative Researchers: An Introduction*. 5th ed. Boston, MA: Pearson, 2016.
- Inman, E.N., R.J. Hobbs, and Z Tsvuura. "No Safety Net in the Face of Climate Change: The Case of Pastoralists in Kunene Region, Namibia." *PLoS ONE* 15, no. 9 (2020): e0238982.
- Kim, S.W., and J.M. Gil. "Research Paper Classification Systems Based on TF-IDF and LDA

- Schemes." *Human-Centric Computing and Information Sciences* 9, no. 1 (2019): 1–21.
- Kioko, John, and JW Kiringe. "Youth's Knowledge, Attitudes and Practices in Wildlife and Environmental Conservation in Maasailand, Kenya." *Southern African Journal of Environmental Education* 27 (2010).
- Kobayashi, V.B., S.T. Mol, H.A. Berkers, G Kismihók, and D.N. Den Hartog. "Text Mining in Organizational Research." *Organizational Research Methods* 21, no. 3 (2018): 733–65.
- Maxwell, J.A. *Qualitative Research Design: An Interactive Approach*. Thousand Oaks, CA: Sage, 2012.
- McKeown, R, C.A. Hopkins, R Rizi, and M Chrystalbridge. *Education for Sustainable Development Toolkit*. Knoxville: Energy, Environment and Resources Center, University of Tennessee, 2002.
- Namibia Statistics Agency. "Namibia 2011 Population and Housing Census Main Report." Windhoek, Namibia., 2011. [http://www.nsa.org.na/files/downloads/Namibia 2011 Population and Housing Census Main Report.pdf](http://www.nsa.org.na/files/downloads/Namibia%2011%20Population%20and%20Housing%20Census%20Main%20Report.pdf).
- Okyere, Charles Yaw, Evita Hanie Pangaribowo, Felix Ankomah Asante, and Joachim von Braun. "The Impacts of Household Water Quality Testing and Information on Safe Water Behaviors: Evidence from a Randomized Experiment in Ghana." *SSRN Electronic Journal*, 2017. <https://doi.org/10.2139/ssrn.2955038>.
- Orr, David W. *Earth In Mind: On Education, Environment and the Human Prospect*. Washington, D.C.: Island Press, 1994.
- Priest, S, and M Gass. *Effective Leadership in Adventure Programming, 3E*, 2018.
- Republic of Namibia. "Namibian Constitution," 1990. https://laws.parliament.na/cms_documents/namibian-constitution-e77d13246a.pdf.
- Republic of Namibia. "National Environmental Education and Education for Sustainable Development Policy." Windhoek, Namibia, 2019.
- Sauvé, L. "Currents in Environmental Education: Mapping a Complex and Evolving Pedagogical Field." *Canadian Journal of Environmental Education* 10, no. 1 (2005): 11–37.
- Taylor, A. "Beyond Stewardship: Common World Pedagogies for the Anthropocene." In *Urban Nature and Childhoods*, 13–26. Routledge, 2020.
- United Nations. "Transforming Our World: The 2030 Agenda for Sustainable Development." *A New Era in Global Health*, 2015. <https://doi.org/10.1891/9780826190123.ap02>.
- United Nations Education Scientific and Cultural Organization. "ESD - Building a Better, Fairer World for the 21st Century," 2012. <https://unesdoc.unesco.org/ark:/48223/pf0000216673>.
- United Nations Educational Scientific and Cultural Organization. "Decade of Education for Sustainable Development," 2008. <http://unesdoc.unesco.org/images/0014/001486/148654e.pdf>.
- Zarrinkalam, F, M Kahani, and E Bagheri. "Mining User Interests over Active Topics on Social Networks." *Information Processing & Management* 54, no. 2 (2018): 339–57.