

A broader definition of cookstove stakeholder: The inclusion of youth and education in sustainable energy development

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

salindgr@illinois.edu

(217) 244 – 6477

College of Education

1310 S 6th Street

Champaign, IL 61820

Introduction

Nearly 3.1 billion people in low- and middle-income countries cook and heat their homes by burning solid fuels such as firewood, charcoal, or crop and animal waste.¹ The collection and subsequent combustion of these fuels indoors are responsible for economic,² environmental,³ and health burdens, including nearly 4 million premature deaths annually.⁴ Women and children are most impacted, both by loss of paid work and educational opportunities, as well as prolonged exposure at the hearth.⁵

These concerns have positioned *efficient cooking technologies*, taken here to include fuel efficient biomass combustion stoves, electric or LPG cookstoves, and solar cookers, as socio-technical solutions for reducing the negative health, economic, and environmental effects associated with indoor biomass combustion.⁶ Efficient, also called improved, cooking has long been of interest for its presence in multiple Sustainable Development Goals (SDGs) including Good Health and Well-Being, Affordable Clean Energy, Quality Education, Gender Equality, and Climate Action among others. And

¹ International Energy Agency, "Tracking SDG7: The Energy Progress Report 2018."

² Clancy et al., "Gender Equity in Access to and Benefits from Modern Energy and Improved Energy Technologies: World Development Report"; García-Frapolli et al., "Beyond Fuelwood Savings: Valuing the Economic Benefits of Introducing Improved Biomass Cookstoves in the Purépecha Region of Mexico"; Sovacool, "What Are We Doing Here? Analyzing Fifteen Years of Energy Scholarship and Proposing a Social Science Research Agenda."

³ Arnold, Kohlin, and Persson, *World Development*.; Hutton et al., *Evaluation of the Costs and Benefits of Household Energy and Health Interventions at Global and Regional Levels*; Bond et al., "Bounding the Role of Black Carbon in the Climate System: A Scientific Assessment."

⁴ Forouzanfar et al., "Global, Regional, and National Comparative Risk Assessment of 79 Behavioural, Environmental and Occupational, and Metabolic Risks or Clusters of Risks, 1990-2015: A Systematic Analysis for the Global Burden of Disease Study 2015"; CBD 2016 Risk Factors Collaborators, "Global, Regional, and National Comparative Risk Assessment of 84 Behavioural, Environmental and Occupational, and Metabolic Risks or Clusters of Risks, 1990-2016: A Systematic Analysis for the Global Burden of Disease Study 2016"; IEA et al., "Tracking SDG7: The Energy Progress Report 2018."

⁵ Masera et al., "Impact of Patsari Improved Cookstoves on Indoor Air Quality in Michoacán, Mexico"; Bonjour et al., "Solid Fuel Use for Household Cooking: Country and Regional Estimates for 1980–2010"; Listo, "Gender Myths in Energy Poverty Literature: A Critical Discourse Analysis"; Evans et al., "Evaluation of Behavior Change Communication Campaigns to Promote Modern Cookstove Purchase and Use in Lower Middle Income Countries"; Lewis et al., "Biogas Stoves Reduce Firewood Use, Household Air Pollution, and Hospital Visits in Odisha, India"; Kelly, "School Absenteeism in Karonga District, Northern Malawi: Trends, Influences and the Impact of Cleaner Burning Biomass-Fuelled Cookstoves."

⁶ Bazilian et al., "Partnerships for Access to Modern Cooking Fuels and Technologies"; Cordes, "Igniting Change: A Strategy for Universal Adoption of Clean Cookstoves and Fuels."; Ezzati and Kammen, "The Health Impacts of Exposure to Indoor Air Pollution from Solid Fuels in Developing Countries: Knowledge, Gaps, and Data Needs"; Masera, Díaz, and Berrueta, "From Cookstoves to Cooking Systems: The Integrated Program on Sustainable Household Energy Use in Mexico."

indeed, widespread uptake of an efficient cooking device does have the potential to contribute to progress of many SDGs simultaneously. However, adoption at scale of these cooking technologies continues to be unrealized.⁷

The challenges associated with sustained use of efficient cooking technologies vary with context and are well-documented.⁸ There are many strategies employed to advance adoption of these devices including, but not limited to, behavior change communication techniques, participatory design, and collaborations with trusted local organizations. Most efforts aimed at increasing rates of adoption, or sustained use, that address the user directly are focused on adult women. Unlike other sustainable and international development fields such as sanitation, nutrition, and sexual health,⁹ few cookstove programs include all household stakeholders, and rarely are youth, current and future users of cookstoves, purposefully engaged in diffusion efforts.¹⁰

The Sustainable Development Goals mention the importance of youth and their position as “critical agents of change,” for their potential to act on a large scale.¹¹ Improved, or efficient, cookstoves have been promoted by the cookstove and broader development community for nearly 40 years. In this time, an entire generation of cookstoves users have been born, raised, and are now making energy-related choices for their own households. And though the inclusion of youth in cookstove efforts has been raised periodically and indirectly, there are few studies that purposefully include children in cookstove implementation efforts.¹² Recently, there have been studies that have indicated that when children are included in the behavior change efforts aimed at their mothers, the uptake rate of the new cooking technology is high,¹³ and that energy transitions within the home require buy-in from all household members, including the children.¹⁴ However youth are often overlooked, not systematically engaged in most cookstove efforts until they are already adults with fully formed habits and attitudes.

⁷ Rosa et al., “Assessing the Impact of Water Filters and Improved Cook Stoves on Drinking Water Quality and Household Air Pollution: A Randomised Controlled Trial in Rwanda”; Shankar et al., “Maximizing the Benefits of Improved Cookstoves: Moving from Acquisition to Correct and Consistent Use.”

⁸ Jeuland and Pattanayak, “Benefits and Costs of Improved Cookstoves: Assessing the Implications of Variability in Health, Forest and Climate Impacts”; Malla and Timilsina, “Household Cooking Fuel Choice and Adoption of Improved Cookstoves in Developing Countries: A Review”; Miller and Mushfiq Mobarak, “Learning about New Technologies through Social Networks: Experimental Evidence on Nontraditional Stoves in Bangladesh”; Mobarak et al., “Low Demand for Nontraditional Cookstove Technologies”; Rehfuess et al., “Enablers and Barriers to Large-Scale Uptake of Improved Solid Fuel Stoves: A Systematic Review”; Shankar et al., “Maximizing the Benefits of Improved Cookstoves: Moving from Acquisition to Correct and Consistent Use.”

⁹ Bresee et al., “‘A Child Is Also a Teacher’: Exploring the Potential for Children as Change Agents in the Context of a School-Based WASH Intervention in Rural Eastern Zambia”; Kepha et al., “Plasmodium Falciparum Parasitaemia and Clinical Malaria among School Children Living in a High Transmission Setting in Western Kenya”; Mahanta et al., “Effect of Social and Behavior Change Communication by Using Infotainment in Community Perception of Adolescent Girls for Reproductive and Sexual Health Care in High Priority Districts of Assam”; Okyere et al., “The Impacts of Household Water Quality Testing and Information on Safe Water Behaviors: Evidence from a Randomized Experiment in Ghana.”

¹⁰ Lindgren, “Clean Cooking for All? A Critical Review of Behavior, Stakeholder Engagement, and Adoption for the Global Diffusion of Improved Cookstoves.”

¹¹ United Nations, “Transforming Our World: The 2030 Agenda for Sustainable Development.”

¹² Lindgren, “Clean Cooking for All? A Critical Review of Behavior, Stakeholder Engagement, and Adoption for the Global Diffusion of Improved Cookstoves.”

¹³ Toonen, “Adapting to an Innovation: Solar Cooking in the Urban Households of Ouagadougou (Burkina Faso).”

¹⁴ Kar and Zerriffi, “From Cookstove Acquisition to Cooking Transition: Framing the Behavioural Aspects of Cookstove Interventions.”

There is evidence that knowledge and attitudes gained in youth-oriented Education for Sustainable Development (ESD) programs can be “transferred between generations and indirectly induce targeted behavioural changes.”¹⁵ When trying to encourage changes in household attitudes and behaviors, it may be more effective to target the children than the parents¹⁶ because the attitudes and behaviors of youth are flexible. ESD, a United Nations policy and agenda aligned to the SDGs, may be one such way of educating and empowering youth to inspire changes in their communities. This study examines the role of youth-oriented ESD as a driver cooking-related energy attitudes and behavior changes in the home and across the community. Specifically, this study seeks to answer the question, *to what extent do households with children exposed to energy-specific ESD programming exhibit attitudes about cooking energy that are more sustainable than similar households without children?*

Methodology

Context

This study occurred in the spring of 2019 in the Hardap region of Namibia. The Hardap is one of Namibia’s poorest states, where less than half of the residents currently have access to the electric grid. Approximately half of all Hardap residents, and 90% of rural Hardap households, burn solid fuels, primarily firewood, for their household energy needs.¹⁷ The majority of rural Namibians cook indoors or in a semi-enclosed space, and more than half are affected by household air pollution.¹⁸ A combination of the state of infrastructure in rural areas as well as a depressed economy, makes cooking with electricity, an energy-intensive task, economically unavailable to many households.

The Namib Desert Environmental Education Trust (NaDEET) is a non-governmental organization dedicated to youth-oriented ESD. NaDEET has been hosting schools from the Hardap and across the country at their camp, NaDEET Centre, situated in the Hardap on the NamibRand Nature Reserve since 2003. School-aged students (Grades 5 - 12) spend four days learning sustainable lifestyle behaviors meant to alleviate the economic and health burdens associated with four main themes; access to clean and modern energy, improved water and sanitation, biodiversity and conservation, and responsible waste management. NaDEET, a recent awardee of the UNESCO-Japan prize, is one of few organizations on the African continent recognized by UNESCO as advancing ESD goals. Since it formed, NaDEET has hosted more than 300 school groups, and nearly 100 teacher and community development groups, at their camp.

As part of energy programming, youth participants prepare their own meals using efficient biomass cookstoves and solar cookers (Figure 1), neither of which are commonly found in the Hardap. Students also learn about the social, economic, and environmental disadvantages of firewood collection, a dwindling resource in the Hardap.¹⁹ This occurs through direct lessons that examine Namibia’s sustainability challenges as well as indirectly through games and activities, such as a relay race that simulates the disadvantages of those who must spend a significant portion of their day

¹⁵ Damerell, Howe, and Milner-Gulland, “Child-Orientated Environmental Education Influences Adult Knowledge and Household Behaviour.”

¹⁶ Robinson and Borzekowski, “Effects of the SMART Classroom Curriculum to Reduce Child and Family Screen Time.”

¹⁷ Namibia Statistics Agency, “Namibia 2011 Population and Housing Census Main Report.”

¹⁸ Global Alliance for Clean Cookstoves, “Country Profile: Namibia.”

¹⁹ Palmer and MacGregor, “Fuelwood Scarcity, Energy Substitution and Rural Livelihoods in Namibia.”

collecting firewood. Students learn about alternatives to firewood and charcoal while using solar cookers and efficient cookstoves, and while making recycled paper fireballs.



Figure 1. A pizza made by camp participants baking in a solar box cooker. Photo taken March 2019.

While solar cookers are used for lunch and dinner preparation at NaDEET Centre, the morning meal, typically *mielie pap*, a maize porridge, and hot water for coffee and tea is prepared over fuel efficient stoves. School groups make recycled fireballs for use in these stoves as an alternative to firewood. All used paper is saved at NaDEET for this purpose, simultaneously teaching children how to decrease fuelwood consumption and eliminate paper-based rubbish, which often becomes litter due to few municipal waste management programs nationally. Paper is soaked in water, children shred the wet paper into small bits, and then press handfuls together to form a tight ball (see Figure 2). Each fireball is then dried on a rack for one week. Fireballs made during the previous session are used in the stoves during the children's camp visit. Approximately ten fireballs are needed to heat a pot of water using a commercially available efficient cookstove. NaDEET knows of no other organization in Namibia that makes recycled fireballs or a similar product.



Figure 2. Student at NaDEET Centre pressing shredded paper into a recycled fireball. Photo taken March 2019.

Survey

A stratified survey of 200 households in two rural towns in the Hardap region of Namibia was conducted in the spring of 2019. Two demographically-similar communities were selected, one with a history of sending school groups to NaDEET Centre, and a second

community, serving as a control group, with no such association. The treatment town, the one with a history of engagement with NaDEET, has sent at least one school group to the camp in 9 of the last 10 years. The two towns are equidistant from NaDEET Centre on NamibRand Nature Reserve, but are not close to each other. Vehicle ownership in both towns is low, and there is no specific pattern of migration between the two communities.

One hundred households in each community were surveyed. All interviews were carried out by two Namibian research assistants, a female interviewer and a male interpreter. Interviews were audio recorded, with participant consent, and later transcribed and translated into English if they were conducted in Afrikaans or Nama/Damara, a local language. This study was approved by the University of Illinois at Urbana-Champaign's Institutional Review Board and by the Republic of Namibia's National Commission of Research, Science, and Technology.

In the treatment town, a third of the households had at least one family member who had previously experienced NaDEET's programming. These households were asked a series of questions about that experience including which family member(s) participated and in what year(s), and what was remembered about their time at the Centre. The responses were either firsthand memories from an adult who had attended NaDEET Centre as a student, or were memories of conversations parents and other guardians had with younger family members upon their return from the Centre.

At the end of the interview, all participants were asked a series of questions from two knowledge and attitude instruments. A short questionnaire developed for assessing women's perceptions and knowledge about solar cookers in Mali was used.²⁰ Consisting of ten 5-point Likert scale items, this instrument was used to assess knowledge and general attitudes about solar cooking. Minor adjustments were made to the instrument to replace references to Mali, the location of the instrument development, with Namibia.

The second instrument, the short, four-question version of the Global Warming's Six Americas Survey, the SASSY, was used to assess a participant's perceptions about global warming risks, expected harm to future generations, and how important the respondent found these issues.²¹ These four questions were asked at the very end of the survey as to not introduce bias into earlier questions, including those regarding solar cooking or NaDEET Centre experience.

Results

Several key variables were measured to ensure that the control town was indeed an appropriate control for the treatment town. Independent samples t-tests and two proportion test of means were used to determine that there were no significant differences across a range of variables including household size, appropriate number of years of schooling based on the child's age, average adult educational level, local language spoken, as shown in Table 1.

²⁰ AO Mercy, CO Asinobi, and I Yemi, "Attitudes of Rural and Urban Women in Bamako District and Koulikoro Region of Mali to the Use of a Solar Cooker," in *24th Annual Meeting of the Association for International Agricultural and Extension Education*, 2008, 15–27.

²¹ Chryst et al., "Global Warming's 'Six Americas Short Survey': Audience Segmentation of Climate Change Views Using a Four Question Instrument."

	Treatment	Control	t(198)	p
Total household size	5.88	5.34	1.35	.177
Number of children in household	2.67	2.55	0.39	.695
Average adult education	7.49	8.20	1.90	.059
Children have appropriate level of education	0.90	0.88	0.46	.645
Female Head of Household	0.45	0.58	1.85†	.066
Age of Respondent	43.6	46.7	1.27	.204
Female Respondent	0.87	0.94	1.69†	.092
Afrikaans Speaker	0.87	0.79	1.51†	.133

Table 1. Demographic comparisons of treatment and control towns using *t*-tests and two proportion test of means.

† Indicates *z*-scores from a two proportion test of means due to the dichotomous nature of these variables.

More households in the treatment town had access to electricity (97%) as compared to households in the control town (81%), however, electricity use (hours used per day) overall is significantly higher in the control town, as measured by an independent samples *t*-test $t(168) = 3.38, p = .009$, with a medium effect size as defined by Cohen (1988), $d = 0.52$. A key difference between the two towns, and one that helps explain the discrepancy in electricity access and usage, is overall socioeconomic status (SES). Initially observed as a visual assessment in the communities, a variable was created as a proxy for SES. Five variables, including percentage of households in the community that are *informal*, or improvised or temporary, presence of an *indoor tap*, primary cooking fuel is *not firewood*, ownership of a *television*, and ownership of an *electric stove*, were selected as indicators of higher SES for the types of amenities and conveniences they afford households. These variables had adequate internal consistency, as measured by Cronbach's alpha, $\alpha = 0.71$. An unrotated factor test was also performed, which produced one eigenvalue over 1.0 accounting for 95% of the variance with all items loading at 0.5 or higher.

An independent samples *t*-test comparing the two towns reveals that households in the control town have a higher mean SES ($M = 3.47, SD = 1.34$) than those in the treatment town ($M = 2.10, SD = 1.79$), $t(198) = 6.13, p < .001$, with a large effect size, Cohen's $d = 0.87$, confirming visual observations. Specifically examining households with children in both communities, parents in the control town again has a significantly higher SES ($M = 3.13, SD = 1.57$) than those in the treatment town ($M = 2.17, SD = 1.47$), $t(160) = 4.00, p < .001$, Cohen's $d = 0.63$. There is not a significant SES difference in households with children who have had NaDEET Centre experience and those who have not in the treatment town, $t(75) = 0.81, p = .418$.

Similarly, there is not a significant difference between children having the appropriate numbers of education for their age between the two towns, $t(131) = 0.46, p = .645$, or between those with and without NaDEET Centre experience in the treatment town, $t(63) = 0.47, p = .640$. NaDEET subsidizes schools who are unable to pay for their attendance through grants and fund-raising, making this opportunity available to all schools, even the most economically under-resourced. School attendance is not based on neighborhood proximity but by family choice, further decoupling SES and NaDEET opportunity. In the last ten years, all four of the primary schools in the treatment town have attended NaDEET Centre at least once.

Treatment Town Participation at NaDEET Centre

Of the 100 households in the treatment town, 34 had at least one family member who had attended NaDEET Centre in the past. Of these, 21 respondents were mothers or other adult female relative with guardianship responsibilities of a past NaDEET Centre participant, including four grandmothers and one aunt. No fathers or other adult male relatives were interviewed. From this point forward, “parent” will refer to any of these guardians, and “children” will refer to the former NaDEET Centre participants whether they are the respondent’s biological child or a child relative.

Recall of Activities or Topics

During the beginning of the survey when household demographics were being collected, parents were asked if their child(ren) had attended NaDEET Centre and if so, to recall what their children had done while at the camp. The majority of parents, 81% ($n = 17$) were able to recall at least one topic. The average length of time since the child’s participation for these parents who was 3.82 years ($SD = 3.30$), and 4.5 years ($SD = 3.51$) for parents who could not recall any specifics ($n = 4$). Of these four parents, one woman expressed sentiments such as “my son tells me nothing,” to explain why she was unaware of what her son did the previous year at NaDEET Centre. The other three parents’ children had attended NaDEET an average of 5.67 years ($SD = 3.21$) in the past.

The parents of former NaDEET participants listed 29 specific topics or activities that their child engaged in, or 1.71 topics per parent. Half ($n = 15$) of all responses were related to energy, while the other 14 topics spanned NaDEET’s other focus areas of biodiversity conservation, water, and waste. Ten of the 15 energy responses were focused specifically on their child’s experiences preparing meals ($n = 1$), solar cooking ($n = 5$), and making recycled fireballs ($n = 4$).

Solar Cooking Attitude Inventory

The average score of all ten Likert-type questions on the solar energy and cooking attitude inventory was used as respondents’ final score on this instrument. Parents of former NaDEET participants, including those who could not recall what their child had done while at NaDEET, scored higher ($M = 4.28$, $SD = 0.35$) than the other parents/guardians in the treatment town ($M = 3.83$, $SD = 0.69$) as indicated by a t-test, $t(76) = 2.78$, $p = .007$, with a medium effect size, Cohen’s $d = 0.72$. This difference persists when compared to all other parents across both communities, $t(163) = 3.04$, $p = .003$, Cohen’s $d = 0.71$.

SASSY

The average score of the four Likert-type questions regarding concern about climate change was used as the respondents’ final scores on this instrument. There is not a significant difference between parents who had a child attend NaDEET Centre, whether or not they recalled specific programming topics, and other parents in the treatment town as measured by an independent samples t-test, $t(76) = 0.40$, $p = .689$. The same is true when comparing NaDEET parents to all parents across both towns, $t(163) = 0.61$, $p = .542$.

Discussion

This study sought to determine if children influence energy-related knowledge or attitudes in the home as a result of their own education at a non-formal ESD camp. Data collected in two rural communities provide support for the view that learning within a household is *bi-directional*, that is, that parents learn from their children in addition to the commonly held belief that children learn from their parents. Support for this idea comes from two primary sources. The first is that majority of respondents that were parents of former NaDEET Centre participants could name specific activities, or topics, in which their child was engaged while attending NaDEET's programming, despite the average length of time since the child's attendance being nearly 4 years. The second is that there are significant differences in knowledge and attitudes about solar energy used for cooking, but not the environment in general, that demonstrate a transfer of knowledge between children and parents.

Having established that children do share their educational experience at NaDEET Centre with their parents, it was necessary to determine whether and how this experience influenced the household. The data collected from respondents regarding their energy-related knowledge, attitudes, and behaviors points to NaDEET programming's impact on adult non-participants within the household.

For instance, on an inventory of solar energy and cooking knowledge and attitudes, parents of past NaDEET participants, whether or not they were able to recall specifics about their child's experience at NaDEET Centre, scored significantly higher than parents of children with no such experience, indicating an openness to, or favorable views of, solar cooking. Not a single parent of a past NaDEET Centre participants reported practicing solar cooking or owning a solar cooker, further suggesting that their views of the practice is not based on their personal experiences but on information learned from their children.

One might expect that an understanding, or a more favorable view, of solar cooking to be correlated with higher attitudes about the environment in general or with higher adult education levels, variables are often correlated with each other. However, this is not found to be the case. Parents of past NaDEET Centre participants scored significantly higher than parents in the control town whose socioeconomic status is significantly higher and who are slightly more educated (Figure 1). Within the treatment town, there is not a significant difference between parents of past NaDEET participants and other parents' educational levels or concern about global warming, as shown by an analysis of SASSY scores above. Residents in both communities live in a desert and are experiencing the effects of a severe drought. Climate change is not a politicized topic in Namibia, and reducing the vulnerability of poor rural communities to the negative consequences of climate change and improving communities' adaptive capacity is a priority in Namibia, and included in their constitution.²²

Taken together, this then suggests the presence of an external source of information influencing parents' views about solar energy and solar cooking, specifically children's exposure to NaDEET's ESD programming. Viewed with a wider lens, this study highlights the ways that youth-oriented ESD, as part of a behavior change framework for international energy development projects, might lead to intergenerational shifts in

²² Republic of Namibia, "Namibian Constitution"; Republic of Namibia, "National Policy on Climate Change for Namibia."

attitudes about sustainable cooking energy, and may complement efforts aimed at adults.

This is not to suggest that educational institutions, whether schools or informal institutions such as camps, should be co-opted for marketing innovations directly to youth. Rather, educational contexts that implement ESD curriculum and principles that promote behaviors and attitudes are already aligned with the goals of the cookstove sector and energy development community, and may be strong local partners. Establishing and developing relationships with educational institutions strengthen the community and the project by preparing the next generation of household energy users to use healthier and more efficient means of cooking, thereby supporting the project's desired outcomes, without waiting until they are adults.

Limitations

Both towns were systematically sampled in an effort to achieve a representative sample of each community, however it is possible that groups of households were missed due to the random walk method employed during sampling or interviewer errors. Households may have been unobserved from the primary residential areas, especially if part of an informal settlements outside of the neighborhood centers.

Two Namibian research assistants conducted the household interviews to minimize social desirability bias, but given that the assistants were in each community for several weeks, it is possible that some respondents, especially those interviewed later in the process, knew who the research assistants were and which organizations they represented before being interviewed.

Lastly, the evidence presented points to NaDEET's impact at the household and community level, however there is no way confirm that observed differences are entirely attributed to NaDEET, and not other factors that remained uncovered during the interview protocols and time spent in these communities. This may also be compounded by the fact that the researcher and her research assistants were outsiders to the communities. Nuance in responses may not have been detected due to a lack of understanding of cultural context, shared experience, and interpretation.

Conclusion

This study highlights the importance of broadening the definition of stakeholder in the cookstove and energy development sector to include children. Households with children who were past participants of energy-themed ESD programming were more receptive to, and had more favorable views of, solar cooking and solar energy. This study also recommends youth-oriented ESD as a framework for shifting intergenerational attitudes and behaviors, by positioning children as agents of change within their own homes. Partnerships with local ESD providers has the potential to strengthen the community by investing in its youth, as well as advancing the desired outcomes of the project by complementing the efforts aimed at adults.

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