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Sustainability Education For Namibian Youth to Advance Efficient Cookstoves And Energy Development

Samantha Lindgren[1]

[1] Assistant Professor, University of Illinois, Urbana-Champaign, Champaign, IL 61820, United States

Abstract

Efficient cooking has long been of interest for its presence in multiple Sustainable Development Goals (SDGs) including Good Health and Well-Being, Affordable and Clean Energy, Quality Education, Gender Equality, and Climate Action among others. Widespread uptake of an efficient cooking device, such as an "improved" biomass or LPG cookstove, has the potential to contribute to progress on many simultaneous fronts. However, unlike other sustainable development and public health initiatives, few cookstove programs include all household stakeholders, and rarely are youth, the future and current users of cookstoves, purposefully engaged in diffusion efforts. The results of a 2019 stratified survey of 200 households in two rural towns, one serving as a control group, in the Hardap region of Namibia indicate that youth-oriented Education for Sustainable Development (ESD) programming may be an effective means of inspiring changes in energy-related attitudes and behaviors in the home and across the community. Households with children who were past participants of an ESD program in the Namib Desert demonstrated an awareness of, and an openness to, solar energy as an alternative to biomass. This study highlights the importance of broadening the definition of stakeholder in the cookstove and energy development sector to include children, and points to youth-oriented ESD as a potential framework for shifting attitudes and behaviors, generationally at home and across the community.

Keywords

Education for Sustainable Development, Energy, Cookstove, Youth, Stakeholder, Sustainable Energy Transition, Technology Adoption

Introduction

Nearly 2.9 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 (International Energy Agency et al., 2020). The collection and subsequent combustion of these fuels indoors are responsible for economic (Clancy et al., 2012; García-Frapolli et al., 2010; Sovacool, 2014), environmental (Arnold et al., 2006; Bond et al., 2013; Hutton et al., 2006), and health burdens, including nearly 2 million premature deaths annually (Forouzanfar et al., 2016; GBD 2019 Risk Factors Collaborators, 2020; IEA et al., 2018). Women and children are most impacted, both by loss of paid work and educational opportunities, as well as prolonged exposure at the hearth (Bonjour et al., 2013; Evans et al., 2018; Kelly, 2018; Lewis et al., 2016; Listo, 2018; Masera et al., 2007).

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 (Bazilian et al., 2011; Cordes, 2011; Ezzati & Kammen, 2002; Masera et al., 2005). 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 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 (Rosa et al., 2014; Shankar et al., 2014).

The challenges associated with sustained use of efficient cooking technologies vary with context and are well-documented (e.g., Jeuland & Pattanayak, 2012; Malla & Timilsina, 2014; Miller & Mushfiq Mobarak, 2015; Mobarak et al., 2012; Rehfuess et al., 2014; Shankar et al., 2014). 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 (Bresee et al., 2016; Kepha et al., 2016; Mahanta et al., 2016; Okyere et al., 2017), few cookstove programs include all household stakeholders, and rarely are youth, current and future users of cookstoves, purposefully engaged in diffusion efforts (Lindgren, 2020).

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 (United Nations, 2015). 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 (Lindgren, 2020). 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 (Toonen, 2009), and that energy transitions within the home require buy-in from all household members, including children (Kar & Zerriffi, 2018). However, youth are often overlooked and not systematically engaged in most cookstove efforts until they are already adults with fully formed habits and attitudes.

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" (Damerell et al., 2013). Further, using ESD or other sustainability education approaches in other public health and international development fields have shown to be successful in promoting healthier behaviors across a range of topics and settings across the globe including household sustainability practices like recycling and energy savings, improved sanitation, agricultural innovations, and disease prevention among others (e.g., Ajiboye & Silo, 2008; Conley & Udry, 2010; Kioko & Kiringe, 2010; Maruyama et al., 2013; Puffer et al., 2016).

Thus, when trying to encourage changes in household attitudes and behaviors, it may be more effective to target the children than the parents (Robinson & Borzekowski, 2006) 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 change within their communities. This study examines the role of youth-oriented ESD as a driver of cooking-related energy attitudes 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?

Background Information

This study occurred in the spring of 2019 in the Hardap region of Namibia. The Hardap is one of Namibia's poorest provinces, where less than half of residents currently have access to the electric grid. Consequently, half of all Hardap residents, and 90% of rural households, burn solid fuels, primarily firewood, for their household energy needs (Namibia Statistics Agency, 2011). The majority of rural Namibians cook indoors or in a semi-enclosed space, and more than half are affected by household air pollution (Global Alliance for Clean Cookstoves, 2017). 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 school groups 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 along 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 concerns of firewood collection, a dwindling resource in the Hardap (Palmer & MacGregor, 2009). 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 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 (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.

Methodology

I. 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, but are not close to each other. Similarly, the two communities are equidistant from the region's largest town, and therefore have similar access to markets. The control town is somewhat closer to the interstate than the treatment town, which may make hitchhiking somewhat easier than from the treatment town. Vehicle ownership is low in both communities.

One hundred households in each community were surveyed, sampling occurred via random walk. 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 (n = 34) 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 or 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 (Mercy et al., 2008). Consisting of ten 5-point Likert scale items, this instrument was used to assess knowledge and general attitudes about solar energy and 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 (Chryst et al., 2018). 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.

	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 proportions test of means. † Indicates z-scores from a two proportions 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 *not informal*, 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 have 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 $d = 0.63$, despite similar rates and types of employment across both towns. Within the treatment town, there is not a significant SES difference in households with children who had NaDEET Centre experience and those who have not, $t(75) = 0.81$, $p = .418$.

Similarly, there is not a significant difference between children having the appropriate years 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.

I. 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 relatives 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.

II. 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 on their child's experiences preparing meals (n = 1), solar cooking (n = 5), and making recycled fireballs (n = 4). The other 5 energy responses were similarly specific, recalling details about the Centre's solar panels and tips learned for conserving energy.

III. 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 either communities, $t(163) = 3.04$, $p = .003$, Cohen's $d = 0.71$.

IV. SASSY

The final score on this instrument was compared for the same groups of parents in both towns. There was 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 in 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 at home nor ownership of such a device, further suggesting that their views of the practice is not based on their personal experiences but rather 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 often correlated with each other. However, this is not 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 (Table 1). Within the treatment town, there is no 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 in the previous section. 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, but a lived reality. Reducing the vulnerability of poor rural communities to the negative consequences of climate change and improving communities' adaptive capacity and resiliency is a priority, and included in the Namibian constitution (Republic of Namibia, 1990, 2011).

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 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 organizations that implement ESD curriculum and principles promote behaviors and attitudes that 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 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 settlement 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, however there is no way confirm that observed differences are entirely attributed to NaDEET and not to other factors that remained uncovered during the interview protocol 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 the inclusion of children as stakeholders in the cookstove and energy development sector through sustainability education. Households with children who were past participants of energy-themed Education for Sustainable Development (ESD) programming, the United Nation's education agenda to support the Sustainable Development Goals (SDGs), were more receptive to, and had more favorable views of, solar cooking and solar energy than households without children in the same community and in the control group. Given that solar cooking is not practiced in either community, and that solar PV systems were not observed, this indicates that the students' learning about such practices had been shared with adult family members and influenced their opinions.

The use of youth-focused ESD as a framework for advancing sustainability within the home is not a new concept, and has in fact enjoyed success across topics and global contexts. Yet its use in household energy research and practice, particularly those that focus on residential solid fuel use, remains largely unexplored.

This study recommends future research evaluating youth-oriented ESD as a framework for shifting intergenerational sustainability attitudes and behaviors, by positioning children as agents of change within their own homes. Specifically, partnerships between energy development projects and local ESD providers need to be fostered in an effort to reinforce the complementary aims of both. For instance, an ESD provider may teach children about energy savings in the home while an efficient cookstove project distributes new stoves to families as a way to make salient energy conservation practices advocated for by the educational programming. In this way, these partnerships have the potential to strengthen their own messaging and behaviors, in the service of the SDGs. Moreover, it is an example of a community investing in its youth, that is supported by an energy initiative, rather than the reverse. Educational organizations and energy development projects that reinforce each other in this way have the potential for the desired outcomes of each to be amplified through the inclusion of youth.

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